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"LET KNOWLEDGE GROW FROM MORE TO MORE
AND THUS BE HUMAN LIFE ENRICHED."

A New Survey of Universal Knowledge

ENCYCLOPÆDIA BRITANNICA

Volume 5

CARTHUSIANS *TO* COCKCROFT

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CARTHUSIANS *TO* COCKCROFT

CARTHUSIANS (ORDO CARTUSIENSIS), an order of eremitical monks, were founded by St. Bruno (*q.v.*), a native of Cologne and a celebrated master of the cathedral school of Reims, who retired with six companions in 1084 to lead a hermit's life in the mountain valley of Chartreuse, north of Grenoble in France. Summoned to Rome in 1090 by his former pupil Odo, now Pope Urban II, Bruno declined all preferment and two years later obtained permission to retire to southern Italy, where he founded a second colony of hermits at La Torre (Calabria). Bruno's plantation resembled many of that age, which either became extinct or reverted to a more normal form of the monastic life, as did Savigny and Cîteaux. The Chartreuse endured partly because of a succession of monks with strong vocations, partly because of the excellent judgment of Prior Guigo I who compiled a directory from the customs of the house (approved in 1133 by Innocent II), and partly because of the skill with which Guigo and his successors adapted to their own requirements the constitutional machinery of the Cistercians. The Carthusians thus became a religious order, with a system of visitation and legislative general chapters. That they should have survived throughout the centuries, neither needing nor experiencing reform, may be ascribed partly to the wise blending of cenobitic and eremitical elements in their life, but perhaps still more to their prudent strictness in testing recruits and to the absolute fidelity, amounting at times to an apparent rigidity, with which they have retained their way of life unchanged even in the varying conditions of the social life of the times.

The Carthusians spread slowly, but at the Reformation they had more than 200 houses in every country of Catholic Europe, and they were the spiritual influence behind much that was best in the 15th and early 16th centuries. In England there were nine Charterhouses (as the word Chartreuse was anglicized) in the middle ages, including Mount Grace (Yorkshire), of which extensive fragments remain, and the London (Smithfield) house, celebrated for its heroic resistance to the royal supremacy in religion claimed by Henry VIII. Some survivors of the English province lived to refound their life in the Netherlands, where they continued till suppressed in 1793. The northern European houses disappeared at the Reformation, but there was revival in the 17th century, especially in France and Spain, which were always recruiting grounds of the order. They suffered greatly under the emperor Joseph II and the French Revolution, but another revival followed, though the French Carthusians were exiled for a second time from the Grande Chartreuse in 1903, to return in 1940. The Carthusians returned to England from France in 1883, when they built a large monastery at Parkminster (Sussex), and in 1951 a foundation was made at Whitingham, Vt., in the United States.

In the early 1960s there were about 25 Charterhouses in the world. The order is governed by a general, the prior of the Grande Chartreuse, elected by the monks of his house; and by a general chapter that meets annually.

The Carthusians have always shunned publicity, and their saints have in general remained hidden in the cloister. St. Hugh, prior of the first English Charterhouse at Witham (Somerset), owed his canonization to his later activity as bishop of Lincoln (d. 1200). Among mystical writers Denis the Carthusian (d. 1471) and Iustus Lanspergius (d. 1535) are well known.

The Carthusian lives in a small house or "cell" with a workroom, oratory, bedroom and miniature garden; the houses surround three sides of the great cloister, the fourth being occupied by the church, chapter house and the cells of prior and procurator. The refectory, library, quarters of the lay brothers and guesthouse lie between the great cloister and the main gateway, the whole complex being surrounded with a wall (*see* MONASTERY: *Carthusians*). The monks study, pray, work, sleep and eat in their cells, repairing to the church only for the night office, vespers and the conventual and private mass, at which they have a rite of their own. They eat together only on Sundays and great feasts, when they also have a period of conversation. Their food is prepared by the lay brothers and delivered to a serving hatch in each cell; they wear a hair shirt and practice total abstinence from flesh meat, and on Fridays and other fast days they take only bread and water. The monks have two short periods of sleep, broken by the long night office, which is recited very slowly. They wear a white habit, scapular and hood, and in choir a white cowl. The lay brethren live in community; originally housed at a distance from the monastery, they still have a separate chapel and refectory, and work in the garden or farm and at crafts of various kinds. At the Grande Chartreuse, as the motherhouse is known, the lay brothers distil the liqueur that bears the name of the motherhouse and of which the profits are distributed to neighbouring religious causes and charities (*see* Chartreuse; Chartreuse, La Grande).

Carthusian nuns, with a few monasteries in France and Italy, and under the direction of the order, also are strictly enclosed and contemplative. Their rule is very similar to that of the monks, and the habit is also very similar except for a black veil and linen wimple.

The Carthusian vocation, with its solitude and silence and long hours of vocal prayer, has always been recognized as the hardest of accomplishment in the Roman Catholic Church, demanding unusual qualities of physical and psychological endurance. In consequence, members of other orders may, if they can satisfy its demands, transfer themselves to a Charterhouse. In practice many attempt the life but few persevere.

See M. Heimbucher, *Orden und Kongregationen,* vol. i, pp. 376–391 (1933–34); E. M. Thompson, *The Carthusian Order in England* (1930). (M. D. K.)

CARTIER, SIR GEORGES ÉTIENNE, Bart. (1814–1873), Canadian statesman and leading advocate of railway construction who played a leading part in the achievement of close political co-operation between French-speaking and English-speaking Canadians, was born in Lower Canada on Sept. 6, 1814. He was called to the bar in 1835, but after taking part in the rebellion of 1837 he was forced to spend several months in the U.S. as an exile. In 1848 he was elected to the Canadian legislative assembly and in 1857 he became leader of the Lower Canadian section in the Macdonald-Cartier administration. He was premier in the Cartier-Macdonald ministry of 1858–62. His alliance with Sir John Macdonald was a principal factor in the development of the Liberal-Conservative party of Canada. He promoted the abolition of seigneurial tenure in Lower Canada and the codification of the civil law of that province. His energy and optimism were largely responsible for the completion of the Grand Trunk railway and the resolve to build the Canadian Pacific. In the face of great opposition he led the movement that carried French Canada into federation (1864–67). He was knighted in 1868. He was minister of militia and defense in the first Macdonald administration after confederation. Defeated at the general election of 1872, another seat was found for him, but he died on May 20, 1873.

See biographies by Alfred D. Decelles (1904); J. Boyd (1914); B. Sulte (1919). (D. C. C. M.)

CARTIER, JACQUES (1491–1557), French navigator who discovered the St. Lawrence river, was born at St. Malo, Brittany, in 1491. Commissioned by the French king, Francis I, to look for a northwest passage to the east, he left St. Malo in 1534 in command of an expedition consisting of two ships and 61 men. On reaching Newfoundland he entered the Strait of Belle Isle, and by following the south side of the strait was led down almost the whole west coast of Newfoundland. Off St. George's bay a storm drove the ships out into the gulf. He mistook Magdalen and Prince Edward islands for the main shore on the south side of this great gulf. Following the coast of New Brunswick northward he was greatly disappointed to discover that Chaleur bay was not a strait. During a ten days' stay in Gaspé harbour Cartier made friends with a tribe of Huron-Iroquois Indians from Quebec, two of whom he carried off with him. On discovering the passage between the island of Anticosti and the Quebec shore it was decided to postpone the exploration of this strait until the following year. Heading eastward along the Quebec shore, Cartier soon regained the Strait of Belle Isle and reached St. Malo on Sept. 5.

Cartier set sail again from St. Malo with three vessels on May 19, 1535, and, passing through the Strait of Belle Isle, anchored on Aug. 9 in Pillage bay, opposite Anticosti, which he named the Bay of St. Lawrence, a name which spread to the gulf and the river. Proceeding through the passage north of Anticosti, Cartier anchored on Sept. 1 at the mouth of the Saguenay, which the two Indians informed him was the name of a kingdom "rich and wealthy in precious stones." Again on reaching the island of Orleans they told Cartier he was now in the kingdom of Canada, in reality the Huron-Iroquois word for village. Leaving his two larger vessels in the St. Charles, which there enters the St. Lawrence, Cartier set off westward with the bark and the longboats. The bark grounded in St. Peter lake but the longboats reached the Huron-Iroquois village of Hochelaga, where Montreal now stands, on Oct. 2. Further progress was checked by the Lachine rapids. On his return to the St. Charles, where during the winter 25 men died of scurvy, Cartier sought further information about the kingdom of Saguenay, which he was informed could be reached more easily by way of the Ottawa. In order to give Francis I authentic information of this mythical northern Mexico, Cartier seized the chief and 11 of the headmen of the village and carried them off to France. This time he passed south of Anticosti and, entering the Atlantic through Cabot strait, reached St. Malo on July 16, 1536.

In the spring of 1541 Cartier set sail with five vessels and took up quarters at Cap Rouge, 9 mi. above Quebec. The seigneur de Roberval had been chosen to command; but when he did not arrive, Cartier made a fresh examination of the rapids of Lachine, preparatory to sending the men up the Ottawa river. Roberval at length set sail in April 1542, but on reaching St. John's, Nfd., met Cartier on his way back to France. The "precious stones" Cartier brought with him were found to be almost worthless, and for the time being French authorities lost interest in Canada; Roberval was recalled in 1543. Cartier died at St. Malo, on Sept. 1, 1557.

For further explorations in Canada *see* Canada: *History.*

CARTILAGE, a specialized, dense connective tissue, forms most of the temporary skeleton of the mammalian embryo and the entire permanent skeleton of sharks and related fishes (*see* Chondrichthyes). Cartilage provides models in which most bones develop and contributes an essential part to their growth mechanism. It persists in adult mammals at the joint surfaces, in the respiratory passages and in the ears, and in the anterior portions of the ribs.

The most widespread and most characteristic form of cartilage is described as hyaline, because of its glassy, translucent appearance. Its cells are chondrocytes, and they are found in spaces called lacunae in the intercellular substance, where they may be present singly or in groups or nests (*see* fig. 1). Except for the bare surfaces of cartilage in joint cavities, cartilage is covered externally by a firm layer of dense connective tissue, the perichondrium.

The characteristics of cartilage, responsible for its function as a supporting tissue, are given to it by its interstitial substance. This has a dense network of collagen fibres, embedded in the form of a very firm gel, three-fourths of the weight of which is water. This structure gives to cartilage the consistency of a plastic and a considerable tensile strength, and enables it to bear weight while retaining a certain degree of elasticity.

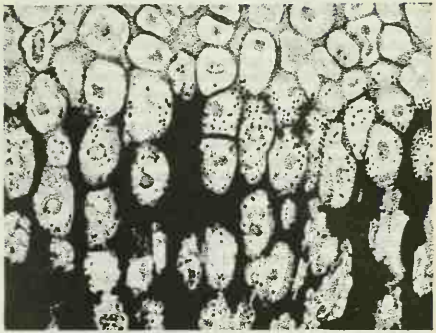
Cartilage has an important part in the formation of the body skeleton and in the continuation of its growth up to maturity. In the embryo most of the bones are preformed as cartilage models. These models are invaded by ingrowths of vascular connective tissue, leading to the formation of ossification centres. The vascular tissue erodes and removes the cartilage cells, this being accompanied by calcification of the cartilage matrix in advance of the disappearance of the cells. The next stage is deposition of bone on the remaining spicules of calcified cartilage, with the cavities within the bone being filled with bone marrow. Not all of the cartilage from the model is removed. A thin plate, the epiphyseal cartilage, remains at the junction of the epiphysis of the bone with its shaft. Within this plate, proliferation of cartilage cells continues throughout the period of growth; this proliferation occurs near the epiphyseal surface of the cartilage plate and results in the formation of rows or columns of cartilage cells. At the opposite face of the plate, invasion of the rows of cells by vascular connective tissue continues, resembling the invasion of the cartilage model, the cartilage cells being replaced by bone.

As the vascular tissue penetrates the rows of cartilage cells, the cells first become enlarged or hypertrophied and then disintegrate and disappear. At the same time the fibrous connective tissue that separates the columns of cells becomes calcified (*see* fig. 2), and this calcified matrix is then enveloped in layers of new bone.

The net result of the activity in and near the epiphyseal cartilage is that the plate remains at a constant thickness, while the shaft of the bone increases in length. The cartilage plate, with its adjacent tissues, has been called the growth apparatus. At the end of the growth period, at different ages in different bones, the growth apparatus disappears, and growth in length is no longer possible. At this time, except in certain locations, as in the sternal portions of the ribs, cartilage disappears from the bony structures, leaving only a thin layer at the joint surfaces. Here it provides a smooth surface, lubricated by the joint fluid (synovial fluid), which makes it possible for the bones to carry the weight of the body, while moving easily and smoothly against one another at the joints.

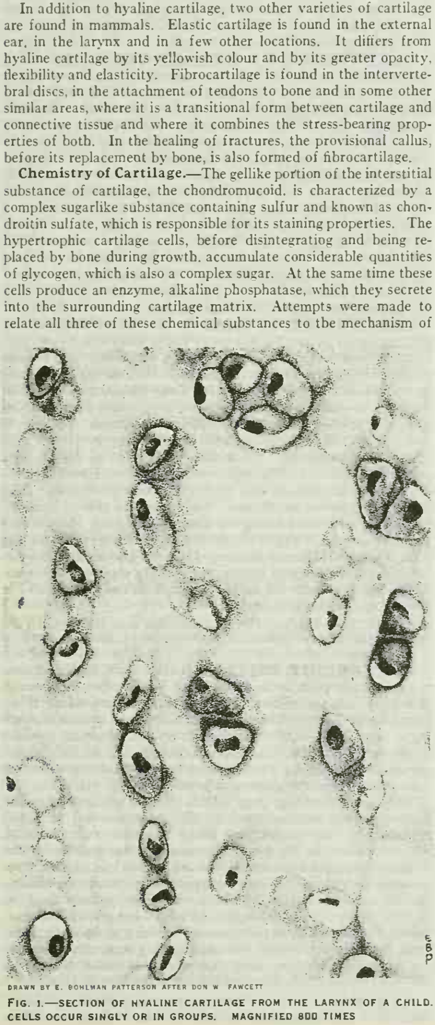
In addition to hyaline cartilage, two other varieties of cartilage are found in mammals. Elastic cartilage is found in the external ear, in the larynx and in a few other locations. It differs from hyaline cartilage by its yellowish colour and by its greater opacity, flexibility and elasticity. Fibrocartilage is found in the intervertebral discs, in the attachment of tendons to bone and in some other similar areas, where it is a transitional form between cartilage and connective tissue and where it combines the stress-bearing properties of both. In the healing of fractures, the provisional callus, before its replacement by bone, is also formed of fibrocartilage.

Chemistry of Cartilage.—The gellike portion of the interstitial substance of cartilage, the chondromucoid, is characterized by a complex sugarlike substance containing sulfur and known as chondroitin sulfate, which is responsible for its staining properties. The hypertrophic cartilage cells, before disintegrating and being replaced by bone during growth, accumulate considerable quantities of glycogen, which is also a complex sugar. At the same time these cells produce an enzyme, alkaline phosphatase, which they secrete into the surrounding cartilage matrix. Attempts were made to relate all three of these chemical substances to the mechanism of the calcification of cartilage matrix during its transformation into bone; as of the early 1960s these attempts had not met with success. *See* Bone; Connective and Supporting Tissue; Joints and Ligaments; Skeleton, Vertebrate; *see* also references under "Cartilage" in the Index volume.



DRAWN BY E. BOHLMAN PATTERSON AFTER MC LEAN AND BLOOM

FIG. 2.—LONGITUDINAL SECTION THROUGH EPIPHYSEAL CARTILAGE OF THE TIBIA OF A NORMAL RAT, SHOWING CALCIFICATION OF CARTILAGE MATRIX IN GROWTH OF LONG BONE. COLUMNS OF CARTILAGE CELLS ARE SHOWN AT THE TOP; BLACK AREAS ALONG THE BOTTOM ILLUSTRATE CALCIFIED MATRIX; STAINED WITH SILVER NITRATE. MAGNIFIED 260 TIMES



DRAWN BY E. BOHLMAN PATTERSON AFTER DON W. FAWCETT

FIG. 1.—SECTION OF HYALINE CARTILAGE FROM THE LARYNX OF A CHILD. CELLS OCCUR SINGLY OR IN GROUPS. MAGNIFIED 800 TIMES

See A. A. Maximow and W. Bloom, *Textbook of Histology*, 7th ed. (1957). (F. C. McL.)

CARTIMANDUA (1st century A.D.), client-queen of the tribe Brigantes (*q.v.*), a people of northern Britain. Tacitus first mentions her as delivering Caractacus (*q.v.*) to Rome in A.D. 51. In A.D. 57 she was supported in civil strife with her consort Venutius by Roman forces, who had before quelled Brigantian disturbances in A.D. 48. In A.D. 69 she repudiated Venutius for Vellocatus, his armour-bearer, thereby losing Brigantian support and provoking Venutius to war with external help. Roman troops rescued her with difficulty and she disappears from history thereafter; the Brigantes were defeated and their country annexed by Petillius Cerealis in A.D. 71. Silver coins assigned to Cartimandua are known.

See I. A. Richmond, *Journal of Roman Studies*, vol. xliv, pp. 43–52 (1954). (I. A. Rd.)

CARTOGRAPHY is the science and art of making maps and charts. *See* Map; Atlas.

CARTOON, originally a full-sized drawing or painting used as a model for a fresco painting, mosaic, tapestry, etc. (*see* Fresco Painting: *Technique;* Stained Glass: *Technique;* Tapestry: *Technique*). A common modern meaning of cartoon is a single or multipanel satirical or humorous drawing, usually for reproduction in newspapers or periodicals (*see* Caricature and Cartoon). For animated cartoons, *see* Motion Pictures: *Animated Cartoons.*

CARTOUCHE, a term applied in architecture to ornamentation in scroll form, especially to the elaborate, scrolled frames around tablets or coats of arms; by extension, the word is applied to any oval shape, or even to a decorative shield, whether scrolled or not. It is also used for the oval frame enclosing the hieroglyphs of the name of an Egyptian royal personage, and also for the amulet of similar shape, worn in ancient Egypt as a protection against the loss of one's name, *i.e.*, personality.

CARTWRIGHT, EDMUND (1743–1823), English inventor of the power loom, younger brother of Maj. John Cartwright, was born at Marnham, Nottinghamshire, on April 24, 1743, and educated at Wakefield grammar school and Oxford university. In 1779 he became rector of Goadby Marwood, Leicestershire, and in 1786 a prebendary in the cathedral of Lincoln. He would probably have passed an obscure life as a country clergyman had not his attention been accidentally turned in 1784 to the possibility of applying machinery to cotton weaving. He invented a power loom, for which he took out a patent in 1785; it was a rude contrivance, though it was improved by subsequent patents in 1786 and 1787, and gradually developed into the modern power loom. Removing to Doncaster in 1785, he soon started a weaving and spinning factory, but in 1793 he had to surrender it to his creditors. A mill at Manchester, in which a number of his machines were installed, was willfully destroyed by fire in 1792. In 1789 he patented a wool-combing machine, for which he took out further patents in 1790 and 1792; it effected large economies in the cost of manufacture, but its financial results were not more satisfactory to its inventor than those of the power loom, even though in 1801 parliament extended the patent for 14 years. In 1807 a memorial was presented to the government urging the benefits that had been conferred on the country by the power loom, and the house of commons voted him £10,000 in 1809. He then purchased a small farm at Hollander, near Sevenoaks, Kent, where he spent many years of his life. He died at Hastings, Sussex, on Oct. 30, 1823. Other inventions of Cartwright's included a cordelier or machine for making rope (1792) and a steam engine working with alcohol instead of water (1797), together with various agricultural implements.

See *A Memoir of . . . Edmund Cartwright*, published anonymously (1843).

CARTWRIGHT, JOHN (1740–1824), English pamphleteer who devoted his life to promoting a radical reform of parliament, was descended from an old Nottinghamshire family and was born on Sept. 17, 1740. He was educated at Newark and in Yorkshire, subsequently entering the navy and serving under Lord Howe during the Seven Years' War. Ill health caused him to retire shortly before the revolt of the American colonies, whose cause he was one of the earliest to support. Three times he tried unsuccessfully to enter the house of commons. In conducting his agitation for parliamentary reform he employed the methods of propaganda which the antislave-trade party had employed, but, on the short view, he was less successful than they, because the country was less prepared for sweeping constitutional change than it had been for ending the slave trade. In a long series of dull and repetitive pamphlets published between 1776 and 1824, he argued his case and helped to found the Society for Constitutional Information (1780) and the London Union society and the Hampden clubs (1812). Most of his proposals were later embodied in the People's Charter, and he was therefore a connecting link between the followers of John Wilkes and the Chartists (*see* CHARTISM). Unlike the radicals of the school of Tom Paine he had no wish to abolish either the monarchy or the house of lords, and at times would have contented himself with household instead of universal manhood suffrage; and he favoured a stiff property qualification for M.P.'s. He opposed a standing army and favoured a national militia on the same grounds that he supported parliamentary reform: "A free parliament and a national militia were the real characteristics of our Constitution and the safeguards of our rights." His aim was to restore the constitution to what he erroneously believed to be its pristine democratic character. In 1819 he was charged with others with conspiring to elect a person to be the parliamentary representative of the unrepresented town of Birmingham, and, being found guilty, was sentenced in June 1821 to pay a fine of £100, his age saving him from imprisonment. He died in London on Sept. 23, 1824. (A. AL.)

CARTWRIGHT, PETER (1785–1872), Methodist circuit rider of the American frontier, was born on Sept. 1, 1785, in Amherst county, Va. His father, a veteran of the Revolutionary War, took his family to Kentucky in 1790. There Cartwright had little opportunity for schooling, but was exposed to the rude surroundings of the frontier, becoming a gambler at cards and horse racing. This came to an abrupt end when he was converted during the great western revival in 1801. He was received into the Methodist Episcopal Church in June, and in less than a year was licensed as an exhorter. In the autumn of 1802 he was commissioned to form a new circuit of preaching points in an unchurched wilderness around the mouth of the Cumberland river. In 1806 he was ordained deacon by Bishop Francis Asbury, and in 1808 he was ordained elder by Bishop William McKendree, under whose guidance he had done some studying. In the latter year he married Frances Gaines. An able and vigorous speaker, Cartwright preached thousands of times in his more than 60 years as frontier minister. He faced many difficult situations with courage, at times relying on his great physical strength. A forceful debater, he defended Methodism and vehemently denounced all other denominations. Though he was no abolitionist, he hated slavery; to be on free soil, he moved to Sangamon county, Ill., in 1824. He entered politics to oppose slavery, and was several times elected to the lower house of the Illinois general assembly. Cartwright recounted his colourful life in a famous *Autobiography* (1856), which has been often reprinted. He died near Pleasant Plains, Ill., Sept. 25, 1872. (R. T. H.)

CARTWRIGHT, SIR RICHARD JOHN (1835–1912), Canadian statesman noted for his vigorous attacks on tariff protection and his advocacy of free trade with the U.S., was born at Kingston, Upper Canada, on Dec. 4, 1835, the son of an Anglican clergyman. In 1863 Cartwright entered the Canadian parliament as a Conservative but in 1869 he quarrelled with his leader, Sir John A. Macdonald, joined the Liberals and from 1873 to 1878 he was finance minister in the Liberal government of Alexander Mackenzie. From 1879 to 1896 he was chief financial spokesman for the Liberal opposition, and when Wilfrid Laurier acceded to power in 1896 Cartwright became minister of trade and commerce. In 1898–99 he represented Canada on the Anglo-American joint high commission. In 1904 he retired to the senate, but retained his portfolio in the Laurier ministry. He was acting prime minister briefly in 1907 and in 1909–11 government leader in the senate. He died on Sept. 24, 1912, at Kingston, Ont. (W. R. GR.)

CARTWRIGHT, THOMAS (*c.* 1535–1603), English Puritan and leader of the Puritan party under Elizabeth I, was educated at Clare hall and St. John's college, Cambridge, and became a convinced Protestant. On the accession of Elizabeth he returned to the university to become in 1569 Lady Margaret professor of divinity. A year later he was deprived of the chair because of his criticisms of the Church of England as unscriptural. The last 30 years of his life were spent partly abroad—for several years he ministered at Antwerp—but mainly in England as master of a hospital at Warwick. The post was exempt from episcopal jurisdiction, but this did not save Cartwright from prosecution; from 1590 to 1592 he was imprisoned. Besides writing biblical commentaries, he used his learning in attacking Richard Hooker and Archbishop John Whitgift and defending the Presbyterian leaders John Field and Thomas Wilcox. He helped to initiate Presbyterianism in the Channel Islands and strongly opposed the Brownists or Independents. He died at Warwick on Dec. 27, 1603. For portrait *see* PRESBYTERIANISM.

See A. F. Scott Pearson, *Thomas Cartwright and Elizabethan Puritanism* (1925); *Cartwrightiana*, ed. by A. Peel and L. H. Carlson (1951). (G. F. N.)

CARTWRIGHT, WILLIAM (1611–1643), English dramatist and minor poet in the tradition of Ben Jonson, was born at Northway, Gloucestershire, in Sept. 1611. Educated at Westminster school and at Christ Church, Oxford, he became, according to Anthony à Wood, "the most florid and seraphical preacher in the university," and also reader in metaphysic. In 1642 he was named one of Charles I's council of war at Oxford and became junior proctor of the university in the following year. He died at Oxford on Nov. 29, 1643. As a scholar, wit and dramatist, Cartwright was much admired by his contemporaries; John Fell thought him "the utmost man could come to," and Charles I, who wore black on the day of Cartwright's funeral, declared that "since the muses had so much mourned for the loss of such a son it would be a shame . . . not to appear in mourning for the loss of such a subject." His plays were written before he took orders in 1638, and are fantastic in plot and stilted and artificial in treatment; *The Ordinary* (1635?) contains amusing satire of the Puritans, but does not justify its contemporary reputation.

Cartwright's *Comedies, Tragi-Comedies, With Other Poems* were published in 1651; G. B. Evans' edition has a critical study (1940).

CARÚPANO is a Caribbean seaport in Sucre state, Venez., situated on the Paria peninsula, 100 mi. N.E. of Barcelona. Pop.

(1961) 37,268. Apart from shipping, trading and fishing, it manufactures straw hats and other fibre products, lumber, pottery, soap and rum. There are petroleum fields to the south in the adjacent state of Monagas, but the oil is moved by pipeline eastward to Caripito or northward to Puerto La Cruz. The city is served by highways from the west, east and south, and has an airport. Salt is produced nearby. (L. We.)

CARUS (Marcus Aurelius Carus) (d. A.D. 283), Roman emperor 282–283, was probably either a Gaul or an Illyrian. Like his predecessors, he adopted the names Marcus Aurelius as part of his imperial titulature, but probably shared his son's family name Numerius. Prefect of the guard to the emperor Probus, he succeeded him as emperor late in 282, in Illyria. He sent his elder son Carinus to the army of the Rhine, and after a brief Danube campaign, led his army into Persia, where he penetrated more deeply than most Roman commanders, reaching the lands beyond the Tigris. There he died suddenly and mysteriously, allegedly struck by lightning, in the summer of 283. He was succeeded by his sons Numerian and Carinus. (Jn. R. M.)

CARUSO, ENRICO (1873–1921), the most admired Italian operatic tenor of the 20th century, and the first singer whose qualities can be confirmed by posterity through the phonograph, whose value he was the first leading musician to recognize. Caruso was born in Naples, Feb. 25, 1873. His debut there in 1894 was modest; but four years later he achieved fame, in Milan, in what was to be his most celebrated part, Rodolfo in Puccini's *La Bohème*. In that year he sang Loris in the premiere of Umberto Giordano's *Fedora;* he was to create the chief tenor roles in Francesco Cilea's *Adriana Lecouvreur* and Alberto Franchetti's *Germania*, as well as in Puccini's *Fanciulla del West*. Puccini caused ill-feeling by denying him the similar privilege in his *Tosca* (1900), and shortly afterward Caruso made a point of including an aria from it in his first recording. His voice was a strong, easy and intensely appealing lyric tenor, unusually rich in lower registers, thrilling in high *tessitura*, and abounding in warmth of feeling, vitality and smoothness. In 1902 he made his London debut at Covent Garden and the next year appeared at the Metropolitan opera house, New York, where he remained chiefly active. In his later years the voice became darker, larger, but also harder. His repertory embraced most of the major French and Italian tenor roles (including Verdi's Radames but not his Otello), as well as Italian ballad songs in profusion. He made a second reputation as a brilliant lightning caricaturist. He died of pleurisy in Naples on Aug. 2, 1921.

See D. P. B. Caruso, *Enrico Caruso, his Life and Death* (1945). (Wi. S. M.)

CARVAJAL, ANTONIO FERNANDEZ (*c.* 1590–1659), a Portuguese Marrano or Crypto-Jew, who went to England in the reign of Charles I. He rendered considerable services to the Commonwealth by his extensive trade with the West Indies and was also politically useful to Oliver Cromwell, as he acted as intelligencer. When Manasseh ben Israel (*q.v.*) in 1655 petitioned for the return of the Jews, who had been expelled by Edward I, Carvajal took part in the agitation and boldly avowed his Judaism. Becoming the first endenizened Jew in England, he may be termed the founder of the Anglo-Jewish community.

CARVAJAL Y MENDOZA, LUISA DE (1568–1614), Spanish missionary in England, was born at Jaraicejo in Estremadura on Jan. 3, 1568. Moved by the execution of the Jesuit Henry Walpole in 1596, she decided to devote herself to the cause of the faith in England. With her share of the family fortune, she founded a college for English Jesuits at Louvain, Belg., which was transferred to Watten near St. Omer in 1612 and lasted till the suppression of the order. In 1605 she arrived in England and established herself under the protection of the Spanish ambassador. From his house she carried on an active and successful propaganda. She made herself conspicuous by her attentions to the Gunpowder plot prisoners, and won converts, partly by persuasion, partly by assisting the poor. She was arrested in 1608, but the protection of the Spanish ambassador and the desire of King James I to stand well with Spain secured her release. She died Jan. 2, 1614.

See L. Muñoz, *La Vida y Virtudes de la Venerable Virgen Doña Luisa de Carvajal y Mendoza* (1632), summarized by Southey in his *Letters From Spain and Portugal* (1808).

CARVER, GEORGE WASHINGTON (*c.* 1864–1943), U.S. Negro chemurgist and agricultural experimenter, devoted his life to agricultural research for the betterment of the south and his people. He was born about 1864, of slave parentage, near Diamond Grove, Mo. Eager for education, he worked his way through school. In 1894 he received his B.S. from Iowa State college, Ames. He worked there as a botanist until he received his M.S. in 1896, when he went to Tuskegee institute in Alabama. Persuading southern farmers to diversify their crops by planting soil-enriching peanuts and sweet potatoes instead of soil-exhausting cotton, Carver next solved the problem of finding uses for these crops, which had become overabundant as foodstuffs. From the peanut he made cheese, milk, coffee, flour, ink, dyes, soap, wood stains and insulating board, to list but a few of his 300 products. From the sweet potato came flour, vinegar, molasses, rubber, etc. Years before plastics from wood wastes were first attempted, he was making synthetic marble from wood shavings. In 1940 he donated his savings of $33,000 to establish the Carver foundation to carry on his research. In 1923 he was awarded the Spingarn medal; in 1939 the Roosevelt medal. He died at Tuskegee, Ala., on Jan. 5, 1943. For portrait *see* Negro, American.

CARVER, JONATHAN (1710–1780), early American explorer and author of a popular travel book, was born in Weymouth, Mass., April 13, 1710. After serving in the French and Indian War he joined the company of Maj. Robert Rogers to explore the great northwestern territories. Rogers sent him by the Fox-Wisconsin route to the Mississippi and up that river to the Falls of St. Anthony to visit the Sioux tribes. He spent the winter of 1766–67 at one of their villages on the Minnesota river. In the spring he started to return to Mackinac, but at the mouth of the Wisconsin river he met Capt. James Tute, in command of a party sent out by Rogers to explore a route to the Pacific ocean. Tute brought orders for Carver to join the party as draftsman and third in command. They proceeded up the Mississippi and crossed to and skirted the shores of Lake Superior to the Grand Portage. There they waited for supplies from Rogers, but his failure to send them caused Tute to abandon his expedition and return by the north shore of Lake Superior to the fort, where he arrived in Aug. 1768. Rogers had exceeded his powers in employing these agents, and Carver was never paid. After nine years of misfortune and poverty his book, *Travels Through the Interior Parts of North America in the Years 1766, 1767, 1768*, was printed in London (1778). Its success was immediate, but this came too late to bring the author any material benefit. He died in London on Jan. 31, 1780, a broken old man, 69 years of age, and was buried in the potter's field. No narrative of early adventure and travel in America has ever approached the popularity of this work. At least 32 editions in English, French, German and Dutch were printed. The second part, dealing with the life and customs of the Indians, is largely plagiarized from earlier French writers, but this does not warrant discrediting the whole. Carver's original journals are in the British museum and substantiate the main facts of the first part of his book. Careful comparison leads to the conclusion that the book was written from memory. Besides the minor inaccuracies, the book is guilty of deliberate falsification when it denies Rogers credit for initiating the expedition and conceals the fact that Tute commanded it. (O. W. H.; X.)

CARVER, ROBERT (b. 1487), outstanding Scottish composer of the 16th century, was born in 1487. His only extant works, five masses and two motets, including one for 19 voices, are to be found in a large choir book compiled in the first half of the 16th century at Scone abbey, Perthshire, and now in the National Library of Scotland. The book also contains works by Robert Fayrfax and Guillaume Dufay. From information in this volume it appears that Carver took orders at the age of 16 and remained at the Augustinian abbey until at least 1546; after that date no more is known of him. In style his compositions, which were prepared for publication by Denis Stevens (American Institute of Musicology, 1959 *et seq.*), are similar to those of the rather earlier Eton choir book. (J. J. N.)

CARY, ALICE (1820–1871) and **PHOEBE** (1824–1871), U.S. poets, were born near Cincinnati, O., on April 26, 1820, and Sept. 4, 1824. The sisters' education was largely self-acquired, and their work in literature was always done in unbroken companionship. Their poems were first collected in a volume entitled *Poems of Alice and Phoebe Cary* (1850). Alice, who was much the more voluminous writer of the two, wrote prose sketches, novels and poems, the best of which treat the surroundings and friends of her girlhood. Her lyrical poem, "Pictures of Memory," was praised by Edgar Allan Poe. Phoebe published two volumes of poems (1854 and 1868), but is best known as the author of the hymn "Nearer Home," beginning "One sweetly solemn thought." Alice died in New York city, on Feb. 12, 1871, and Phoebe in Newport, R.I., on July 31, 1871.

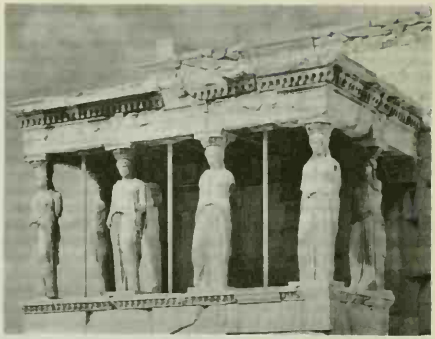
CARY, HENRY FRANCIS (1772–1844), English translator of Dante, was born at Gibraltar on Dec. 6, 1772, and educated at Christ Church, Oxford. In 1796 he took orders; he was later assistant-librarian in the British museum. He died in London on Aug. 14, 1844. His *Lives of English Poets* and *Early French Poets* were published in 1846. His translation of *The Birds* by Aristophanes appeared in 1824 and his *Pindar in English Verse* in 1833, but he is best remembered for *The Inferno* (1805–06) and *The Vision, or Hell, Purgatory, and Paradise of Dante* (1814). Although Cary's blank verse hardly reproduces the strength of Dante's *terza rima*, his translation retains some of the vividness of the original and has great merit.

CARY, (ARTHUR) JOYCE (LUNEL) (1888–1957), English novelist of remarkable individuality, whose theme was that "we live in an everlasting battle, an everlasting creation," and whose diverse characters have a common creative energy and joy in creating. Born at Londonderry, N.Ire., Dec. 7, 1888, of an old Anglo-Irish family, he was educated at Clifton college, Edinburgh art school and Trinity college, Oxford. He served with the British Red Cross in the Montenegrin army in the Balkan War of 1912–13 and, having joined the colonial service in Nigeria (1914), in the Nigeria regiment in World War I until 1917, when he became a district officer. He returned to England in 1920, settling at Oxford, and devoted himself to writing until his death there on March 29, 1957.

He published nothing until *Aissa Saved* (1932), not having found an idea of life that satisfied him as a basis for his work until then. His first seven novels (1932–41) have primitives as their central characters—Nigerians, Irish peasants and children; the last of these, *A House of Children* (1941), is based on his own childhood. Of his nine later novels, which portray life in 20th-century England, his first trilogy—*Herself Surprised* (1941), *To Be a Pilgrim* (1942) and *The Horse's Mouth* (1944)—is concerned largely with art, and the second trilogy—*Prisoner of Grace* (1952), *Except the Lord* (1953) and *Not Honour More* (1955)—with politics. He planned a third trilogy, on religion, but, afflicted with muscular atrophy, realized he would not live to complete it and so treated the theme in a single novel, *The Captive and the Free* (published posthumously in 1959). The trilogies are Cary's most impressive achievements; each volume is narrated by one of the three protagonists, thus giving a self-portrait and "mirror-image" portraits of the other two protagonists. This enabled him to add a dimension to his characterization, to give variety of range to his settings and to illuminate the central theme from many angles.

See W. Allen, *Joyce Cary* (1953); A. Wright, *Joyce Cary* (1958).
(W. D.)

CARYATID, a draped female figure employed instead of a column as an architectural support. Vitruvius in *De Architectura* (book i) related that caryatids represented women of Caryae, doomed to hard labour because the town sided with the Persians in 480 B.C. (a historical impossibility). Their origin may be traced back to mirror handles, ivory (nude) in Phoenicia and bronze (draped) in archaic Greece. In marble architecture they first appeared in pairs in three small buildings (treasuries) at Delphi (550–530 B.C.). A type (of which the missing original must date from about 460 B.C.) was copied in Roman times at Tralles in Asia Minor and Cherchel in North Africa, with variants elsewhere. The most celebrated instance is the caryatid porch of the Erechtheum (*q.v.*) with six such figures (420–415 B.C.). They were directly copied, in alternation with columns, in Hadrian's villa at Tivoli. There is an example also in the Villa Albani at Rome. Two colossal caryatids were used in the smaller propylon at Eleusis. They appeared in the upper stories of Agrippa's Pantheon and of the colonnade surrounding the forum of Augustus at Rome, as well as in the "Incantada" at Salonika. From fanciful illustrations in early printed editions of Vitruvius, Jean Goujon almost succeeded in recreating the Erechtheum type in the Louvre (1550). They are also called canephoroe (*see* CANEPHOROS) or korai ("maidens"). For the male type, *see* ATLANTES.
(W. B. D.)

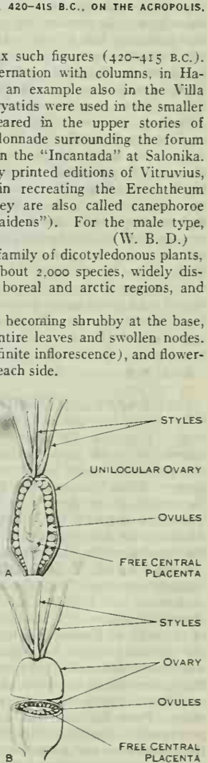

A. F. KERSTING

CARYATID PORCH OF THE ERECHTHEUM, 420–415 B.C., ON THE ACROPOLIS, ATHENS, GREECE

CARYOPHYLLACEAE, a family of dicotyledonous plants, containing about 80 genera with about 2,000 species, widely distributed, especially in temperate, boreal and arctic regions, and alpine situations.

The plants are herbs, sometimes becoming shrubby at the base, with opposite, simple, generally entire leaves and swollen nodes. The main axis ends in a flower (definite inflorescence), and flower-bearing branches are borne one on each side.

The flowers are regular, with five (or four) sepals which are free or joined to form a tube in their lower portion, the same number of petals, free and rising from below the ovary, commonly twice as many stamens, inserted with the petals, and a pistil of two to five carpels joined to form an ovary usually containing a large number of ovules on a central placenta and bearing two to five styles; the ovary is one-celled, or is completely partitioned, or incompletely septate at the base, into two to five cells; nectar is secreted at the base of the stamens. The fruit is a capsule containing a few or large number of small seeds and opening usually by apical teeth, or a utricle; the seed contains a floury endosperm and a curved embryo.



DETAIL OF THE MOUSE-EAR CHICKWEED (CERASTIUM HIRSUTUM)
(A) Pistil cut vertically and (B) pistil cut horizontally, the halves separated to show the interior of the cavity of the ovary

The family is divided into three well-defined subfamilies.

1. Paronychioideae: the sepals are free, petals lacking, and the fruit a one-seeded utricle. There are sev-

eral genera such as *Paronychia* (nailwort), *Scleranthus* and *Drymaria*.

2. Alsinoideae: the sepals are free and the flowers are open, with spreading petals, and the nectar which is secreted at the base of the stamens is exposed to the visits of short-tongued insects, such as small bees and flies; the petals are white in colour. It includes several genera, chiefly: *Cerastium* (mouse-ear chickweed), *Stellaria* (stitchwort and chickweed), *Arenaria* (sandwort), *Sagina* (pearlwort), *Spergula* (spurry) and *Spergularia* (sand spurry).

3. Silenoideae: the sepals are joined to form a narrow tube, in which stand the long claws of the petals and the stamens, partly closing the tube and rendering the nectar inaccessible to all but long-tongued insects such as the larger bees and Lepidoptera. The flowers are often red. It includes several genera of wide distribution: *Dianthus* (pink), *Silene* (catchfly, campion), *Lychnis* (bladder campion) and *Agrostemma* (corn cockle). Several, such as *Lychnis vespertina* and *Silene nutans*, open their flowers and are fragrant in the evening or at night, when they are visited by night-flying moths.

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PINK (DIANTHUS), A REPRESENTATIVE OF THE TRIBE SILENOIDEAE

In North America the family is represented by about 300 species, most numerous in mountain regions and belonging chiefly to *Silene*, *Lychnis*, *Arenaria*, *Stellaria* and *Cerastium*. *Dianthus* (carnation and pink), *Silene*, *Tunica*, *Gypsophila*, *Arenaria*, *Cerastium* and others are choice garden plants.

Glucosides, saponins and alkaloids are to be found in most genera. Some, particularly *Drymaria*, are poisonous to livestock.

The carnation (*q.v.*) (*Dianthus caryophyllus*) is a half-hardy perennial, herbaceous but suffrutescent at the base. Of ancient horticultural origin, numerous varieties have been developed.

See F. Pax and K. Hoffmann, "Caryophyllaceae," in A. Engler and K Prantl, *Die Natürlichen Pflanzenfamilien*, ch. 16, pp. 275–367, fig. 120–150 (1934). (B. Me.)

CASA, GIOVANNI DELLA (1503–1556), Italian poet, author of a famous treatise on manners (*Il Galateo*), was born in the Mugello, near Florence, June 28, 1503, and studied in Bologna. In 1530 he went to Rome, and in 1544 became archbishop of Benevento, but was sent as papal nuncio to Venice; in 1555 Paul IV made him secretary of state. He died at Montepulciano, Nov. 14, 1556. Besides some youthful *rime bernesche* (satirical verse in the manner of Francesco Berni [*q.v.*]) Della Casa produced lyrical poems characterized by a majestic style, and political orations in which he expressed his sorrow for the calamities of Italy. The *Galateo* (1550–55), which derives its title from the name of bishop Galeazzo Florimonte, who suggested the work, expresses the author's witty and balanced mind, as well as the refinement of contemporary Italian society. It enjoyed wide and immediate popularity and was translated into many languages.

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CASABIANCA, RAPHAEL, Comte de (1738–1825), French Revolutionary general, was born on Nov. 27, 1738, at Vescovato in Corsica, of a Corsican noble family. He was made lieutenant general of the forces and governor of the island by the Convention in place of Pasquale Paoli (*q.v.*) and was appointed general (March 19, 1794) during Paoli's subsequent revolt. He was made a senator on Dec. 25, 1799, and a count of the empire in 1808.

His nephew Louis de Casabianca (1762–1798) entered the French navy and in 1798 was in command of the "Orient," the flagship of Adm. François Paul Brueys, at the battle of the Nile. When the admiral was killed, Casabianca, though badly wounded, fought the burning ship to the end and perished with most of the crew, including his ten-year-old son Jacques de Casabianca whose heroic refusal to leave his father is the subject of the ballad "Casabianca" by Felicia Hemans.

CASABLANCA (Arabic Dar el-Beida, "the white house"), a port on the Atlantic coast of Casablanca province, Morocco, is situated at the head of a small bay between Rabat and Mazagan. Pop. (1960) 965,277 of which 778,780 were Moroccan Muslims, 72,026 Moroccan Jews and 114,471 Europeans and others. Although its origin is unknown, it seems to have been built on the site of a straggling Berber fishing village known in the 13th century as Anfa. It became a pirates' base for harrying Christian ships and, to put an end to these raids, the Portuguese destroyed it in 1468. During the 16th and 17th centuries the town remained in ruins and was uninhabited. Late in the 18th century it was rebuilt by the sultan Sidi Mohammed ben Abdallah who opened the port to foreign trade. In the following century Spanish, French, English and then German traders settled, increasing the town's commercial importance until by 1906 its trade exceeded that of Tangier. French occupation dated from 1907. In the early years of the French protectorate (1912–56) Marshal Louis H. G. Lyautey (*q.v.*) determined on a policy of expansion and development to make Casablanca the chief port of Morocco.

Inland from the docks and harbour is the original Arab town or old medina, quite distinct from the modern buildings. Still walled in parts by its original ramparts, it is a maze of narrow streets and whitewashed brick or stone houses. Before 1918, when the first European houses were built, the entire population of French, Muslims and Jews lived there. In modern times it houses almost all the Jewish population of Casablanca, the Jews having overflowed from the old mellah (Jewish quarter), forcing the Muslims to settle elsewhere. The great mosque built at the order of Sidi Mohammed ben Abdallah dates from the second half of the 18th century. In a semicircle outside the walls is the town built by the French. Avenues radiating from the Place de France are intersected by ring roads which reach to the coast on either side of the harbour. The Place de France, near the gateway of the old medina, is the business and administrative centre of the town, with banks, hotels and large modern stores. Farther south overlooking the gardens of the Parc Lyautey is the white cathedral of Sacré Coeur (1930) and nearby are the law courts and town hall. West of the Parc Lyautey and stretching toward the coast are the gardens and villas of residential districts like Anfa, where in Jan. 1943 the Casablanca conference took place between Winston Churchill and Pres. Franklin D. Roosevelt after the Allied landing of Nov. 1942.

New Muslim districts have surrounded the French-built town just as the latter encircled the former medina. The new medina, called Derb-Sultan or Derb-Sidna, first developed around a palace which the sultan built close to the town after World War I. It is a modern Moorish-style group of buildings set in a high-walled garden. The construction of new houses was begun in 1923 to combat the squalid conditions of the Muslim encampments and shanty towns. The experiment was so successful that an almost self-contained town with its own schools, shops and mosques has grown to meet the requirements of the Muslim population.

To the northeast the road to Fedala leads to the industrial outskirts, and the road to Rabat, to the east, is lined with factories. With the exception of mining, nearly nine-tenths of Moroccan industry is centred in Casablanca. Since 1923 phosphates have been the town's main export but other important products include sugar, tobacco, cement and textiles. There are also brickworks, sawmills and a fish-canning factory. Carpetmaking is the only handicraft of commercial importance remaining. Employment in the factories and port has attracted manpower from the southern regions of Marrakech and Agadir. Casablanca largely owes its rapid expansion to constant harbour development since the French protectorate was established in 1912. Three-quarters of Moroccan foreign trade now passes through the port.

The town is linked by road and rail with Marrakech to the south, and to the north and east with Rabat and Tangier, Fes and Oujda and beyond these to Oran, Algiers and Tunis. There are regular shipping services to Bordeaux, Marseilles and Dakar. Prior to the building of the American base at Nouaseur, 14 mi. from Casablanca, the airfield at Camp-Cazes was the most important in Morocco. There are air services to France, Portugal, Algeria, Tunisia and west Africa.

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CASABLANCA CONFERENCE, a World War II conference held in a suburb of Casablanca, Mor., in Jan. 1943, attended by Pres. Franklin D. Roosevelt and Prime Minister Winston S. Churchill. Generals Henri Giraud and Charles de Gaulle of France were also present. Plans were made for the invasion of Sicily. President Roosevelt announced that "unconditional surrender" would be demanded of the Axis powers and suggested that the conference be termed the "unconditional surrender conference."

See World War II Conferences, Allied.

CASALE MONFERRATO, a town and episcopal see of Alessandria province, Piedmont, Italy, lies on the south bank of the Po on the Monferrato hills. Pop. (1957 est.) 38,632 (commune). A settlement existed there in the middle ages, known as San Evasio; the town was successively under the rule of the Alerami, Visconti and Palaeologi. It became the capital of the marquisate of Montferrat in 1435 and passed to the Gonzaga family in 1533 and was long the subject of dispute between France and Spain. The 11th–12th century basilica of S. Evasio has five naves and a restored façade; S. Domenico is an early Gothic church with a Renaissance portal; and there are fine palaces. The soil is fertile and rice is an important crop. Vines flourish in the hills and wine is exported. Lime, cement and artificial stone are produced; also agricultural machinery, electric appliances and tartaric acid. The town has good rail connections with Turin and other towns. (M. T. A. N.)

CASALS, PABLO (Pau) (1876–), Spanish musician, the leading cellist of his time, was born at Vendrell, near Tarragona, on Dec. 29, 1876. He studied with José García in Barcelona in 1888 and in 1895 he was principal cellist at the Paris Opéra. He first appeared as a solo cellist in Paris and London in 1898 and in 1905 he formed a trio with Alfred Cortot and Jacques Thibaud. In 1919 he founded and conducted the Orquestra Pau Casals in Barcelona to introduce orchestral music to the Catalan working classes. After the Spanish Civil War he refused to return to Spain and settled at Prades, in the French Pyrenees, where, after World War II, he organized annual festivals of chamber and orchestral music. His technique and his musicianship became the model of many later cellists. An annual Casals festival was inaugurated in 1957 in Puerto Rico, where he resided after 1956. His public performances away from Prades and Puerto Rico were few after 1950, although he appeared in 1960 at a Casals festival in Mexico, and in 1961 at a festival in Israel and at a White House concert in Washington, D.C.

See L. Littlehales, *Pablo Casals* (1949); A. Conte, *La Legende de Pablo Casals* (1950).

CASANOVA (DE SEINGALT), GIOVANNI JACOPO (1725–1798), the prince of Italian adventurers, *abbé*, soldier and diplomatist, was born in Venice on April 5?, 1725, the son of an actor. As a young man, he was expelled from the seminary of St. Cyprian for scandalous conduct and entered the service of Cardinal Acquaviva in Rome. In 1745 he was a violinist in the San Samuele theatre, Venice. At Lyons (1750) he entered the masonic order; and after two years in Paris he traveled to Dresden, Prague and Vienna. Back in Venice, in 1755, Casanova was denounced as a magician and sent to prison for five years in the Piombi. On Oct. 31, 1756, however, he achieved the spectacular escape described in his famous *Histoire de ma fuite* (1788; ed. by R. Vèze, 1929; Eng. trans. by A. Machen, 1925) and made his way to Paris, where he introduced the lottery (1757), gained a financial reputation and cut a figure in high society. Casanova again set out on his travels in 1759, visiting the Netherlands (where he acquired the title of chevalier de Seingalt), southern Germany, Switzerland (where he met Voltaire), Savoy, southern France, Florence (whence he was expelled) and Rome (where the pope gave him the Order of the Golden Spur). He also spent some time in London. In Berlin (1764) he was offered a post by Frederick II. He then traveled to Riga, St. Petersburg and Warsaw. A scandal, followed by a duel, forced him to flee, and he eventually sought refuge in Spain. Between 1774 and 1782 Casanova acted as a spy in the service of the Venetian inquisitors of state. His last years (1785–98) were spent in Bohemia, as the librarian of Count von Waldstein in the chateau of Dux (Duchcov), where he died on June 4, 1798.

Casanova's works include occasional verse, operatic librettos, a confutation of Amelot de la Houssaye's *Histoire du gouvernement de Venise* (1768), a translation of the *Iliad* (1775), the libel *Nè amori nè donne* (1782), and an imaginary voyage entitled *Icosameron* (5 vol. 1788; 1928) dealing with the remarkable adventures of two young people in the world of the Mégamicres at the centre of the earth. Apart from the *Histoire de ma fuite*, his best-known work is the *Mémoires écrits par lui-même* (1826–38; best modern editions, 12 vol. 1922–35; and 2 vol., 1958; Eng. trans. by A. Machen, 1922; and unexpurgated, 1958–)—a vivid autobiography which provides a lively picture not only of the dissolute life of its author but also of 18th-century society in all the capitals of Europe.

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CASAS GRANDES ("Great Houses"), a small village of Mexico, in the state of Chihuahua, notable only for remains nearby of impressive aboriginal buildings. Pop. (1950) 1.101. It is on the Casas Grandes river, about 35 mi. S. of Janos and 150 mi. N.W. of Chihuahua city. The village is on a branch of the railway between Ciudad Juárez and Mexico City; it also has an airfield. Although mention of the ruins was made by various Spanish chroniclers, the earliest usable accounts begin in 1819 and culminate in the descriptions provided by Guillemin Tarayre in his *Rapport sur l'exploration mineralogique des regiones mexicaines* (1867). Modern archaeologists systematically surveyed and analyzed the cultures represented in efforts to date the buildings and the people who occupied them; they were already ruined and abandoned when Spaniards came upon them in the 16th century. There are several large buildings, made of huge adobe blocks as much as 5 ft. thick, so nicely joined without mortar that an early observer said they were "born so." A principal edifice measures 800 ft. by 250 ft., with walls 40 to 50 ft. high, and may originally have contained six or seven stories. In the immediate vicinity of Casas Grandes are more than 2,000 mounds and ruined buildings, with numerous surface objects of pottery and obsidian thickly strewn about. In addition to the building style, beautiful and skilfully made polychrome modeled pottery in a variety of colours and combinations is characteristic of the Casas Grandes complex. On the basis of available material, a fraction of the total, archaeologists hypothesize that there are seven periods of development, culminating in "Classic Casas Grandes" or what E. B. Sayles in his *An Archeological Survey of Chihuahua, Mexico* (1936) called the "Ramos Phase." (Hd. C.; R. B. McCk.)

CASATI, GAETANO (1838–1902), Italian geographer and traveler in Africa, the account of whose travels increased the knowledge of the headwaters of the Nile, was born at Lesmo on Sept. 4, 1838. He entered the *bersaglieri* of the Italian army in 1859 and took part in the third and fourth wars of independence against Austria. Subsequently he was employed in making ordnance survey maps of Italy. In 1879 he left for the Bahr el Ghazal province of the Sudan, where he joined Romolo Gessi (Gessi Pasha), the Italian explorer who had conquered the province that year. He traveled widely in the region and visited the upper Uele basin of the Congo.

On the rise of the Mahdi he made his way to Lado, where he joined the governor of the equatorial province of the Sudan, Emin Pasha, in 1883. He was for some time Emin's agent in Unyoro, was made prisoner, but escaped and rejoined Emin. In 1889 he accompanied H. M. Stanley and Emin to Bagamoyo on the east African coast, and then returned to Italy. Later he published an account of his travels (Eng. trans., *Ten Years in Equatoria*, 1891). He died at Como on March 7, 1902.

CASAUBON, ISAAC (1559–1614), French scholar (later naturalized English), famous for his erudition and industry as a classical commentator, was born in Geneva, Switz., on Feb. 18, 1559, of French refugee parents. On the publication of the edict of Jan. 1562, which allowed Protestants limited rights of assembly, the family returned to France and settled at Crest in Dauphiné, where Isaac's father became a pastor. Until he was 19, Isaac had no other instruction than could be given him by his father, who was away from home whole years together in the Calvinist camp, or fleeing with his family to the hills to hide from the fanatical bands of armed Catholics who patrolled the country. Thus it was in a cave in the mountains of Dauphiné, after the massacre of St. Bartholomew's day, that Isaac received his first lesson in Greek.

At 19 Isaac was sent to the Academy of Geneva, and in 1581 became professor of Greek. He remained there until 1596. He married twice, his second wife being Florence, daughter of the scholar-printer, Henri Estienne. Without the stimulus of example or encouragement, in a city peopled with religious refugees, and struggling for life against the troops of the Catholic dukes of Savoy, Casaubon made himself a consummate Greek scholar and master of ancient learning. His great wants were books and the sympathy of learned associates. He spent all he could save out of his small salary in buying books and in having copies made of such classics as were not then in print. The sympathy and help which Casaubon's native city could not afford him he endeavoured to supply by cultivating the acquaintance of the learned of other countries. Geneva, as the metropolis of Calvinism, received a constant succession of visitors. It was there that Casaubon made the acquaintance of young Henry Wotton, the poet and diplomatist, and of Richard Thomson ("Dutch" Thomson), fellow of Clare college, Cambridge, through whom the attention of Joseph Scaliger, settled in 1593 at Leiden, was directed to him. Scaliger and Casaubon began in 1594 a correspondence which culminates in a tone of the tenderest affection and mutual confidence. Influential French men of letters, the Protestant Jacques Bongars, the Catholic Jacques de Thou, and the Catholic convert Philippe Canaye, sieur du Fresne, aided him by presents of books and encouragement and endeavoured to get him invited, in some capacity, to France.

In 1596 Casaubon accepted an invitation to the University of Montpellier, with the titles of *conseiller du roi* and *professeur stipendié aux langues et bonnes lettres*. He held the professorship there only three years, for he was badly treated by the authorities. But the love of knowledge was gradually growing upon him and he began to perceive that editing Greek books was an employment more congenial to his peculiar powers than teaching. At Geneva he had first tried his hand on some notes on Diogenes Laërtius, on Theocritus, and on the New Testament, the last undertaken at his father's request. His debut as an editor had been a complete Strabo (1587), of which he was so ashamed afterward that he apologized for its crudity to Scaliger, calling it "a miscarriage." This was followed by the text of Polyaenus, an *editio princeps*, 1589; a text of Aristotle, 1590; and a few notes contributed to Estienne's editions of Dionysius of Halicarnassus and Pliny's *Epistolae*. It is not until his edition of Theophrastus' *Charactères* (1592) that there is a specimen of that peculiar style of illustrative commentary, at once apposite and profuse, which distinguishes Casaubon among annotators. At the time of his moving to Montpellier he was engaged upon what is the capital work of his life, his edition of, and commentary on, Athenaeus.

In 1598 Casaubon was in Lyons, superintending the passage of his Athenaeus through the press. There he lived in the house of Méric de Vicq, *surintendant de la justice*, a Catholic whose connections were with the circle of liberal Catholics in Paris. In the suite of De Vicq, Casaubon visited Paris and was presented to Henry IV, who said something about employing his services in the "restoration" of the University of Paris. In 1600 Casaubon was summoned by De Vicq, who was then in Paris, to go to him in all haste on an affair of importance. The business proved to be the Fontainebleau conference, a public disputation between the bishop of Evreux, Cardinal Duperron, and Duplessis-Mornay, a leading Protestant who had written a controversial work on the doctrine of the Eucharist. Casaubon allowed himself to be persuaded to sit as one of the referees and by so doing placed himself in a false position. The issue was so contrived that the Protestant party could not but be pronounced in the wrong. By concurring in the decision, which was unfavourable to Duplessis-Mornay, Casaubon lent the prestige of his name to a court whose verdict, without him, would have been worthless, and confirmed the suspicions already current among the Reformed Churches that he was meditating abjuration. From this time he became the object of the hopes and fears of the two religious parties; the Catholics lavishing promises and plying him with arguments; the Reformed ministers insinuating that he was preparing to forsake a losing cause and only haggling about his price. At the time it was not possible for the immediate parties to the bitter controversy to understand the intermediate position between Genevan Calvinism and Ultramontanism, to which Casaubon's reading of the Fathers had conducted him.

Meantime the efforts of De Thou and the liberal Catholics to retain him in Paris were successful. The king repeated his invitation to Casaubon to settle in the capital and assigned him a pension. No more was said about the university. The reform of the University of Paris had already closed its doors to all but Catholics. In Nov. 1604, however, Casaubon succeeded to the post of sub-librarian of the royal library, with a salary of 400 livres in addition to his pension.

Casaubon remained in Paris until 1610. Those ten years were the brightest period of his life. He had attained the reputation of being, after Scaliger, the most learned man of the age. He was placed above penury. He had such facilities for religious worship as a Huguenot could have. He enjoyed the society of men of learning. Above all, he had ample facilities for using Greek books, both printed and in manuscript, which no other place but Paris could at that period have supplied.

In spite of all these advantages Casaubon grew restless, and offers came to him from various quarters, from Nîmes, from Heidelberg, from Sedan. His friends Jacques Lect and Giovanni Diodati wished, rather than hoped, to get him back to Geneva, but the principal source of Casaubon's uneasiness lay in his religion. The life of any Huguenot in Paris was hardly secure at that time, but Casaubon was exposed to persecution of another sort. Ever since the Fontainebleau conference, an impression prevailed that he was wavering. It was known that he rejected the *outré* antipopery opinions current in the Reformed Churches; that he read the Fathers and wished for a church after the pattern of the primitive ages. He was given to understand that he could have a professorship only by recantation. When it was found that he could not be bought, he was plied by controversy. By the king's orders Duperron was untiring in his efforts to convert him. On the other hand, the Huguenot theologians, and especially Pierre du Moulin, chief pastor of the church of Paris, accused him of conceding too much, and of having departed already from the lines of strict Calvinistic orthodoxy.

When the assassination of Henry IV gave full rein to the Ultramontane party at court, Casaubon began to listen to overtures, which had been faintly made before, from the bishops and the court of England. In Oct. 1610 he went to England at the invitation of Richard Bancroft, archbishop of Canterbury. He had the most flattering reception from James I, who was perpetually sending for him to discuss theological matters. The English bishops were equally delighted to find that the great French scholar was an Anglican ready made, who had arrived, by independent study of the Fathers, at the very *via media* between Puritanism and Romanism which was becoming the fashion in the English Church. Casaubon, though a layman, was collated to prebendal stalls at Canterbury and at Westminster, and a pension was assigned him from the exchequer. He was naturalized on Jan. 3, 1611. He still retained his appointments in France, and his office as librarian. In order to retain their hold upon him, the government of the queen regent refused to allow his library to be sent over. It required a special request from James himself to get leave for Mme Casaubon to bring him a part of his most necessary books. Casaubon continued to speak of himself as the servant of the regent and to declare his readiness to return when summoned to do so.

Meanwhile his situation in London gradually developed unforeseen sources of discomfort. Not that he had any reason to complain of his patrons, the king and the bishops, but he had to share in their rising unpopularity. The courtiers looked with a jealous eye on a pensioner who enjoyed frequent opportunities of taking James I on his weak side—his love of book talk—opportunities which they envied him. His windows were broken by the roughs at night, his children pelted in the streets by day. On one occasion he himself appeared with a black eye, having received a blow from some ruffian's fist in the street. These outrages seem to have arisen solely from the cockney's antipathy to the Frenchman. Casaubon could not speak English. This deficiency excluded him altogether from the circle of the "wits"; either this or some other cause prevented him from being acceptable in the circle of the lay learned—the "antiquaries." Casaubon had to suffer also the open attacks of the Jesuit pamphleteers. They had spared him as long as there were hopes of converting him, but when he was committed to Anglicanism, even those previously friendly to him gave currency to the insinuation that he had sold his conscience for English gold.

But the most serious cause of discomfort in his English residence was that his time was no longer his own. He was perpetually being summoned to one or another of James's hunting residences that the king might enjoy his talk. The king and the bishops wanted to employ his pen in their literary warfare against Rome. They compelled him to write first one, then a second pamphlet on the subject of the day—the royal supremacy. At last, ashamed of thus misappropriating Casaubon's stores of learning, they set him upon a refutation of the *Annals* of Baronius, then in the full tide of its credit and success. Upon this task Casaubon spent his remaining strength and life. He died in London on July 1, 1614. His end was hastened by an unhealthy life of overstudy, and latterly by his anxiety to acquit himself creditably in his criticism on Baronius. He was buried in Westminster abbey.

Besides the editions of ancient authors which have been mentioned, Casaubon published with commentaries Persius, Suetonius and the *Scriptores Historiae Augustae*. The edition of Polybius, on which he had spent vast labour, he left unfinished. His most ambitious work was his revision of the text of the *Deipnosophistae* of Athenaeus, with commentary. The Theophrastus perhaps exhibits his most characteristic excellences as a commentator. The *Exercitationes in Baronium* are but a fragment of the massive criticism which he contemplated. His correspondence (in Latin) was finally collected by T. J. Van Almeloveen (1709), who prefixed to the letters a life of Isaac Casaubon. But the learned Dutch editor was acquainted with Casaubon's diary only in extract. This diary, *Ephemerides*, of which the manuscript is in the chapter library of Canterbury, was printed in 1850. It forms the most valuable record in existence of the daily life of a 16th-century scholar.

BIBLIOGRAPHY.—The most complete account of Casaubon remains the full biography by Mark Pattison (1875), 2nd and revised ed. by H. Nettleship (1892); *see* also L. J. Nazelle, *Isaac Casaubon, sa vie et son temps* (1897). The British museum has a large collection of books containing manuscript notes by Casaubon. (M. PA.; X.)

CASCADE RANGE, a chain of mountains extending from Mt. Lassen in northern California to the Fraser river in southern British Columbia. In Canada the range is known as the Coast mountains. To the south of Mt. Lassen the range is separated from the Sierra Nevada range by the north fork of the Feather river. The Cascade range is bordered on the east by the Rocky mountains of northeastern Washington, by the Columbia plateau of Washington and Oregon and by the Basin range region. On the west lie the Puget Sound lowland, the Willamette valley and the Klamath mountains. The Cascades have the highest relief of the Pacific Northwest, ranging from near sea level on Puget sound to 14,410 ft. at Mt. Rainier.

The Cascade range is usually divided, in the latitude of Seattle, into two parts, the southern portion being covered almost entirely by extrusive igneous rocks. Numerous volcanic cones, Rainier, Adams (12,307), Hood (11,245), Jefferson (10,495), Three Sisters (10,354), Shasta (14,162) and Lassen (10,457), more or less dissected by glacier and stream action, rise above a plateau, the crest of which is only slightly dissected. Many of the younger lava flows, only a few centuries old, are almost devoid of vegetation. Lakes, many of igneous or glacial origin, are common. The most spectacular of these is Crater lake, which occupies the nearly circular caldera of a volcano which lost its top by a combination of explosion and subsidence. The northern Cascades are underlain by old sediments and metamorphic rocks which have been intruded by granitic batholiths. Glaciation and stream dissection have carved rugged canyons, leaving little of the original plateau surface.

The natural vegetation of the Cascades reflects the variation in rainfall, which reaches more than 100 in. on the western slope. Here the Douglas fir forest provides the largest stands of timber. The east slope is drier, with open stands of ponderosa pine, while the summit plateaus have pine, fir, spruce and hemlock. The higher peaks are generally above the timberline.

Lumbering is carried on in the region. The Cascades also provide water for cities, irrigation and hydroelectric power. The numerous parks, wilderness areas and national forests are popular for skiing, hiking, mountain climbing, fishing and hunting. Population is largely restricted to the lower fringing valleys such as Skagit, Yakima and Hood River.

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CASCARA SAGRADA ("sacred bark"), the dried bark of *Rhamnus purshiana*, used in medicine as a laxative. The tree is cultivated in North America and Kenya. Cascara sagrada is prepared in both liquid and solid forms and is often prescribed in single and in divided doses. The activity is apparently due to the combined action of several substances, a number of which have been isolated, chiefly anthraquinones. (F. L. A.; X.)

CASE, SHIRLEY JACKSON (1872–1947), Canadian-U.S. theological scholar and educator, whose principal contribution to theological scholarship lay in his emphasis upon the importance of the social environment in the history of Christianity, was born Sept. 28, 1872, in Hatfield Point, N.B. After studying at Acadia university he went to Yale, where he received both his B.D. and his Ph.D. A brief tenure at Bates college, Lewiston, Me., was followed by his transfer to The University of Chicago, where he was professor of New Testament, then professor of church history, and from 1933 to 1938 dean of the divinity school. He died in Lakeland, Fla., Dec. 5, 1947.

Case's emphasis on social environment was applied, first of all, to the person of Jesus himself, as his *Jesus: A New Biography* (1927) makes clear. The same orientation characterized studies such as those on Christian millennialism (1918) and Christian supernaturalism (1929; rev. 1946). Case shared the interest of the "social gospel" in the relation between Christianity and society, but he used it more for scholarship than for social action.

See John T. McNeill, Matthew Spinka and H. R. Willoughby (eds.), *Environmental Factors in Christian History* (1939); Louis B. Jenning, *The Bibliography and Biography of Shirley Jackson Case* (1949). (J. J. PN.)

CASEIN, the chief protein in milk and the essential ingredient of cheese. Skim milk gets its white turbidity from colloidal particles of calcium caseinate and calcium phosphate. There are 5×10^{13} particles in a cubic inch of skim milk, ranging in diameter from 3 to 78×10^{-7} in. Rennet changes casein to paracasein and clots calcium paracaseinate. Casein curdles from soured or acidified skim milk; calcium salts are left in the whey. Milk contains 3% of casein.

Properties.—Pure casein is an amorphous white solid without taste or odour. Commercial casein is slightly yellow, with a pleasant odour. Dry casein keeps well if protected from insects and rodents; damp casein is quickly attacked by molds and bacteria and acquires a disagreeable odour. The specific gravity is 1.25 to 1.31. Casein is a mixture of phosphoproteins of differing molecular weight.

Casein is a lyophilic colloid akin to albumin and gelatin. Casein is isoelectric at pH 4.6 where its solubility in water is but 0.01%. It is amphoteric: below pH 4.6 casein forms moderately soluble salts such as casein chloride; above pH 4.6 casein forms salts with bases. Sodium caseinate and other alkali salts are soluble without limit; calcium caseinate, other alkaline earth salts and heavy metal salts are nearly insoluble. Caseinates readily form gels when slowly coagulated from concentrated solutions. Formaldehyde forms an insoluble compound with casein. Casein is insoluble in most organic solvents.

Paracasein is less lyophilic but otherwise identical with casein.

Manufacture.—Casein is usually made from skim milk, rarely from buttermilk, by one of three methods: (1) naturally soured casein curdles when enough lactic acid develops from fermentation of milk sugar by the ever present bacterium *Streptococcus lactis;* (2) acid casein is precipitated by adding dilute hydrochloric acid or sulfuric acid; (3) for rennet casein, warm skim milk is "set" with rennet extract until the calcium paracaseinate clots, after which the clot is cut into small pieces to allow the whey to drain. In all three methods the whey is drawn off, the curd washed with water, drained or pressed, dried in warm air, ground and packed for sale. Rennet casein retains much of the calcium phosphate from the milk.

Uses.—Casein is used in prepared foods, in medicines and in cosmetics. Minor industrial applications include the seasoning and dressing of leather, cleaners and polishes for white shoes, textile printing and sizing, insecticide sprays, soapmaking and many uses in which casein serves as a protective colloid, emulsifying agent or binder. Major applications of casein are paper coatings, glues, paints, plastics and man-made fibres.

Paper Coatings.—Book and art papers are coated with pigmented casein to provide a suitable surface for half-tone illustrations. A moderately alkaline solution of naturally soured or acid casein is mixed with a water slurry of the pigments. Formaldehyde or lime may be added for better resistance to water. The mixture is spread on the paper in a coating machine and dried.

Glues.—Wood joints made with casein glue withstand dampness for some time. Prepared casein glue is a powder composed of naturally soured or acid casein, lime, suitable sodium salts and a fungicide. The powder is dissolved in water shortly before the glue is used, whereupon the sodium salts precipitate part of the lime, release sodium hydroxide and dissolve the casein as sodium caseinate; later the rest of the lime slowly changes the sodium caseinate to insoluble calcium caseinate.

Paints.—Casein paints or distempers provide moderately washable, lustreless decoration for interior walls or for exterior masonry. Casein powder paints, to be mixed with water, are similar to casein glue in composition except for the further addition of pigments. Casein paste paints, to be diluted with water, are made by pigmenting weakly alkaline solutions of casein. Casein is also used as the emulsifying agent in emulsion paints, which are oil paints that can be thinned with water. *See* also WATER-COLOUR PAINTING: *Technique;* TEMPERA.

Plastics.—Molded plastics of casein resemble horn, ivory, ebony and marble in appearance. The principal use is for buttons for clothing. Rennet casein is granulated, moistened with water and kneaded thoroughly. Dyes or pigments may be added. The granules absorb the water and are softened. The material is then passed through a heated cylinder press with rotating screw from which soft plastic is extruded under pressure in rods or tubes. The soft plastic may then be molded in the desired shape. The shaped plastic is hardened by long soaking in formaldehyde solution after which it is slowly dried. *See* also PLASTICS: *Casein Plastics.*

Man-made Fibres.—Woollike textile fibres are made from casein by extruding an alkaline solution of casein through spinnerets of the kind used in making rayon and then hardening the fibres in an acid bath containing formaldehyde.

See E. Sutermeister and F. L. Browne, *Casein and its Industrial Applications* (1939). (F. L. BE.)

CASELLA, ALFREDO (1883–1947), Italian composer, pianist, conductor and teacher whose cosmopolitan outlook permeated 20th-century Italian music-making, was born in Turin, July 25, 1883, and studied piano under Louis Diémer in Paris, where he stayed till 1914. His early symphonies (1905–09) show the influence of Strauss and Mahler, and his later chamber and orchestral works that of Ravel and Stravinsky; but he established a more personal style in the ballet *La Giara* (1924) and in the orchestral works *Scarlattiana* (1926) and *Paganiniana* (1942). In 1917 he founded the *Società Nazionale di Musica* and helped to revive interest in early Italian music. He published valuable editions of the piano works of Bach, Mozart, Beethoven and Chopin. He died in Rome on March 5, 1947.

See A. Casella, *Music in My Time*, trans. by S. Norton (1955).

CASEMENT, SIR ROGER DAVID (1864–1916), Irish patriot, whose execution during World War I placed him among the foremost martyrs of the Irish nationalist cause, was born at Dun Laoghaire (formerly Kingstown), County Dublin, on Sept. 1, 1864. He was brought up by his uncle, an Ulster Protestant. He went to Africa in 1883, served in the Niger Coast protectorate, and then entered the British consular service (1892). He was appointed consul at Lourenço Marques for Portuguese East Africa in 1895, then at Luanda, for Angola, and at Boma, for the Congo Free State, in 1898. He returned to England in 1903, and held consular posts in Brazil between 1906 and 1911. Casement gained international fame for his two investigations into the methods of white traders, the first in the Congo (1901–03) and the second to the Putumayo river in Peru (1910–11). On both these expeditions Casement revealed atrocious cruelty by white traders and their agents in the exploitation of African and Indian labour. The report of his Congo investigation, published in Feb. 1904, led to the appointment of a Belgian commission which supported his findings and resulted in a change in the Congo government. His Putumayo report earned him a knighthood (1911), and created a sensation on its publication in 1912, although the advent of World War I prevented effective action being taken.

Casement retired in 1912 and returned to Ireland. Always a strong Irish nationalist, he was prominently associated with the formation of the Irish National Volunteers in 1913, and opposed the participation of Irishmen in World War I. Hoping that German assistance might be used to win Irish independence, he went via the United States to Berlin in Nov. 1914. He published anti-British pamphlets in 1915, and attempted to recruit a brigade, for service against England, from Irish prisoners of war, who, however, indignantly rejected his proposals. He found the Germans were not prepared to risk an expedition to Ireland, and, learning of the plans for an Irish rising at Easter 1916, he tried in vain to prevent it. He sailed for Ireland in a German submarine (April 12, 1916). The accompanying ship, with its load of German arms for the rebels, was captured, and Casement, landing at Banna Strand, County Kerry, was arrested on April 24 and taken to London.

Tried for treason before the lord chief justice, he was convicted and sentenced to death on June 29. His appeal against conviction was dismissed on July 18, and on Aug. 3, 1916, he was hanged at Pentonville prison, London, despite strong efforts to secure a reprieve. The extent to which opinion was unfavourably influenced by the private circulation of diaries reputedly written by Casement and containing detailed descriptions of homosexual practices was a matter of much subsequent controversy. The diaries themselves, the authenticity of which had been much disputed, were made available for inspection by scholars at the Public Record office, London, by the home secretary in July 1959. Most experts considered that the passages in question were in Casement's handwriting. This did not exclude the possibility of their having been copied, as was also suggested, from other sources.

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CASERTA, a town and episcopal see in the province of the same name, Campania region, Italy, is situated 28 km. (17.4 mi.) N. of Naples by road. Pop. (1957 est.) 47,711 (commune). The old town (Caserta Vecchia) founded by the Lombards in the 9th century lies on hills 5 km. (3 mi.) N.N.E. and is dominated by St. Michael's cathedral (1135), which is a copy of that at Sessa Aurunca and preserves the type of the Latin basilica. Its pulpit is decorated with rich polychrome mosaic. The modern town was a village known as La Torre belonging to the Caetani family of Sermoneta until the erection of the royal palace in the 18th century. Begun by Luigi Vanvitelli (van Wittel) in 1752 for the Bourbon Charles III but not completed until 1774 for his son, Ferdinand IV, it forms a rectangle, the south front being 830 ft. long and 134 ft. high. The interior is richly decorated with marbles and the staircase, chapel and theatre are especially sumptuous. The extensive gardens on the hillside behind the palace are adorned with fountains and cascades, the water for which is brought by an aqueduct more than 27 mi. long with three lofty bridges, the largest being the Ponti della Valle (the Arches of the Valley) near Maddaloni. Two miles north is St. Leucio, a village founded by Ferdinand IV in 1789, with large silk factories. Caserta is on the main railway lines from Naples to Foggia and Rome.

In the Italian *risorgimento* (movement for political unity) the battle of the Volturno (1860) was fought round Caserta; the combat was particularly fierce at Old Caserta and the Arches of the Valley before Garibaldi defeated the Neapolitan forces. In World War II the royal palace served for a time as the headquarters of the Allied command and the surrender of the German army in Italy was signed there on April 29, 1945. Parts of it are now used for an air force officers' academy and a commercial school.

CASH. In commercial use, this term denotes coin and bank notes, as distinguished from promissory notes, drafts and other forms of obligations payable. Cash is legal tender and is by law acceptable in payment of all debts. Individuals and commercial establishments usually distinguish between cash on hand, meaning money in their own possession, and deposits left with an agent such as a bank. Cash in the bank, from the individual and business point of view, means a sum payable in cash immediately, during regular banking hours, on order, deposited in what is called a commercial or checking account. Individuals and businesses ordinarily keep their cash holdings at a minimum. They prefer to have the larger part of their assets in physical goods, income-producing holdings and other contracts, securities and investments which may be converted into cash in the ordinary course of commerce or when the need arises.

Historically, cash was the name that British residents of the east gave to native coins of small value and particularly to the copper coins of China, the native name for which was *tsien*. The English term was apparently derived from the Sinhalese *kasi* and Tamil *kasū*, a small coin. (O. R. G.)

CASHEL (Caiseal Mumhan, "stone fort of Munster"), a town and urban district of County Tipperary, Republic of Ireland, is 100 mi. S.W. of Dublin by road. Pop. (1956) 2,817. It is dominated by the Rock of Cashel (358 ft.), a limestone outcrop which, according to legend, the devil spat forth into the plain below after biting it from the Devil's Bit mountains, where a gap roughly corresponds to the rock's dimensions. The summit is crowned by a group of ruins which include remains of the defenses, St. Patrick's cathedral (adjoined by a round tower and Cormac's chapel), the bishop's castle, and an ancient cross on the pedestal of which the Munster kings were crowned. Tradition relates that the vision of an angel blessing the rock, seen by two swineherds during the 4th century, led the king of Munster to establish a stronghold there. Below the rock is Hore abbey, a Cistercian foundation (1272) and within the town a Dominican priory (1243). St. Patrick visited Cashel in A.D. 450 and baptized the reigning king. Some early bishops were also warriors, notably Olchobar who defeated Norse invaders nearby. In 1101 King Murtagh O'Brien granted the town to the Church. Henry II received the homage of Donnell O'Brien, king of Thomond, there in 1171 and in 1315 Edward Bruce held his Irish parliament. St. Patrick's cathedral (burned in 1495 by the earl of Kildare and stripped of its lead roof in 1749) underwent restorations. Cashel also has a Georgian cathedral (1784), the seat of a Protestant bishop; the Catholic archbishopric of Cashel is at Thurles. Towns named Cashel also occur in counties Galway and Mayo.

CASHEW, the edible seed or nut of *Anacardium occidentale* (family Anacardiaceae), a polygamous, tropical and subtropical evergreen which ranges in size from a small shrub in poor, dry soil to a 40-ft. tree where soils are fertile and the humidity great. While the species is chiefly important for the nuts it produces, the wood is useful as material for shipping crates, boats; charcoal, etc., and a gum similar to gum arabic is obtained from the stem. The species is related to the American poison ivy and poison sumac and, like them, must be handled with extreme care by persons susceptible to this kind of poisoning. Of eight known species, this is the only one cultivated as a food producer. The nut, which is shaped like a large, thick bean and is sometimes more than an inch long, forms in a most singular manner. It appears as though one of its ends had been forcibly sunk into the calyx end of a fleshy, pear-shaped fruit, called the cashew apple, which is about three times as large as the nut and of reddish or yellow colour. The cashew apple is much used where the tree grows, in beverages, jams and jellies, but is unimportant commercially. The nut has two walls or shells, the outer of which is smooth and glasslike over the surface, thin and somewhat elastic, but stout, and of olive-green colour until mature, when it becomes strawberry roan. The inner shell is considerably harder and must be cracked like the shells of other nuts. Between the shells, there is a brown oil which has an extremely blistering effect on the skin. This finds use as a lubricant and insecticide, and in the production of plastics. More than 8,000,000 lb. are produced annually.

The fruits are picked by hand, and the nuts are first detached, then thoroughly dried in the sun. By the primitive methods used in some localities, the dried nuts are roasted by being placed among burning logs, where the heat causes the outer shells to burst open and release the oil. The latter quickly catches fire, giving off fumes which are dangerous to the eyes and skin. By improved methods of roasting, the nuts pass through large revolving cylinders of sheet iron with perforated sides, which are made to revolve above well-controlled flames. The oil drains into containers below and is salvaged. The roasting process entirely dispels all poisonous properties.

Later, the inner shells are broken open by hand labour and the kernels given further heating treatment by which the skins are removed and the kernels made ready for consumption.

The cashew is indigenous to the tropics of Central and South America. It was discovered during the 15th century by Portugese missionaries, who took it to east Africa and India. It later became thoroughly established and very abundant at low altitudes near the seacoast in both places, and eventually throughout tropical countries generally. Until 1923 losses due to weevil infestation while in transit practically prohibited exports to distant countries. In that year, a process was discovered and patented for using hermetically sealed shipping containers within which the air had been replaced with carbon dioxide. This method largely eliminated losses. From that time, exports increased rapidly until World War II, the United States being the principal buyer. Annual purchases by the U.S. rose to more than 50,000,000 lb., about 97% of the imports being from India. *See* also Poisonous Plants.

(C. A. Rd.; F. A. By.)

CASHIER'S CHECKS: *see* Check.

CASHIN, SIR MICHAEL PATRICK (1864–1926), prime minister of Newfoundland in 1919, is remembered chiefly for his work as minister of finance during World War I. Born on Sept. 29, 1864, at Cape Broyle, Ferryland district, he was educated at St. Bonaventure's college (a high school) at St. John's, and became a fishery merchant. In the house of assembly he represented Ferryland from 1893 to 1923, and St. John's West from 1923 to 1924. Originally a Liberal, he became an independent in 1905 to oppose the Foreign Fishing Vessels act (the Bait act) by which Prime Minister Robert Bond tried to prevent the sale of bait to U.S. fishermen. In 1908 Cashin joined with various independents and Conservatives under Edward Morris to form a new People's party and Morris became prime minister in 1909, with Cashin as minister of finance and customs (1909–19). In 1917 the People's party and the Liberal-Union opposition formed a National or coalition government, and Cashin launched a successful Victory Loan. When the Liberal-Union leader William Lloyd succeeded Morris as prime minister on Jan. 5, 1918, certain members of the People's party, including Richard Squires, withdrew their support from the wartime government, but Cashin remained at his post. However, when Cashin himself became prime minister on May 22, 1919, he took the step that led to his political defeat by breaking with William Coaker, president of the Fishermen's Protective union, in order to gain the support of mercantile elements who had supported Morris but had opposed the Lloyd administration. Squires, remaining in opposition, organized a Liberal Reform party on Aug. 21, with the demagogic slogan, "the grafters must go." On Sept. 24 the Cashin government adopted the designation Liberal Progressive. Like Prime Minister Morris before him, Cashin was a Roman Catholic, and in the general elections of Nov. 3 he retained most of the Catholic seats. But Squires and Coaker swept almost all the rest of Newfoundland, the final result being: Liberal Reform 24, Liberal Progressive 12.

On Nov. 17, 1919, Cashin was succeeded as prime minister by Squires, but he continued to lead the Liberal Progressives (forerunners of the Progressive Conservatives) until 1923. He retired from politics in 1924, the year in which his party returned to power. He died at St. John's on Aug. 30, 1926. (G. O. R.)

CASHMERE, one of the finest and softest animal fibres used in the textile industry. Cashmere is the down fibre derived from the underfleece (pashm) of a domesticated Asian goat. The name cashmere became well known because of the fame of the beautiful shawls handwoven of pashm in the city of Srinagar, Kashmir.

The annual production of the three leading cashmere producing countries, China, Outer Mongolia and Iran, is estimated at between 7,000,000 and 9,000,000 lb. One goat yields from a few ounces to one pound of down fibre per year.

During the molting season, which lasts for several weeks in late spring, the goat herders remove the down from the goats with a coarse comb. In its raw state cashmere hair is an unsightly mixture of fine undercoat and coarse outercoat fibres in the form of loose locks, batches or rolls. The scouring yield for the main types ranges between 65% and 85%. The scoured cashmere, still a mixture of fine cashmere fibres and coarse hairs, undergoes further mechanical processing, such as dehairing and carding, to remove the coarse hairs; the final yield may be as high as 50% from the best-quality fibres or as low as 20% from the poorest quality.

The finest down fibres are grown by Chinese and Mongolian goats and have an average thickness of between 14.5 and 16.5 microns. (One micron = $\frac{1}{25,400}$ in.)

Cashmere is used mainly for producing high-quality knitwear, such as sweaters, men's hose, women's dress goods and coats, men's sport coats, top coats and overcoats.

The term cashmere is also applied to several distinct varieties and qualities of dress fabrics of lightweight texture either made from 100% wool or from combinations of wool and cotton or silk warps.

See CASHMERE GOAT; SHAWL. (W. v. B.)

CASHMERE (KASHMIR) **GOAT,** a breed of domestic goat valued for its soft silky wool (*see* CASHMERE), used in India for the manufacture of cashmere shawls. It varies in build and colour but the most highly esteemed has large ears, slender limbs, curved spreading horns not spirally twisted, and a long, straight, silky white coat. Beneath the outer coat of coarse hair the fluffy, soft underfur or pashm (present in all goats) is particularly luxuriant and forms the product for which the breed is valued. *See* also GOAT. (L. H. M.)

CASH ON DELIVERY, also known as Collect On Delivery and popularly known by the letters C.O.D., is a common business term indicating that goods must be paid for at the time of delivery. The payment is due in cash but may be made by check if acceptable to the seller. The transfer agent very often used is the postal service, but it is common for consumer and business shipments to be sent C.O.D. by express companies, commercial truck forwarders or the seller's own delivery organization. C.O.D. sales usually involve a collection charge levied by the delivery agent and usually paid by the buyer. In retailing and wholesaling transactions, shipments are made on a C.O.D. basis when the buyer does not have a credit account with the seller and does not choose to pay in advance. C.O.D. terms are also often used when the amounts involved are small and the cost of advancing credit would be high in proportion to the size of the purchase.

C.O.D. general postal service was first introduced in Switzerland in 1849, India and Australia in 1877, the United States in 1913, Canada in 1922 and Great Britain in 1926. (O. R. G.)

CASH REGISTER: *see* OFFICE MACHINES AND APPLIANCES.

CASIMIR I THE RESTORER (Pol. KAZIMIERZ ODNOWICIEL) (1016–1058), ruler of Poland, was the son of King Mieszko II and Richeza (Ryksa) of Lorraine. Brought up in a monastery, he began to rule on his father's death (1034), but was deposed about 1037 and exiled with his mother during a rising of the magnates against the royal power and a popular revolt against the lords, joined with the reaction in favour of paganism. The German kings Conrad II (1038) and Henry III (1039) helped him to regain his throne. An alliance with Yaroslav the Great, of Kiev, whose sister Dobronega he married, helped Casimir to regain Mazovia, after defeating Metslav (Maslaw), the self-appointed ruler of that province, in 1047.

Casimir also seized Silesia, then under Czech occupation, and in 1054 got Henry III's assent to this re-annexation on the proviso that tribute should be paid to the Czechs (this tribute, however, was soon discontinued). Casimir restored the state administration and the church organization that had been weakened by the troubles at the beginning of his reign. During his reign Aaron, bishop of Cracow, received the pallium of an archbishop, but the metropolitan see remained in Gniezno. Casimir I had three sons: Boleslaw II (*q.v.*) the Bold; Wladyslaw Herman; and Mieszko, who died young.

See S. Ketrzynski, *Polska x–xi wieku* (1961). (A. Gi.)

CASIMIR III THE GREAT (Pol. KAZIMIERZ WIELKI) (1310–1370), king of Poland from 1333, was born at Kowal in Kujavia, the son of Wladyslaw I Lokietek, king of Poland, and Jadwiga, princess of Kalisz. He was educated at the court of his brother-in-law, Charles I of Hungary (Charles Robert of Anjou-Naples), where he had a reputation for frivolity. When Casimir became king of Poland on April 24, 1333, his kingdom, consisting of the lately reunited provinces of Great and Little Poland, was at war with the Teutonic Order and with John of Luxembourg, king of Bohemia, who claimed the Polish crown. Casimir, preferring a wise diplomacy to bloodshed, began by temporarily neutralizing the Teutonic Order with the truce of Torun (Thorn) and by inducing the king of Bohemia, at the conference of Trencin (Trencsén) early in 1335, to relinquish his claims to Poland in return for a free hand in Silesia. At the congress of Visegrád, where Casimir and John were entertained by the king of Hungary, later in 1335, the differences between them were finally adjusted. Casimir paid a large sum of money to John, renounced Polish claims to sovereignty over Mazovia and agreed to collaborate with Charles of Hungary in acquiring Halicz (Halych) or Red Ruthenia. Moreover, John put forward suggestions for a peace between Poland and the Teutonic Order, on the basis that Casimir should cede eastern Pomorze and the Chelmno territory to the knights and that they should retrocede Kujavia and Dobrzyn to him. Finally, at a second conference at Visegrád in 1339, Casimir, who had no male issue, recognized Louis, Charles I's son, as the successor to the Polish crown, Louis contracting to confirm the privileges of the Polish gentry and clergy and to rule Poland through Poles only.

In 1340 the death of the last prince of Halicz and the ravaging of that principality by the Tatars induced Casimir and Charles to establish their joint influence there, and in 1344 the Ruthenian boyar Dmitro Detko was appointed starosta, or governor, in the names of the two kings. In 1353 Lubart of Lithuania disputed the rule of Poland in that principality. Hungary coming to the assistance of Poland, Lubart was defeated and taken prisoner; but Casimir, to avoid a bloody war with Lithuania's Tatar allies, came to a compromise with Lubart whereby Poland retained Halicz with Lwow (Lviv), while the territories of Wlodzimierz (Volodymir), Belz and Brzesc (Brest) fell to Lithuania.

With the Teutonic Order, Poland's worst enemy, Casimir always preserved peace: the disputes between them were settled by the treaty of Kalisz (July 23, 1343), when the knights engaged for the first time to pay tribute to the Polish crown. Casimir, however, had trouble with Bohemia over Silesia. He invaded that country, took Wschowa and captured Prince Charles of Bohemia, but was besieged in Cracow by the retaliating Bohemians. Hungary hastened to his assistance, and the papacy restored peace in 1346.

Casimir codified the laws of Poland at Wislica and at Piotrkow in 1347; and in 1356 a supreme court of appeal was established. Casimir, the "peasant's king," put down aristocratic oppression, offenders being often put to death. Stimulated by the example of the Holy Roman emperor Charles IV, John's successor as king of Bohemia, who had founded the University of Prague in 1348, Casimir on May 12, 1364, established and richly endowed the first Polish university in Cracow. Casimir reorganized the state finances. He introduced the conscription of landowners for national defense. He founded towns, developed architecture (giving Poland "brick for wood") and protected home industries with tariffs, which led to a tariff war with Bohemia. He also encouraged immigration of the Jews. He unified Poland, making "one law, one king, one currency."

In the course of his reign Casimir subdued Volhynia, Podolia and the territory of Belz, beat the Russians as well as the Lithuanians and Tatars and finally acquired control over Mazovia. He set up a cordon of fortresses on his northeastern borders. His last political act was the conclusion of an alliance with Louis of Hungary against Charles IV at Buda in 1369. Casimir died on Nov. 5, 1370, as the result of a hunting accident. His last will, whereby his grandson Casimir of Pomerania was to be king of Poland after Louis of Hungary, was annulled by Louis and the Polish lords.

See Z. Kaczmarczyk, *Monarchia Kazimierza Wielkiego,* 2 vol. (1939–46) (R. N. B.; A. Gi.)

CASIMIR IV (Pol. KAZIMIERZ JAGIELLONCZYK) (1427–1492), king of Poland from 1445, was the second son of Wladyslaw II Jagiello. In his youth he was appointed grand prince of Lithuania by his father. He was crowned king of Poland in Cracow in June 1447, three years after the death of his elder brother, Wladyslaw III. Throughout life Casimir aimed at preserving the personal union between Poland and Lithuania and at recovering the lost western and northern lands of the old Poland. Thanks to his steadfast adherence to these principles, Poland in the 15th century became a great power.

Casimir tended to reinforce the royal power at the expense of the magnates and to rely rather on the support of the representatives of the gentry, to whom he granted the Nieszawa privilege in 1454, binding the king to obtain the consent of the land councils for new taxes and for the general levy.

Casimir finally subjugated the Teutonic Order after a 13 years' war, during which his subjects troubled him more than his enemies. In Oct. 1453 the cities and gentry of Prussia, in dispute with the order (which had been excommunicated by the pope and put under the ban of the Holy Roman empire), placed themselves under Casimir's overlordship; and on Feb. 4, 1454, they renounced their allegiance to the order. They then captured 57 towns and castles, and on March 4, 1454, Casimir incorporated Prussia with Poland, with a guarantee of autonomy and of freedom from taxation. The king, irritated by the parsimony of the estates, threatened to retire to Lithuania, but after the bloody victory over the order at Puck (Sept. 17, 1462) fortune favoured Poland. Finally the papacy intervened, and by the second peace of Torun (Thorn), on Oct. 19, 1466, all the western part of Prussia, with Chelmno and Malbork (Marienburg), called Royal Prussia, was ceded to Poland, while the remainder of Prussia was held by the knights as a fief of the Polish crown.

At the beginning of his reign Casimir had profited from the rivalry between Pope Nicholas V and the antipope Felix V to acquire for the crown the right of appointing bishops. This success was naturally resented in Rome. Popes Pius II and Paul II, however, adopted a more friendly attitude in the hope that Casimir would join in a crusade against the Turks. Thus Casimir was able to obtain papal acquiescence to the election of his son Wladyslaw (Czech Vladislav) as king of Bohemia in succession to George of Podebrady in 1471, though the pope would otherwise have preferred Matthias of Hungary.

Casimir died in June 1492. (R. N. B.; A. Gi.)

CASIMIR-PÉRIER, JEAN PAUL PIERRE (1847–1907), French statesman, the fifth president of the third republic, was born in Paris on Nov. 8, 1847, the grandson of Casimir Périer, Louis Philippe's prime minister. He was deputy for Nogent-sur-Seine from 1876 and for Aube from 1885. Although very rich (he was one of the largest shareholders in the great coal and iron company of Anzin) and belonging to a family with strong Orleanist sympathies, he sat with the left-wing republicans. Having been undersecretary for education (1877–79), undersecretary for war (1883–85), vice-president of the chamber (1890–92) and president of the chamber (1893), he became prime minister on Dec. 4, 1893. His period of office was marked by the creation of the colonial ministry, by the repression of anarchist activities and by determined opposition to any revision of the constitution and to the separation of church and state. His resignation (May 22, 1894) was followed by his re-election (June 2) to the presidency of the chamber. He was elected president of the republic on June 27, 1894. Criticism from the left-wing members of the chamber, together with the fact that the prime minister, Charles Dupuy, failed to keep him informed of affairs, caused his resignation a few months later (Jan. 15, 1895). Abandoning politics, he became president of the Anzin company and devoted himself to business until his death in Paris on March 11, 1907.

CASKET LETTERS, the name given to eight letters and a series of irregular sonnets written by Mary, queen of Scots, to the earl of Bothwell, which were alleged by James, 4th earl of Morton, to have been found in a silver casket and which were used by Morton and the Protestant rebels of 1567 to implicate the queen in the death of Lord Darnley and to justify their rebellion. If the letters are genuine—particularly Letter II, or the Glasgow letter—they are evidence of Mary's complicity in the murder. Whether or not the letters are authentic must remain a matter of opinion for each historian, with two overriding considerations: the letters are probably only evidence against Mary, not for her; and even if the letters are completely spurious the circumstantial evidence may be sufficient to indicate Mary's guilt.

The history of the letters as seen by the anti-Marians can be summarized (*see* Malcolm Laing, *History of Scotland,* vol. i, 2nd ed., 1804). After receipt of the letters Bothwell deposited them (with other documents including the Darnley murder bond signed by the conspirators) in the casket, which itself was put in the care of Sir James Balfour (*q.v.*) of Pittendreich. After the defeat of Mary's forces at Carberry Hill (June 15, 1567), Balfour at Mary's request gave the casket to a servant of Bothwell; Balfour warned the Protestant lords; they intercepted the casket; but not before he or William Maitland (*q.v.*) had abstracted and destroyed the murder bond. The letters (which were in French) were translated into Scots and, for the benefit of the Westminster conference held by Queen Elizabeth to investigate the charges against Mary, into English. The English translations (or some text of them) were produced there on Dec. 14, 1568. Subsequent translations were made into Latin and French, the latter being regarded as the originals until 1754 (Walter Goodall, *Examination of the Letters,* 1754). After the Westminster conference the original letters remained with Morton until his execution in 1581, when they came into the hands of William, 1st earl of Gowrie. Gowrie refused, as requested by Elizabeth, to send them to England, but when he was executed in 1584 the originals disappeared—possibly at the hands of Mary's son, James VI.

This narrative is open to attack at almost every point, but the battle has been fought chiefly on the authenticity of Letter II. John Hosack's theory of forgery put forward in *Mary, Queen of Scots and her Accusers*, 2 vol., 2nd ed. (1870–74), held the field until the publication of Harry Bresslau's article, "Die Kassetenbriefe der Königin Maria Stuart," *Historisches Taschenbuch* (1882), and T. F. Henderson's *The Casket Letters and Mary, Queen of Scots*, 2nd ed. (1890). The discovery of the "Lennox narrative" and other papers of Darnley's father, Matthew, 12th earl of Lennox, brought Andrew Lang to the view that "the least difficult theory is that Letter II is in part authentic, in part garbled," in *The Mystery of Mary Stuart*, rev. ed. (1904). This was answered by Henderson in *Mary, Queen of Scots*, 2 vol. (1905), and Lang, on different grounds from Henderson, retracted his earlier view in "The Casket Letters," *Scottish Historical Review*, vol. v (1908), and was convinced Mary "wrote the whole letter." Henderson restated his view in "Mr. Lang and the Casket Letters," *Scottish Historical Review*, vol. v (1908). Since then Maj. Gen. R. H. Mahon has advanced arguments against the genuineness of Letter II in his *Indictment of Mary, Queen of Scots* (1923), *Mary, Queen of Scots* (1924) and *The Tragedy of Kirk o' Field* (1930); and J. B. Black in *The Reign of Elizabeth*, 1st ed. (1936), accepted the state of the argument as it was after 1907 but in the 2nd ed. (1959)—using the criteria of the courtroom—came out strongly against the authenticity of the letters.

See also MARY (Mary Stuart); BOTHWELL, JAMES HEPBURN, 4th Earl of; MORTON, JAMES DOUGLAS, 4th Earl of; DARNLEY, HENRY STEWART, Lord. (P. G. B. McN.)

CASLON, the name of a family of English type founders.

WILLIAM CASLON (1692–1766), the first of the name, was born at Cradley, Worcestershire. In 1716, after an apprenticeship to a London engraver of gunlocks and barrels, he set up his own shop in which he did similar work, as well as silver chasing and the cutting of bookbinders' gilding tools and letter stamps. Under the patronage of William Bowyer, although at the suggestion of John Watts, Caslon became a letter designer and type founder. His success was almost instantaneous. From 1720 to 1780, few works were printed in England that did not use type from his foundry.

Caslon's first commission was to cut a font of Arabic letters. Then came a modified roman, or old style, type face that later came to be called Caslon; it was first used in an edition of the works of John Selden published in 1726 by William Bowyer. Caslon's first specimen sheet of type faces was issued in 1734 and exhibited the Caslon roman and italic in 14 different sizes, together with other faces and a few "flowers," or ornaments. Caslon's types were soon in use all over Europe and in the American colonies, where a font was used to print the Declaration of Independence.

He modeled his letters after Dutch types, but most students of typographic arts of that day considered them much better. His type faces were marked by more thin, delicate strokes and a freedom of vigour that was typically Anglo-Saxon. He introduced into his fonts a quality of interest, a variety of design and a delicacy of modeling that few Dutch type faces possessed. Dutch types were monotonous, but Caslon's fonts were not.

Although their popularity waned during the first half of the 19th century, they were revived in 1859 when a U.S. type foundry imported Caslon old style matrices; by 1900 leading makers of types and type-casting machines in the U.S. were producing this face in quantities. In the early 1960s, about 15 different variations of Caslon were available.

After Caslon died on Jan. 23, 1766, his eldest son, WILLIAM CASLON (1720–78), who had been his father's partner for a number of years, continued the business. Other descendants of the original Caslon continued to operate the type foundry until 1874. The foundry was still in operation in the early 1960s.

(W. V. HA.)

CASPER, a city in central Wyoming, U.S., and seat of Natrona county, is on the North Platte river 186 mi. N.W. of the state capital, Cheyenne. Casper was founded in 1888 as a small tent town when the Chicago and North Western railroad tracks approached from the east. It was named for a young lieutenant, Caspar Collins, who was massacred by Indians while trying to rescue a stranded wagon train; the present spelling of the city's name is the result of an error of the railroad clerk who filed the original plat. It was incorporated as a town in 1889 and became a city of the first class in 1917.

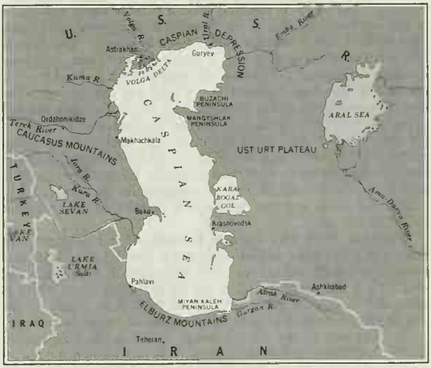
Almost from its birth Casper has been closely identified with the oil industry. To the north of the city, often known as the "Oil Capital of the Rockies," lies the remarkably long-lived Salt Creek oil field, which gave Casper its first impetus in the oil business in the 1890s. After that time, as other fields were developed, Casper continued to be the state's chief supplier of oil industry equipment and services and its oil refining centre.

Although Casper is marked indelibly by oil, other industries provide diversification. Cattle and sheep have always been important in the city's economy and, since there are extensive grazing areas in all directions, the city is a wholesaling and retailing centre for a large hinterland. The North Platte river offers trout fishing; Casper Mountain park, owned by the city, is nearby. Old Ft. Casper, which guarded the main crossing of the North Platte in the days of the covered wagon, is also a city park. Casper college, a two-year public institution, was founded in 1945.

For comparative population figures *see* table in WYOMING: *Population*. (T. A. LN.)

CASPIAN SEA, largest inland salt lake of the world, between Europe and Asia, extending from 37° to 47° N., and from 47° to 55° E. Shaped roughly like the letter S, it is 746 mi. long from north to south, and 100 to 270 mi. wide. From 1830 until 1929, its average level was 84 ft. below sea level and its area was 169,300 sq.mi. From 1929 to 1956, the level of the Caspian sea dropped by about 8 ft. to 92 ft. below sea level, and its area was reduced to 152,239 sq.mi. The Caspian sea fills the deepest part of a vast depression between the Caucasus and central Asia, sometimes known as the Aralo-Caspian depression, which was once an inland sea. The name Caspian is derived from the ancient Latin name Caspium mare, which was named for the ancient Caspi people of Transcaucasia. The sea is also known as the Hyrcanian sea, in antiquity Hyrcanium mare.

Hydrography and Shores.—The huge lake basin of the Caspian sea can be divided into three distinct sections: (1) a northern shallow section adjoining the mouths of the Volga and Ural rivers, the two principal sediment-carrying tributaries of the Caspian sea; (2) a middle section with an average depth of about 700 ft. and a maximum of 2,592 ft.; (3) a deeper southern section with an average depth of 1,000 ft. and a maximum of 3,215 ft. The middle and southern sections are separated by a submarine ridge extending from the Apsheron peninsula of the Caucasus to the central



CASPIAN SEA, INLAND SALT LAKE FORMING DEEPEST PART OF THE ARALO-CASPIAN DEPRESSION

Asian shore near Krasnovodsk. All bays and inlets of the Caspian sea are quite shallow. They include the Kara-Bogaz-Gol, Komsomolets bay and Kaidak bay. The Kara-Bogaz-Gol, the largest of the Caspian inlets, is a subsidiary basin separated from the sea by a narrow sand bar and situated at a somewhat lower level. The sand bar is pierced by a strait 300 to 400 ft. wide. Prior to the reduction in level of the Caspian sea that began in 1929, a swift current flowed through the narrow strait into the Kara-Bogaz-Gol, which functioned as a natural evaporation basin for the Caspian sea, depositing mirabilite (Glauber's salt), which is a sodium sulfate decahydrate, as well as other salts, such as sodium chloride, magnesium chloride and magnesium sulfate. As a result of the drop of the Caspian's level, the steady one-way flow into the Kara-Bogaz-Gol ceased and an equilibrium was established. The Komsomolets bay (the former Mertvy Kultuk bay) and Kaidak bay, both situated in the northeastern part of the Caspian sea, have been transformed into salt flats as a result of the drop in the sea level.

The total shoreline of the Caspian sea is 4,000 mi. long, of which 3,350 mi. are in the U.S.S.R. and the rest in Iran. The Caspian shores are generally low-lying and consist of sandy and clayey sediments left by the Caspian marine transgressions of Quaternary times, as well as of recent fluvial and marine alluvial deposits. A distinctive type of shoreline is found west of the Volga delta, where the shore is gashed by a multitude of channels and lagoons, known in Russian as *liman,* separated by chains of hillocks, termed *bugor,* that extend even under the Caspian sea. As a result of the drop in sea level, the shoreline, here as elsewhere, has assumed a simpler and less convoluted outline. Along the western shore, mountain spurs of the Caucasus reach the Caspian sea only in a few places and are generally separated from the sea by wave-cut terraces. Tectonic processes that have been particularly intensive in the Caspian basin in Upper Tertiary and Quaternary times have resulted in relatively rapid and irregular vertical displacements of the shoreline. Because of these processes the elevated marine terraces of a given geologic stage are found at different elevations along the Caspian shores. Some shore sections have had a recent tendency to emerge, others to submerge.

Currents and Climate.—Currents follow the coasts in counterclockwise direction both in the deeper middle and southern sections of the Caspian sea. Along the Caucasus coasts, currents have a tendency of flowing southward from the Volga delta; along the east coast they go northward as far as the Mangyshlak peninsula. Because of the great latitudinal extent of the Caspian sea—through 11° of latitude—there are climatic differences in its various sections. The sea affects the climate of the surrounding land areas as a result of the formation of local areas of low pressure (in winter) and high pressure (in summer), with corresponding wind systems. The effect on the land climate is particularly noticeable in the southern Caspian, where it results in a seasonal wind shift, blowing landward in summer and seaward in winter. The distinctive north wind of the Baku area is strong and sustained, especially common in summer. The seasonal wind pattern is further complicated by the diurnal alternation of land and sea breezes. The average temperature of the air in winter is 16° in the north and 46° in the south; for the summer the average temperatures are 73° and 82° respectively. At a depth of 1,000 ft. the temperature remains at about 41° to 43°. Near the Volga mouths the Caspian is frozen for 112 days on an average, and winter in the northern basin is very severe with frequent falls of temperature to −13°, and to −22°, and lower still, on the Ust-Urt plateau on the northeast shores of the sea.

Drainage Area and Former Extent.—The catchment area from which this great inland sea is fed is about 1,441,311 sq.mi., and extends much farther west and north than it does south and east. From the north the sea is fed by the Volga river, which is estimated to provide about 80% of the total river supply to the sea, or 9,000,000,000,000 cu.ft. out of a total of 11,500,000,000,000 cu.ft. The rest of the surface waters is fed to the Caspian sea by the Ural, Terek, Sulak and Samur rivers in the north and northwest, and by the Kura, Aras, Safid Rud and Atrak rivers in the southwest and south.

The level of the Caspian was formerly about the same as that of the Black sea, with which it was connected before the emergence of the Caucasus mountain system in Tertiary times, as well as later, in Quaternary times. The former level of the Caspian sea is shown by evidences of erosion on the face of rocks that formed the original shoreline. Large portions of the vast region comprised between the lower Volga, the Aral-Irtysh watershed, the Dzungarian Ala-tau and the outliers of the Tien Shan are actually covered with Aralo-Caspian deposits, nearly always a yellowish-gray clay, which occasionally assumes the character of a more or less compacted sandstone of the same colour. These deposits attain their maximum thickness of 100 ft. east of the Caspian, and have in many parts been excavated and washed away by rivers or been transported by winds.

A key fossil that indicates the former extent of the Caspian waters is that of *Cardium edule,* a mollusk that penetrated into the Caspian sea from the Black sea during one of the late epochs of the Quaternary period. The exact limits of the ancient Aralo-Caspian sea are not exactly defined, except in the northwest where the Yergeni scarp south of Stalingrad constitutes an unmistakable barrier. Caspian marine deposits are known to exist 80 mi. north and 100 mi. east of the Aral sea, as well as in the Sarykamysh depression, 150 mi. south of the Aral sea. Hence the Aralo-Caspian sea is believed to have covered a vast expanse of territory in late Tertiary and post-Tertiary times, embracing large islands, such as the Ust-Urt, which divided it into an eastern and a western portion.

During the Ice Age of Quaternary times, the Caspian was once again linked with the Black sea by way of the Manych depression of the northern Caucasus. After the great icecap had thawed and a period of general desiccation set in, the Caspian began to shrink in area, and simultaneously its connections with the Black sea and the Aral sea were severed.

Level Changes and Water Balance.—The Russian geographer L. S. Berg, in a paper published 1934, investigated changes in the level of the Caspian sea during the historic period. Using ancient maps and documents for the period from 1550 to 1830, and water-level records kept after 1830, he established definite rhythmic cycles with relative maximums in the level about 1650, 1770 and 1900, and minimums about 1590, 1710 and 1840. The average length of each cycle was therefore 120 years. Projecting into the future, he predicted minimums for 1960 and 2080, and maximums for 2020 and 2140. However, other authorities reject the cyclic theory of level changes, citing increased solar activity in recent decades, which tends to reduce runoff and increase evaporation. These experts also note that the increased use of river water for irrigation, hydroelectric power generation and other economic uses, particularly on the Volga river, will tend to reduce the volume of water carried to the Caspian sea by its tributaries. An estimate of the water balance published in 1954 showed that the sea received a total of 14,000,000,000,000 cu.ft. of water a year, of which 11,500,000,000,000 was river supply and 2,500,000,000,000 precipitation. Water losses were figured at 14,700,000,000,000 cu.ft., of which 14,000,000,000,000 were attributed to evaporation and 700,000,000,000 to the outflow into the Kara-Bogaz-Gol. The problem of erasing the present deficit by increasing the water supply of the Caspian sea has occupied Soviet experts for many years. Many plans have been proposed, including the diversion of the rivers of northern European Russia to the Volga river; the diversion of the great Siberian streams—the Ob and the Yenisei—to the Aral sea and on to the Caspian, and the construction of a canal from the Sea of Azov, an arm of the Black sea, to the Caspian sea. None of these projects has reached the stage of implementation.

Salinity.—The average salinity of the Caspian sea is 13 per 1,000, which means that 1,000 lb. of Caspian water contain 13 lb. of salts. The average salt content of the world's oceans, by comparison, is 35 per 1,000. The chemical composition of the salts is distinguished by an unusually large percentage of sulfates (30.5%) compared with only 10% in ocean water, and a lesser percentage of chlorides (68%) compared with 90% in the oceans. The chemical composition of Caspian sea salts reflects the influence of river waters, notably the Volga, which carries 33% sulfates and only 10% chlorides, most of its mineral matter consisting of calcium carbonate. Because of the proximity of the Volga mouths, salinity in the Caspian is lowest in the northern section and increases toward the middle and southern sections.

Economic Significance.—The Caspian sea plays a vital role in the economy of the U.S.S.R., and to a lesser extent of Iran, as a source of fish and a means of water transportation. Both fisheries and navigation have been adversely affected by the drop in the level of the sea. The richest fisheries in the shallow northern portion of the Caspian sea off the delta of the Volga river have been most directly affected by the reduction of the area under water. Many fishing villages were left far from the receding waterline and had to be moved to new sites. Ports have been subjected to intense silting, requiring expensive dredging work and relocation of harbour installations. The importance of the Caspian in the total Soviet fish catch has sharply declined. In 1913 it accounted for 680,000 tons, or about two-thirds of the total catch; by 1955 the Caspian share had dropped to 450,000 tons, or 17% of the total catch. However, the Caspian continues to contribute several important types of fish, notably sturgeon, which is the source of caviar. Other Caspian fish are the roach, pike perch, pike, bream, catfish and gray mullet. The Caspian seal is also hunted.

The principal ports of the Caspian sea are Baku (*q.v.*), Makhachkala, Astrakhan (*q.v.*), Guryev and Krasnovodsk (*q.v.*) in the Soviet Union, and Pahlavi (*q.v.*) and Bandar Shah in Iran. By far the most important commodity carried by Caspian ships is petroleum. Until World War II, while the Caucasian oil fields contributed 70% or more of the U.S.S.R.'s crude oil, the Caspian tankers were engaged almost entirely in carrying crude oil and refined products from Baku and Makhachkala to Astrakhan, where they were transshipped to Volga river tankers for the industrial oil consumers of European Russia. Since World War II, Baku has lost its pre-eminence in favour of the newly developed oil fields of the Volga-Urals area. While Baku continues to ship about 10,000,000 tons of oil a year, a return movement has developed consisting of crude oil from the Volga-Urals area that is shipped for refining to the Baku area. Oil receipts at Baku, which were negligible as late as 1950, rose to 3,000,000 tons by the mid-1950s. The importance of Caspian sea navigation can be judged from the fact that it handles about one-third of all freight carried in Soviet seagoing ships. Baku alone handles one-half of all Caspian sea traffic, followed by Astrakhan and Krasnovodsk. (T. Sd.)

CASQUE: *see* Helmet.

CASS, LEWIS (1782–1866), U.S. army officer, ambassador and presidential candidate, was born at Exeter, N.H., on Oct. 9, 1782. He was educated at Phillips Exeter academy, joined his father at Marietta, O., about 1799, studied law there in the office of Return Jonathan Meigs (1764–1824), and was admitted to the bar at the age of 20. Four years later he became a member of the Ohio legislature. During the War of 1812 he served under Gen. William Hull, whose surrender at Detroit he strongly condemned, and under Gen. William Henry Harrison. He rose from the rank of colonel of volunteers to be major general of Ohio militia and finally to be a brigadier general in the regular U.S. army. In 1813 he was appointed governor of the territory of Michigan, which covered an area much larger than the present state. This position gave him the chief control of Indian affairs for the territory, which was then occupied almost entirely by natives, there being only 6,000 white settlers. During the 18 years in which he held this post he rendered valuable services to the territory and to the nation. His relations with the British authorities in Canada after the War of 1812 were at times very trying, as these officials persisted in searching U.S. vessels on the Great Lakes and in arousing the hostility of the Indians of the territory against the American government. To those experiences was largely due the antipathy for Great Britain that he manifested in his later career. He was secretary of war in President Jackson's cabinet in 1831–36, and it fell to him, therefore, to direct the conduct of the Black Hawk and Seminole wars.

In 1836 General Cass was appointed minister to France and became very popular with the French government and people. In 1842, when the Quintuple treaty was negotiated by representatives of England, France, Prussia, Russia and Austria for the suppression of the slave trade by the exercise of the right of search, Cass attacked it in a pamphlet which was probably instrumental in preventing the ratification of the treaty by France. In this same year the Webster-Ashburton treaty between Great Britain and the United States was concluded, and, as England did not thereby relinquish her claim of the right to search American vessels, Cass felt himself in an awkward position and resigned his post. His attitude on this question made him very popular in America. From 1845 to 1848 and from 1849 to 1857 he was a member of the U.S. senate. In 1846 he was a leader of those demanding the "re-annexation" of all the Oregon country south of 54° 40′ or war with England, and was one of the 14 who voted against the ratification of the compromise with England at the 49th parallel. He loyally supported Polk's administration during the Mexican War, opposed the Wilmot proviso, and advocated the Compromise of 1850 and the Kansas-Nebraska bill of 1854.

In 1848 he received the Democratic nomination for the presidency, but owing to the defection of the so-called "Barnburners" (*see* Free Soil Party) he did not receive the united support of his party, and was defeated by the Whig candidate, Zachary Taylor. On account of his eminently conservative attitude on all questions concerning slavery, General Cass has been accused of pandering to the southern Democrats in order to further his political aspirations. His ideas of popular sovereignty, however, were not inconsistent with the vigorous democratic spirit of the west, of which he was a typical representative, and it is not clear that he believed that the application of this principle would result in the extension of slavery. As the west became more radically opposed to slavery after the troubles in Kansas, Cass was soon out of sympathy with his section, and when the Republicans secured control of the legislature in 1857 they refused to return him to the senate. President Buchanan soon afterward made him secretary of state, and in this position he at last had the satisfaction of obtaining from the British government an acknowledgment of the correctness of the American attitude with regard to the right of search. In Dec. 1860 he retired from the cabinet when the president refused to take a firmer attitude against secession and he remained in retirement until his death at Detroit, Mich., on June 17, 1866. He wrote for the *North American Review* and the *American Quarterly Review*, and published *Inquiries Concerning the History, Traditions and Languages of Indians Living Within the United States* (1823), and *France: Its King, Court and Government* (1840).

See Andrew C. McLaughlin, *Lewis Cass* (1899) in the "American Statesmen Series"; Frank B. Woodford, *Lewis Cass* (1950).

CASSAGNAC, PAUL GRANIER DE (1843–1904), French political writer, a Bonapartist and a notorious duelist, was born in Paris on Dec. 2, 1843. Becoming a journalist, he founded *L'Indépendance* in 1862 and also wrote later for *La Nation* and for *Le Pays* (*Journal de l'Empire*), edited by his father, Bernard Adolphe Granier de Cassagnac. In the Franco-German War he joined the Zouaves and was taken prisoner at the battle of Sedan.

After the war Cassagnac became editor of *Le Pays*, but the violence of his articles involved him in constant duels and caused the suspension of the paper in 1874. He left *Le Pays* because of differences with the Bonapartist pretender and founded an independent paper, *L'Autorité*, in 1886.

Elected deputy in 1876, Cassagnac supported Marshal MacMahon in his attempt to overthrow the republican constitution. Thereafter he made himself conspicuous for his extravagant and outspoken criticism of the regime. He was partisan of Gen. Georges Boulanger and advocated an alliance of all opposition parties against the republic. His many publications include *Empire et royauté* (1873) and *L'Histoire de la troisième république* (1875). He died in Paris on Nov. 4, 1904.

CASSANDER (*c.* 358–297 B.C.), king of Macedonia 305–297, was the son of Antipater (*q.v.*), regent of the Macedonian empire. After his father's death (319), refusing to acknowledge the new regent Polyperchon, he made war upon him and seized Macedonia and most of Greece, including Athens (319–317), with the help of Antigonus I (*q.v.*). When Antigonus returned from the eastern provinces intending to reunite the empire under his own rule, however, Cassander joined with Ptolemy I, Seleucus and Lysimachus, to frustrate him (*see* LYSIMACHUS; PTOLEMIES; SELEUCID DYNASTY).

Between 315 and 302 he fought frequently with the generals and supporters of Antigonus in Greece. In 307 he lost Athens, and in the campaign of 303–302 all his other possessions south of Thessaly. But the defeat of Antigonus and his son Demetrius at the battle of Ipsus in Phrygia (301) made him secure. He had not taken the royal title until 305, although he had murdered Alexander IV and Roxana, the son and widow of Alexander the Great, about five years earlier. His ruthlessness toward Alexander's family was partly dictated by political considerations, as was his marriage to Thessalonice, daughter of Philip II of Macedonia, whose name he gave to one of his city foundations, Thessalonica (modern Salonika). In rebuilding Thebes, destroyed by Alexander, he showed the measure of his personal hatred for the dead king.

Like Ptolemy I in Egypt, Cassander deliberately created for himself a strong kingdom of limited territorial extent. He was no less a patron of the arts than other Hellenistic kings. The philosophers of the Peripatetic school, being hostile to Alexander, were well disposed to him. (R. H. Si.)

CASSANDRA, in Greek tradition, daughter of Priam, the last king of Troy, and his wife Hecuba. Cassandra was beloved of Apollo, who promised to bestow on her the spirit of prophecy if she would comply with his desires. Cassandra accepted the proposal, received the gift, and then refused her favours. Apollo revenged himself by ordaining that her prophecies should never be believed. On the capture of Troy she was ravished by Ajax, the son of Oileus, king of the Locrians, in the temple of Athena. In the distribution of the booty, Cassandra fell to the lot of Agamemnon and was murdered with him. There is no mention in Homer of prophetic gifts, which appear for the first time in Pindar and Aeschylus. She was worshiped together with Apollo, under the name of Alexandra.

CASSATION, an 18th-century work of orchestral or chamber music in several short movements similar to a serenade or a suite. Among suggested origins of the term are the Italian *cassa*, "a drum" (Mozart's cassations K. 63 and 69 open with marchlike movements), and the Austrian dialect expression *gassatim gehen*, "to go courting," which would explain the serenadelike nature of the cassation.

Cassation is also a legal term signifying quashing, annulling or reversing, hence court of cassation as the name for a court of appeal.

CASSATT, ALEXANDER JOHNSTON (1839–1906), U.S. railroad executive, was born of a well-to-do family in Pittsburgh, Pa., Dec. 8, 1839. He went to Europe with his family for travel and study. After returning to the United States he attended Rensselaer Polytechnic institute, Troy, N.Y., and graduated there in 1859 as a civil engineer. He obtained a position with the Pennsylvania railroad in 1861 and by 1870 had become general superintendent. He was a first vice-president of the railroad in 1882 when he retired at the age 42. In 1899 he was called back to serve as president and continued in that position until he died on Dec. 28, 1906. One of his greatest achievements was inaugurating the construction of the Pennsylvania terminal in New York city. (H. J. Sg.)

CASSATT, MARY (1844–1926), U.S. artist, often called America's greatest woman painter, was born in Allegheny city (later part of Pittsburgh), Pa., May 22, 1844. From 1861 to 1865 she attended the Pennsylvania Academy of the Fine Arts. She worked briefly with Charles Joshua Chaplin in Paris but preferred to copy old masters and be on her own. After a trip home she went to Italy and spent eight months at Parma studying the works of Correggio. In 1872 she exhibited in the Paris Salon the first of five successive years. In 1877 Edgar Degas invited her to join the Impressionists, and she exhibited with them in 1879, 1880, 1881 and in their last show in 1886. Her own first one-man show was held at Durand-Ruel in 1891 where, two years later, she exhibited a considerably larger group.

Mary Cassatt greatly admired Gustave Courbet, but was especially allied with the Impressionist group. Degas more than anyone else was a close friend and greatly influenced her style in the late 1870s. In the 1880s she developed a more solid manner of painting with strong modeling. After the great exhibition of Japanese prints held in Paris in 1890, her emphasis was less on form and more on line and pattern. At this time she brought her print techniques to perfection in a series of ten coloured aquatints combining both drypoint and soft ground etching. Soon after 1900 her eyesight began to fail and by 1914 she had ceased all work.

Aside from her ability as an artist, recognized far more in France than in her native country, she had an unfailing sense of quality in pictures and was largely responsible for building up the great Havemeyer collection in New York.

Mary Cassatt died on June 14, 1926, at Château de Beaufresne, her country place north of Paris.

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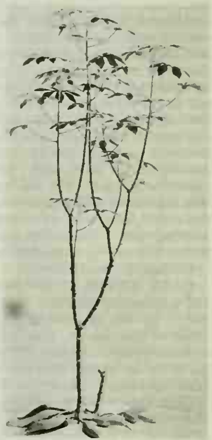
CASSAVA, the starchy root of two plants of the spurge family (Euphorbiaceae, *q.v.*), the bitter cassava, *Manihot esculenta*, and the sweet cassava, *M. dulcis*, both important sources of food starches. They are herbaceous or semi-shrubby perennials with very large fleshy, cylindrical, tapering roots as much as 3 ft. long and 6 to 9 in. in diameter, and filled with milky juice. The slender stems, 5 to 9 ft. high, bear large, spreading, long-stalked leaves, with the blade divided nearly to the base into three to seven long, narrow segments. The plants are probably natives of South America, but the bitter cassava, which is the more important of the two in an economic sense, has been introduced into most tropical regions, and is extensively cultivated in west tropical Africa and the Malay archipelago, from which, as well as from Brazil and other South American states, its starch in the form of tapioca is a staple article of export.


BY COURTESY OF CHICAGO NATURAL HISTORY MUSEUM

COMMON CASSAVA (MANIHOT ESCULENTA)

The sap of the bitter cassava root contains hydrocyanic acid, and the root, being therefore highly poisonous, cannot be eaten in a fresh condition; while on the other hand the sweet cassava is perfectly innocuous, and is employed as a table vegetable. Exposure to heat dissipates the poisonous principle, and the concentrated juice is in that state used as a basis of cassareep and other sauces. From the bitter cassava roots many different food preparations are made in Brazil. The roots are preserved for use by being cleaned, sliced and dried; from such dried slices manioc or cassava meal, used for cassava cakes, etc., is prepared by rasping. The starch also is separated and used for food under the name of Brazilian arrowroot; and this, when agglomerated into pellets on hot plates, forms the tapioca (*q.v.*) of commerce.

CASSEL, (KARL) GUSTAV (1866–1945), Swedish economist, best known for his value theory, an attempt to escape the hedonism of English and Austrian economists, his theory of money, and an unswerving belief in the principle of free competition. He was born at Stockholm on Oct. 20, 1866, and from 1904 to 1933 was professor of economics in the University of Stockholm. Cassel gained international prominence through his work on world monetary problems at the Brussels conference in 1920 and the League of Nations Finance committee in 1921. He was a Swedish delegate to several meetings of the International Chamber of Commerce. When he was in the United States on a lecture tour in 1928, the banking and currency committee of the house of representatives invited him to appear at the hearings on monetary stabilization. In 1933 the Swedish government sent him to the World Economic conference at London. He died Jan. 14, 1945.

Among Cassel's published works are: *The Nature and Necessity of Interest* (1903); *The World's Monetary Problems* (1921); *Money and Foreign Exchange After 1914* (1922); *The Theory of Social Economy*, rev. ed. (1932); *The Crisis in the World's Monetary System* (1932); *I Förnuftets Tjänst* (autobiography), 2 vol. (1940–41). (E. W. Sn.)

CASSEL: *see* KASSEL.

CASSERIUS, JULIUS (GIULIO CASSERIO) (1552?–1616), Italian anatomist who gave the first detailed descriptions of the organs of speech and hearing, was born in Piacenza. He was employed as a servant by Hieronymus Fabricius, distinguished professor of anatomy and surgery at the University of Padua, where Casserius observed and became intensely interested in his master's anatomical investigations. Instructed by Fabricius and Hieronymus Mercurialis, he acquired such skill in anatomical dissection that in 1604 the university recognized him as the regular substitute in anatomical instruction for the aging Fabricius, who, however, still nominally held the chair. In addition, Casserius gave private instruction in anatomy in a special theatre built in his home. In 1609 Fabricius formally relinquished the chair of surgery to his assistant but retained the chair of anatomy until 1613.

Casserius's first work, *De vocis auditusque organis historia anatomia* (1601), deals with the vocal and auditory organs and contains 37 fine illustrations by Joseph Maurer, a German artist. The *Pentaestheseion* (1609) again deals with the auditory organ and reproduces the 12 related plates from the earlier work as well as a text and new illustrations on the other sense organs. Casserius left unpublished a third work, *Tabulae Anatomicae*, covering the whole of human anatomy, for which 78 plates had been prepared. With one exception these were employed in a posthumous publication edited by Daniel Bucretius in 1627, as well as in the works of Adrian van der Spiegel (Spigelius) in 1645, successor to Casserius at Padua. Casserius's anatomical illustrations are a landmark of correctness and beauty, and his texts are notable for descriptive accuracy and detailed investigation into human and comparative anatomy.

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CASSIA, the aromatic bark derived from *Cinnamomum cassia* (family Lauraceae), sometimes termed Chinese cinnamon. The bark is much thicker than that of true cinnamon; the taste is more pungent and the flavour less delicate, though somewhat similar to that of cinnamon. The properties of cassia bark depend on the presence of a volatile oil—the oil of cassia. Cassia bark is in considerable demand on the continent of Europe, being preferred to cinnamon by southern Europeans. The chief use is for flavouring liqueurs and chocolate, and in cooking generally. When ground as a spice it is difficult to distinguish cassia from cinnamon, and it is a common practice to substitute the cheap common spice for the more valuable article. Cassia buds, which have a pleasing cinnamon flavour, are believed to be the immature fruits of the tree that yields Chinese cinnamon. They are brought in considerable quantities from China and used as a spice and in confectionery.

Cassia pulp, used as a laxative, is obtained from the pods of *Cassia fistula*, or pudding pipe tree, a native of Africa that is cultivated in the West Indies and in southeast Asia. Some confusion occasionally arises from the fact that Cassia is the generic name of an extensive genus of leguminous plants, which, in addition to various other medicinal products, is the source of senna (*q.v.*) leaves. *See* also CINNAMON.

CASSIANUS, JOHANNES (JOHANNES MASSILIENSIS, JOHANNES EREMITA OR JOHN CASSIAN) (360–435), monk and theologian, a leading exponent of Semi-Pelagianism in its early phase, was, according to the 5th-century chronicler Gennadius, a "Scythian" by birth. The current interpretation is that Cassianus was a Roman born in modern Rumanian Dobruja on the Black sea in 360. As a youth he became a monk and lived in Bethlehem and Egypt. About 399 he went to Constantinople, where he was ordained a deacon by John Chrysostom; in 405 he was ordained a priest in Rome. In 415 he moved to Marseilles and there founded the famous Monastery of St. Victor, of which he was abbot until his death. He also founded another monastery for women in the same region. Cassianus' overriding concern was the ascetical life. He was indeed a theologian, but his theology, the anti-Augustinian doctrine called Semi-Pelagianism, is dominated by his concept of monasticism. Cassianus never thought out his theory systematically, but the nuclear idea was that man's moral effort, born of his own initiative, draws grace from God, thus enabling man to strive successfully for salvation. His writings, especially the *Collations*, written as dialogues of the Fathers of the Desert, have influenced all western monasticism, and were themselves influenced by the life and action of the eastern monks. Besides the *Collations*, his work titled *De Institutis coenobiorum* must be mentioned. His theological dissertation *De Incarnatione Domini*, written against Nestorius at the request of Leo the Great, is an inferior work. Cassianus died in 435. He is treated as a saint by the Eastern Church, and in spite of past opposition there is liturgical veneration of him in southern France, where his feast day is July 23.

Cassianus' works may be found in J. P. Migne, *Patrologia Latina*, vol. 49 and 50, and in M. Petschenig, *Corpus Vindobonense*, vol. 13 and 17 (1886 and 1888).

See O. Chadwick, *John Cassian, Study in Primitive Monasticism* (1950). (G. WL.)

CASSINI, the name of an Italian family of astronomers, four generations of whom succeeded each other in official charge of the observatory of Paris.

GIOVANNI DOMENICO CASSINI (1625–1712) was born at Perinaldo near Nice on June 8, 1625. Educated by the Jesuits at Genoa, he was nominated in 1650 professor of astronomy in the University of Bologna. In 1667 he became director of the Paris observatory, and became a French subject in 1673. Between 1671–84 he discovered four Saturnian satellites, and in 1675 the division in Saturn's ring (*see* SATURN); made the earliest sustained observations of the zodiacal light, and published, in *Les Éléments d'astronomie vérifiés* (1693), an account of Jean Richer's (1630–96) geodetical operations in Cayenne. He also made an extensive study of the eclipses of Jupiter's satellites with a view to using them for the determination of longitude at sea. Certain oval curves which he proposed to substitute for Kepler's ellipses as the paths of the planets were named after him "Cassinians." He died at the Paris observatory on Sept. 14, 1712.

A partial autobiography left by Giovanni Domenico Cassini was published by his great-grandson, Count Cassini, in his *Memoires pour servir à l'histoire des sciences* (1810).

JACQUES CASSINI (1677–1756), son of Giovanni Domenico Cassini, was born at the Paris observatory on Feb. 8, 1677. Having succeeded to his father's position at the observatory in 1712, he measured, in 1713, the arc of the meridian from Dunkerque to Perpignan, and published the results in a volume entitled *De la grandeur et de la figure de la terre* (1720) (*see* GEODESY). He wrote besides *Éléments d'astronomie* (1740), and died on April 18, 1756, at Thury, near Clermont. The first tables of the satellites of Saturn were supplied by him in 1716.

CÉSAR FRANÇOIS CASSINI DE THURY (1714–1784), son of Jacques Cassini, was born at the observatory of Paris on June 17, 1714. He succeeded to his father's official employments, continued the hereditary surveying operations, and began in 1744 the construction of a great topographical map of France. He became director of the Paris observatory in 1771, when the establishment ceased to be a dependency of the Academy of Sciences. Cassini de Thury died at Thury on Sept. 4, 1784. His chief works are: *Méridienne de l'observatoire de Paris* (1744), *Description géo-*

métrique de la terre (1775), and *Description géométrique de la France* (1784).

Jacques Dominique Cassini, Count (1748–1845), son of César François Cassini, was born at the observatory of Paris on June 30, 1748. He succeeded in 1784 to the directorate of the observatory; but his plans for its restoration and re-equipment were wrecked in 1793 by the French Revolution. After some months in prison in 1794, he withdrew to Thury. He completed his father's map of France, which was published by the Academy of Sciences in 1793. It served as the basis for the *Atlas National* (1791), showing France in departments. Cassini died at Thury on Oct. 18, 1845.

See C Wolf, *Histoire de l'observatoire de Paris* (1902).

CASSINO, a town in the Frosinone province, Latium region, Italy, 140 km. (87 mi.) S.E. of Rome by rail, is situated in the valley of the Rapido river, against the foot of Monte Cassino. Pop. (1961) 20,903 (commune).

Ancient Casinum, a Volscian town adjacent to the modern town on the lower slopes of the mountain with a citadel at the summit, passed under Roman control in 312 B.C. During the Samnite wars the colony of Interamna Lirenas was founded five miles to the southwest, controlling the Via Latina. After the Second Punic War, in which it played a modest part, the history of Roman Casinum was one of solid but uneventful prosperity. Profiting from the decline of Interamna and the transfer of the main line of the Via Latina to approximately that followed by the modern Via Casilina, it achieved municipal, and in due course colonial, status. In the 5th century it was the seat of a bishopric, but it suffered badly from the successive barbarian incursions. In 529, when St. Benedict of Nursia established the nucleus of his famous monastery on Monte Cassino the ancient citadel was already derelict. A remnant of the city below lingered on under the name of Castrum Casinum (later Castel San Pietro) and about 866 the remaining inhabitants deserted to the present site, originally called Eulogomenopolis, later San Germano, and since 1871 Cassino. The settlement was strengthened in the 9th century by the building of a castle, the Rocca Janula, where in 1139 Innocent II was besieged and captured by Roger II of Sicily, and where in 1230 Gregory IX made peace with Frederick II of Hohenstaufen. It was sacked by French troops in 1799.

The Benedictine monastery, stormed by the Lombards in 589 and by the Saracens in 884, and temporarily deserted, was each time refounded on the original site. The parent house of western monasticism, it was during the early middle ages an outstanding centre of the arts and of learning. Paulus Diaconus (*q.v.*; Paul the Deacon, d. *c.* 797) wrote his history of the Lombards there, founding a long tradition of historical scholarship; and the radical reconstruction of the abbey in the 11th century by the abbot Desiderius (later Pope Victor III) was a major event in the history of Italian architecture. In 1349 the buildings suffered from a severe earthquake, and in the 16th and 17th centuries church and monastery were almost entirely rebuilt. In 1944 Cassino was a key point of the German winter defensive line (Garigliano-Sangro), and in the course of four months' bitter fighting the abbey was shattered and the town totally destroyed. The flooding of the Rapido valley, accentuated by the results of heavy aerial bombardment, virtually precluded the use of armoured forces, and it was only after an intensive and costly infantry assault (May 11–20) that the Allies were finally able to break through. Town and monastery have both since been reconstructed on their previous sites, the former on a completely new plan, the latter following substantially the lines of its predecessor. Polish and British military cemeteries are nearby.

Of ancient Casinum the only monuments of note are the amphitheatre, the theatre and the ruins of the Cappella del Crocifisso, a Roman mausoleum converted into a church in the 10th century. Of the medieval town, little more than the site of the upper town, clustered around the ruins of the Rocca Janula, can now be made out; the remarkable centrally planned church of Sta. Maria delle Cinque Torri, built by abbot Theodemar (778-797), was completely destroyed in 1944. Very little of the earlier abbey buildings survived the radical reconstructions of the 16th and 17th centuries; of the latter the main architectural lines, but little or nothing of the decorative detail, proved to be recoverable. The famous bronze doors, cast in Constantinople for Desiderius in 1066, were found and restored. (J. B. W.-P.)

CASSINO (Casino), a card game for two, three or four players, which probably takes its name from the word for a public gambling hall (casino). Forerunners of cassino include *callabra*, named for Calabria region at the "toe" of Italy, where it originated in the early 19th century, and *papillon* (butterfly), much played in 18th-century France.

The game is best played by two persons, or four players in two partnerships, although three can play, each for himself. The standard deck of 52 cards is used. An ace counts as 1. Other cards count their pip value. Face, or picture, cards have no numerical value and suits are not considered. In a two- or three-handed game, each player takes a turn at dealing unless each deal is a separate game, in which case the winner is the next dealer.

Play.—In the first deal of a two-handed game the dealer gives his opponent two cards; deals two, face up on the table; and gives two to himself. He then repeats this, giving himself, his opponent and the table a total of four cards each. After each hand is played, the dealer gives himself and his opponent four cards, two at a time, until all cards have been dealt. No cards are dealt to the table after the first deal. The dealer must announce "last" on beginning the final deal.

The goal in cassino is to take in cards from the table. A card from the hand may take all others of the same rank on the table. This is called "pairing" and is the only way face cards can be taken. Cards may also be won by "building."

In building, a card from the hand, whose value is equal to the combined pip count of two or more cards on the table, may take in those cards. A card from the hand may also be played upon one or more cards on the table with the intention of taking in the resulting combination on a later play. In doing this the player must announce "building," and the value of the card he intends to use to take in the build. This is particularly important if, for example, a trey from a player's hand were placed with a trey on the table. This might mean building six or threes.

To build, a player must have the proper card in his hand to take in the build on his next turn, even though he does not have to play it then if he can duplicate or increase the build or take in a pair, or an opponent's build.

The opponent may not capture individual cards in the build by pairing, but may take the entire build if he has the necessary card in his hand. He may also increase it by adding a card from his hand and taking the increased build later. A build cannot be taken by a player in the same turn in which he makes or increases it.

A double build may be made when cards amounting to the same total are available, but may not be increased. For example, a player builds four with two deuces. On his next turn, finding a trey and an ace on the table, he may take all of these with the four in his hand. If only a trey is on the table, he may add an ace from his hand, continuing to build fours, but may not take in the double build until his next turn.

When a player is unable or unwilling to take in, he may place a card from his hand on the table, face up. This is called "trailing." A player makes a "sweep" when he takes in all the cards on the table. Sweeps, condemned by some cassino players as a modern invention, were a regular feature of *papillon*. After the last card of the last hand is played, cards remaining on the table go to the player who was last to take in. This, however, is not a sweep.

Scoring.—After the pack is played out each player totals the points in his cards. Points are scored as follows:

Cards (a majority of the 52 cards)	3
Spades (a majority of the 13 spades)	1
Big cassino (the diamond 10)	2
Little cassino (the spade deuce)	1
Aces	1 each
Sweeps (not scored in all localities)	1 each

Game is commonly set at 21 points. If, during any deal, a player correctly claims to have 21 points, he wins, even though his opponent may have reached that total but failed to claim the game. This is called "counting out." If counting out is not permitted and if both players reach 21 on the same deal, the points are counted in the order given in the scoring table.

Three-handed cassino, except for the additional player, is played in exactly the same way as the two-handed game, with the deal rotating clockwise.

Partnership Cassino.—In this form of the game four persons play in two partnerships. Turn to play and turn to deal rotate clockwise. After the last hand is played, cards taken by each partnership are combined and counted together. A player may help his partner by trailing cards he thinks may be useful, but may not build a rank he knows his partner holds unless he too holds a card of that rank in his hand.

Draw Cassino.—After the first deal in draw cassino, the rest of the pack is placed, face down, on the table to form the "stock." After each player takes his turn he restores his hand to four cards by drawing from the stock. When the stock is exhausted, the play continues as usual.

Royal Cassino.—Many experts consider this variation a superior test of skill. Face cards are used in building. A jack counts 11, a queen 12 and a king 13. An ace may be 1 or 14 at the holder's option.

Spade Cassino.—Each spade won in spade cassino counts one point except the jack and the deuce which are worth two points. There is no score for a majority of spades since each counts individually. Game is 61 points, which may be scored on a cribbage board, and is won by the first player to count out.

Cassino is a very popular game for children because of the practice it offers in elementary arithmetic. For younger children, who have not reached the counting age, the game may be played without permitting builds. (R. L. Fy.)

CASSIODORUS (Flavius Magnus Aurelius Cassiodorus Senator) (*c.* A.D. 490–*c.* 585), historian, statesman and monk, rendered a great service to posterity by helping to save the culture of Rome from being lost at a time of impending barbarism. A member of an influential family living at Scyllacium (Squillace) in Bruttium, south Italy, he was born not much before A.D. 490, and reached, if he did not pass, the age of 92. During the period of the rule of the Ostrogothic kings in Italy he held several important offices. He was quaestor during 507–511, consul in 514, and at the time of the death of Theodoric in 526 was *magister officiorum* ("chief of the civil service"). Under Athalaric he became in 533 praetorian prefect. Not long after 540 he retired from public service. A few years earlier he had proposed to the pope Agapetus the foundation of a Christian university in Rome. The troubles of the time made this impossible but Cassiodorus founded near his native place a monastery which was named Vivarium after neighbouring fishponds. It was his aim to perpetuate the culture of Rome. He was not a great writer nor a great scholar but his importance in the history of culture can hardly be overestimated. He collected manuscripts and enjoined his monks to copy pagan as well as Christian authors and to this is due the preservation of many authors, for his monastery set an example which was followed elsewhere in later centuries. His own works can be divided into two groups: (1) historical and political; and (2) theological and grammatical.

1. (*a*) The *Variae*, in 12 books, were published in or not much later than 537 and contain, as models of style, 468 official letters and documents which Cassiodorus composed in the names of Theodoric, Athalaric, Theodat and Vitiges, and his own edicts issued when he was praetorian prefect. The work is important as a source of historical knowledge and is of interest to the student of Latin style. It was edited by T. Mommsen in *Monumenta Germaniae Historica: Auctores Antiquissimi*, xii (1894) and there is a condensed English translation by T. Hodgkin (1886).

(*b*) The *Chronica*, covering the period from Adam to 519, the year of publication, are not accurate and are rather partial to the Goths. The work was edited by Mommsen in *Monumenta Germaniae Historica: Auctores Ant.* XI, i (1893).

(*c*) Surviving fragments of his panegyrics on Gothic kings and queens were edited by L. Traube at the end of Mommsen's edition of the *Variae*.

2. (*a*) The *De anima*, in which Cassiodorus drew upon Augustine and Claudianus Mamertus, discusses among other matters whether the soul has shape, its virtues, its origin and its seat and ends with an eloquent description of its life after death. The work was looked upon by Cassiodorus as an extra book to the *Variae* and was published almost at the same time.

(*b*) The *Institutiones diuinarum et saecularium litterarum*, is the most important of the works which Cassiodorus wrote with the aim of educating his monks in sacred and profane learning. The first part discusses the study of holy scripture and touches on the Christian fathers and historians. The second part, widely used in the middle ages, gives a brief exposition of the seven liberal arts, a kind of encyclopaedia of pagan learning regarded as indispensable for an understanding of the Bible. The *Institutiones* were edited by R. A. B. Mynors (1937) and translated into English with introduction and notes by L. W. Jones (1946).

(*c*) Cassiodorus wrote a commentary on the Psalms and short notes on the Pauline epistles, the Acts and the Apocalypse.

(*d*) The *De Orthographia*, a compilation made by Cassiodorus in his 93rd year from the works of eight grammarians, is valuable because it contains a number of extracts from works now lost. It was edited by H. Keil in *Grammatici Latini*, vii (1880).

Cassiodorus edited a Latin translation made by others of the *Jewish Antiquities* of Josephus and a Latin adaptation of the ecclesiastical histories of Theodoret, Sozomen and Socrates. The latter work has been edited by W. Jacob and R. Hanslik (1952).

Of the lost works of Cassiodorus the most important was the *Historia Gothica*, in 12 books, which has survived only in the meagre abridgement by Jordanes, edited by Mommsen (1882).

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CASSIOPEIA, in Greek mythology, the wife of Cepheus and mother of Andromeda; in astronomy, a constellation of the northern hemisphere, easily recognized by the group of five stars forming a slightly irregular W. The most brilliant nova (*see* Nova and Supernova) on record broke out in this constellation in 1572 when it was observed by Tycho Brahe.

CASSIRER, ERNST (1874–1945), German-Jewish philosopher, remarkable for his interpretation and analysis of cultural values, was born at Breslau (Wroclaw) in Silesia on July 28, 1874, and educated at the universities of Berlin, Leipzig, Heidelberg and Marburg, where he was strongly attracted by the Neo-Kantianism of Hermann Cohen. After working first as *Privatdocent* in Berlin and then, during World War I, as a civil servant, he was in 1919 appointed professor of philosophy at Hamburg university, of which he became rector in 1930. Resigning his post when Hitler came to power, Cassirer went to teach at Oxford (1933–35), then at Göteborg in Sweden (1935–41) and finally in the United States. There he lectured at Yale university from 1941 to 1944 and then at Columbia university, where he died on April 13, 1945.

Cassirer's works include: *Leibniz' System in seinen wissenschaftlichen Grundlagen* (1902); *Das Erkenntnisproblem in der Philosophie und Wissenschaft der neueren Zeit*, 3 vol. (1906–20; Eng. trans., including a previously unpublished part, *The Problem of Knowledge: Philosophy, Science and History Since Hegel*, 1950); *Substanzbegriff und Funktionsbegriff* (1910; Eng. trans., *Substance and Function*, 1923), in which he attacks the view that a concept is formed by abstraction from numbers of particular instances and argues that the concept, at least in its function as an instrument of human knowledge, is presupposed by any process of classifying particulars; *Philosophie der symbolischen Formen*, 3 vol. (1923–29, with index, 1931; Eng. trans., *The Philosophy of Symbolic Forms*, 1953–57), an examination of the mental images and functions of the mind underlying every manifestation of human culture; *Sprache und Mythos* (1925; Eng. trans., *Language and Myth*, 1946); *Die Platonische Renaissance in England und die Schule von Cambridge* (1932; Eng. trans., *The Platonic Renaissance in England*, 1953); *Die Philosophie der Aufklärung* (1932; Eng. trans., *The Philosophy of the Enlightenment*, 1951); *Das Problem Jean Jacques Rousseau* (1932; Eng. trans., *The Question of Jean-Jacques Rousseau*, 1954); *Determinismus und Indeterminismus in der modernen Physik* (1936); *An Essay on Man* (1944); and *The Myth of the State* (1946).

See *The Philosophy of Ernst Cassirer* (1949), vol. 6 of the *Library of Living Philosophers*, ed. by P. A. Schilpp.

CASSITERIDES, in ancient geography the name of islands regarded as being situated somewhere near the west coasts of Europe; the name is derived from the Greek for "tin"—*i.e.*, "Tin Islands." Herodotus (430 B.C.) had dimly heard of them. Later writers call them smallish islands off the northwest coast of Spain, which contained tin mines, or, as Strabo says, tin and lead mines. A passage in Diodorus derives the name rather from their nearness to the tin districts of northwest Spain. While geographical knowledge of the west was still scanty and the secrets of the tin trade were successfully guarded, the idea of tin-producing islands easily arose. Later, when the west was better explored, it was found that tin actually came from two regions, northwest Spain and Cornwall. Neither of these could be called small islands or described as off the northwest coast of Spain, and so the Cassiterides were not identified with either by the Greek and Roman geographers. Instead, they became a third, ill-understood source of tin, conceived of as distinct from Spain or Great Britain. Modern archaeological research has enlarged knowledge of early sources of tin, and islands off the coast of Brittany which have tin-bearing sands have been suggested as the original Cassiterides. It may well be, however, that the name represents merely early and vague knowledge of the Greeks that tin was found overseas somewhere in or off western Europe.

CASSITERITE, or Tinstone, is the mineral from which most of the world's tin is obtained. Named from the Greek word for tin, it is usually massive and granular but may also form pebbles and grains (stream tin), or reniform or kidney shapes with banded, radiating fibres (wood tin). The mines of Cornwall in England were for a long time the principal source of tin, and appreciable production also came from Portugal, Saxony, and Bohemia. Most of the world's cassiterite is mined in Malaya, Indonesia, Bolivia, Republic of the Congo, China, Thailand and Nigeria, although smaller amounts are produced in many other countries. Commercial production is principally from veins and placer deposits, but cassiterite is also a minor constituent in granites and pegmatites. Associated minerals are quartz, fluorite, topaz, tourmaline, wolframite, mica, feldspar and apatite.

Cassiterite crystallizes in the tetragonal system and crystals are generally short and prismatic; elbow-shaped twins also are found. Crystals are uncommon. Cassiterite is usually brown or black, has a hardness of 6 to 7, specific gravity of 6.8 to 7.1, and an adamantine to submetallic lustre. Occasionally it is yellow or white. The streak is white. Composed of tin dioxide, the formula is SnO_2 with $Sn = 78.6\%$ and $O = 21.4\%$. The high specific gravity, high lustre, and white streak are distinguishing characteristics. For further discussion of occurrences, mining and metallurgy, and for its uses, *see* Tin. (A. F. Hr.)

CASSIUS, the name of a distinguished Roman family, originally patrician. Its most important members are the following:

Spurius Cassius Vecellinus (late 6th and early 5th century B.C.), said to have been three times consul. In his first consulate (502 B.C.) he defeated the Sabines; in his second (493) he made a treaty with the Latins, and dedicated the temple of Ceres in the Circus; in his third (486) he made a treaty with the conquered Hernici, and proposed an agrarian law to help the needy plebeians. This was violently opposed both by the patricians and by the wealthy plebeians, and Cassius was condemned and executed. The story is sometimes regarded as an invention of a later age, based on the proposals of the Gracchi and M. Livius Drusus, but it probably has a basis of fact. Further, his Latin treaty must be accepted. It endured until about 380, establishing peace throughout Latium, and providing that Rome and the Latins should on equal terms render mutual military aid. (*See* Roman History: *The Beginnings of Rome.*)

The following Cassii are all plebeians. It has been suggested that the sons of Spurius Cassius were expelled from, or voluntarily left, the patrician order in consequence of their father's execution.

Gaius Cassius Longinus (1st century B.C.), consul 73 B.C. With his colleague, Terentius Varro Lucullus, he carried a law (*lex Terentia Cassia*) that facilitated the dispatch of Sicilian corn to Rome, and established a monthly distribution of five *modii* of corn to perhaps 40,000 people in Rome at the Gracchan price. Cassius was defeated by Spartacus in 72, gave evidence against Gaius Verres in 70, and in 66 supported the Manilian law.

Gaius Cassius Longinus (d. 42 B.C.), prime mover in the conspiracy against Julius Caesar. In 53 B.C. he served as quaestor in the Parthian campaign under M. Licinius Crassus, saved the remnants of the army after the defeat of Carrhae, and for two years successfully repelled the Parthian attacks on Syria. In 49 B.C. he became tribune of the plebs. The outbreak of the civil war in that year saved him from being brought to trial for extortion in Syria. He at first commanded part of the fleet of Pompeius. After Pharsalus he was pardoned by Caesar, who made him one of his legates. In 44 B.C. he became *praetor peregrinus* with the promise of the Syrian province for the ensuing year; yet he was one of the leading conspirators against Caesar, taking an active part in the actual assassination. Though soon forced to withdraw from Rome, he was given a corn commission and the province of Cyrene, but in September he left Italy for Syria, where he raised a considerable army, and defeated P. Cornelius Dolabella, to whom the province had been assigned by the senate. When in 43 M. Antonius (Mark Antony), Octavian and Lepidus combined to form the triumvirate, he subdued Rhodes and joined Brutus at Sardis; with their combined armies, they crossed the Hellespont, marched through Thrace, and encamped near Philippi in Macedonia. Their intention was to starve out the enemy, but they were forced into an engagement. Brutus was successful against Octavian, but Cassius, defeated by Antony, gave up all for lost, and ordered his freedman to kill him.

Quintus Cassius Longinus (d. 47 B.C.), the brother or possibly cousin of the murderer of Caesar, quaestor of Pompeius in Further Spain in 54 B.C. In 49, as tribune of the plebs, he supported the cause of Caesar, by whom he was made governor of Further Spain. His oppression of the provincials led to an unsuccessful revolt at Corduba (Córdoba). Cassius punished the leaders with merciless severity, and made the lot of the provincials harder than ever. At last some of his troops revolted (48) and proclaimed the quaestor M. Marcellus governor of the province. Bogud, the king of Mauretania and Lepidus, the proconsul of Hither Spain, to whom Cassius had applied for assistance, arranged with Marcellus that Cassius should go free with the legions that remained loyal to him. Cassius sent his troops into winter quarters and took ship at Malaca (Málaga), but was wrecked at the mouth of the Ebro river (47). His tyrannical government of Spain had greatly injured the cause of Caesar.

Gaius Cassius, called Parmensis from his birthplace Parma (d. after 31 B.C.), was one of the assassins of Julius Caesar, and after his death joined the party of Brutus and Gaius Cassius Longinus (the assassin). In 43 B.C. he was in command of the fleet that engaged Dolabella off the coast of Asia, but after the battle of Philippi he joined Sextus Pompeius in Sicily. When Sextus Pompeius was defeated at Naulochus by Agrippa and fled to Asia, Cassius went over to Antony, and was present at Actium (31). He afterward fled to Athens, where he was put to death by Octavian. Cassius is credited with satires, elegies, epigrams and tragedies, and Horace, to judge from a remark in the *Epistles*, thought well of his poetry. Nothing of his work survives: the hexameters with the title *Cassii Orpheus* are the work of a 16th-century humanist. The story that L. Varius Rufus took his tragedy *Thyestes* from a manuscript found among the papers of Cassius is due to a confusion.

Gaius Cassius Longinus (1st century A.D.), Roman jurist, consul in 30, proconsul of Asia (40–41), and governor of Syria under Claudius (45–49). He was banished by Nero (65) to Sardinia. He was recalled by Vespasian and died at an advanced age. Cassius was a pupil of Massurius Sabinus, with whom he founded a legal school, the followers of which were called Cassiani. His chief work was the *Libri Juris Civilis* in ten books, which was used by the compilers of Justinian's *Digest*. (H. H. Sd.)

CASSIUS, GAIUS AVIDIUS (d. A.D. 175), Roman general, Syrian by birth and son of a high civil servant of the emperor Hadrian, was director of operations in the war against Parthia (A.D. 162–165) nominally commanded by the emperor Lucius Verus, in which Avidius sacked Seleucia and Ctesiphon. Subsequently he was put in over-all charge of the eastern provinces, and in 172 he put down an agrarian rebellion in Egypt. In April 175, apparently on a false rumour of the death of the emperor Marcus Aurelius, he proclaimed himself emperor. Marcus set out for the east to combat him, but Avidius was assassinated in July by his own soldiery.

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CASSIVELLAUNUS (1st century B.C.), a British chieftain, ruler of the Catuvellauni of Hertfordshire, whom he led against Julius Caesar during the latter's second expedition of 54 B.C. (*see* Britain). After several indecisive engagements, Caesar took the principal fortified settlement (*oppidum*) of Cassivellaunus, identified by archaeological excavation at Wheathampstead (Hertfordshire), and granted him peace on condition of paying tribute and giving hostages.

See Caesar, *Gallic War*, v, 10–22; for Wheathampstead, R. E. M. Wheeler, *Verulamium, a Belgic and Two Roman Cities*, pp. 16–22 (1936). (I. A. Rd.)

CASSOCK, a long-sleeved, close-fitting robe worn by the clergy and others engaged in ecclesiastical functions. Originally applied to the dress of soldiers and horsemen, and later to the long garment worn in civil life, the name came into ecclesiastical use somewhat late; it now survives in this sense alone. The cassock, though part of the canonical costume of the clergy, is not a liturgical vestment (*see* Vestments, Ecclesiastical).

In the Roman Catholic church the cassock must be worn by the clergy both in ordinary life (except in Protestant countries) and under their vestments in church. It varies in colour with the wearer's rank: white for the pope, red for cardinals, purple for bishops, black for the lesser ranks. The equivalent garment in the Eastern Orthodox churches is the rhason. In the Church of England the cassock, prescribed in 1604 as the canonical dress of the clergy, has been continuously, though not universally, worn by the clergy since the Reformation. It is now, however, usually only worn in church, at home or within the precincts of the parish. (J. J. Pn.)

CASSONE: *see* Cabinet Furniture.

CASSOWARY, a large flightless bird inferior in size only to the emu of Australia and the ostrich of Africa. Cassowaries belong to the genus *Casuarius*, containing six species. They are among the very few birds that can easily kill a man. They do this by jumping and stabbing forward with their powerful legs and toes. On each foot they have three toes, the innermost of which is fitted with a long, straight, stilettolike nail.

Cassowaries are confined to New Guinea (where they are actually the largest land animal) and to nearby islands. One species reaches the northeastern tip of Australia. Cassowaries live in family groups in tropical and mid-mountain forests; they are very wary but are easily detected because of the hollow, resonant sound of their deep, windy sighs. They are characterized by rudimentary wings, each with four or five veinless shafts up to 11 in. in length; they use these shafts to fend off obstructions as they run through the forest at speeds of up to 30 m.p.h. They also are protected by crown casques (helmets), and a long and thick, tough and slippery, hairlike covering on their wedge-shaped bodies. The feathers of cassowaries are doubled; that is, at the base of each shaft grows a secondary feather or aftershaft that is nearly as long as the main feather. In cassowaries, as in hawks and a few other birds, the female is larger than the male. After the female lays the three to six green eggs, the male attends to incubating them and caring for the young. The latter, which are hatched with prominent buff striping that tends to camouflage them, are soon able to look out for themselves.

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COMMON CASSOWARY (CASUARIUS CASUARIUS)

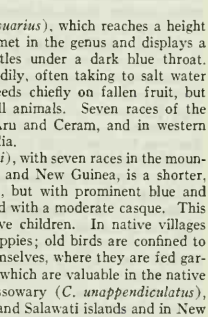
The common cassowary (*C. casuarius*), which reaches a height of five feet, wears the largest helmet in the genus and displays a pair of grotesque red-tipped wattles under a dark blue throat. Like all cassowaries, it swims readily, often taking to salt water beaches. It lives in pairs and feeds chiefly on fallen fruit, but it also feeds on all kinds of small animals. Seven races of the species occur on the islands of Aru and Ceram, and in western New Guinea and northern Australia.

Bennett's cassowary (*C. bennetti*), with seven races in the mountains of Jobi Island, New Britain and New Guinea, is a shorter, more robust bird without wattles, but with prominent blue and orange naked areas on the neck and with a moderate casque. This species is a favourite pet of native children. In native villages the young birds run about like puppies; old birds are confined to cribs only slightly larger than themselves, where they are fed garbage and plucked of their plumes, which are valuable in the native economy. The single-wattled cassowary (*C. unappendiculatus*), a species with eight races on Jobi and Salawati islands and in New Guinea, has a single wattle that hangs from the middle of the lower throat. Even the foot-tall chicks wear this distinctive adornment. Cassowaries form a distinct order of birds, the Casuariiformes, which also includes the emu of Australia. (E. T. Gi.)

CASTAGNO, ANDREA DEL (1423–1457), Italian painter who, with Masaccio and the sculptor Donatello, was one of the great Renaissance naturalists of his period, was born at San Martino a Corella, near Castagno. He worked mostly in Florence and died there of the plague in Aug. 1457. When only 17 he was commissioned to paint the dead criminals who had been hanged for revolting against the Medici, a fresco long since lost.

His most important panels are the "Crucifixion" in the National gallery, London, and the "Assumption of the Virgin" in the Kaiser Friedrich museum, Berlin, executed in 1449. In Sant' Apollonia in Florence, now a museum, his most famous frescoes have been collected, the "Last Supper" with scenes from the Passion, the "Crucifixion" and his impressive series of famous men and women. His last known work is the equestrian portrait of the *condottiere* Niccolò da Tolentino, a fresco of 1456 in the cathedral. Castagno's teacher is not known, but his strong style reflects his Florentine predecessor, Masaccio, and the sculptor Donatello.

See G. M. Richter, *Andrea dal Castagno* (1943). (M. M. S.)



BY COURTESY OF NATIONAL GALLERY OF ART, WASHINGTON, D.C., WIDENER COLLECTION

"THE YOUTHFUL DAVID," A LEATHER SHIELD PAINTED BY ANDREA DEL CASTAGNO

CASTANETS, musical instruments of percussion, perhaps Phoenician in origin, introduced into Spain by the Moors. They were used by the ancient Greeks, the Egyptians and also by the Romans. Originally shaped like a small boot, they later resembled a chestnut (*castaña*), from which wood they were made and from which they took their name. As *castañuelas* they became the characteristic instrument of the Spanish peasantry, and their use remains a feature of Spanish dancing.

Each pair of castanets consists of two hollowed-out, pear-shaped pieces of hardwood (now ebony, rosewood or other similar wood), sometimes ivory or even plastic, hinged together and sprung by a cord that is secured firmly to the thumb. The two halves are struck together by the fingers. The fingers of the left hand perform a simple rhythm on a larger pair (*macho*, male) while the right-hand fingers manipulate a more complicated dance rhythm on a smaller pair (*hembra*, female).

In the orchestra, the two bowls are attached to one or more handles, and played either singly or with a handle in each hand.

Another method is to secure the bowls to a block of wood by spring steel or elastic, and manipulate them with the fingers or with drumsticks. (J. Bl.)

CASTE (INDIAN). No term in the literature of social science has been so misused and misinterpreted as "caste"; indeed it is arguable that the ambiguity of the term itself has been a major reason for the difficulty in reaching a clear understanding of the system it describes. The Hindu caste system is unique, not because it embodies any unique modal principles of social structure, but because of the many different principles of status evaluation which validate it and which are so intricately interwoven to form the pattern of Hindu life. While, therefore, it is justifiable to use "caste" as an adjective in describing social groups of various kinds organized according to these principles, its use as a descriptive noun is fraught with difficulty. The truth of the matter is that no sociological entities have been discovered in Hindu India which are sufficiently alike in all their characteristics or sufficiently uniform or homogeneous in composition to justify being classed together under the label "caste" used as a noun. There are thousands of groups in India which are divided one from the other either by rules of descent, rules of marriage, ritual, occupation, ideas about purity and pollution, or by various combinations of these criteria of differentiation. There are sufficient underlying similarities in the way these rules affect the composition of Hindu groups as a whole to justify identification of a castelike quality which distinguishes them all from otherwise similar groups in other societies. These similarities occur, however, not at one level in Hindu society nor in one particular kind of group, but at many levels and in many different kinds of groups. Thus, while it is misleading to write of castes because this implies the existence of a category of groups with similar structural characteristics, it is meaningful and useful to write of caste groups, denoting groups of various kinds which have a range of similar qualities despite their structural differences. By using "caste" as an adjective instead of as a noun it is possible to distinguish the differences as well as the similarities among Hindu groups, and to avoid the pitfalls of throwing together within one portmanteau term a number of dissimilar units.

Almost all the so-called castes in India differ from each other in composition, and in many cases it is difficult to discover any criteria by which they properly can be regarded as a unit at all. Take, for example, the so-called Brahman caste. This has been described as "the most heterogeneous collection of minute and independent subdivisions that ever bore a common designation." It is not an organized social entity, for its units neither meet nor associate with each other. It is not an occupational entity, for the Indian census tables show clearly that Brahmans pursue many occupations, including those of cultivator, labourer and cook. It is not a jural entity; the law-enforcing functions of the caste system are located in exogamous groups within which intragroup marriage is forbidden, in endogamous groups within which intragroup marriage is mandatory and in commensal groups which place restrictions on accepting food from outsiders. The "Brahman caste" does not correspond to any of these. It is not a status entity—though many of the lesser groups subsumed under the label occupy the summit of local caste hierarchies—because it is subdivided into groups so different in status that they will neither intermarry nor eat with each other (or interdine, to use the modern Indian phrase for commensality). Some of these lesser groups, for example the Mahabrahmans who officiate at the funerals of many caste groups, by their degraded occupations lowered themselves below the level of many so-called low castes. If "Brahman caste" conveys any meaning at all, it indicates at the most a vague putative descent group, but there seems to be no analytical advantage in describing it as such since its component parts have been separate social units for many centuries and none of the privileges or restrictions usually associated with common descent—such as the right of inheritance and succession or the rules of exogamy—apply in this case. It is largely because "caste" has been used as a descriptive noun to denote amorphous entities of this order as well as a wide range of real social groups—lineages, endogamous groups, commensal groups, aggregations of endogamous groups with a common origin or equal status and so on—that all the confusion of the past has arisen. In this article, therefore, "caste" will be used as an adjective denoting groups governed by the causal principles outlined in the section below on the nature of the Hindu caste system, and these groups themselves will be given the structurally descriptive labels (*e.g.*, endogamous group) normally used in sociological literature.

Origins and Historical Development.—The complexities of the Hindu caste system have presented a challenge to students of human behaviour for more than 2,000 years, and arguments concerning its true nature and development continue unabated. Many theories have been advanced concerning its origins, most of which proved unacceptable because they sought to establish one or two causal factors as fundamental, whereas historical evidence shows beyond doubt that many factors have played equally important roles in the creation of this unique system. The incursion of the Aryan-speaking invaders into north India, which is believed to have occurred about 1500 B.C., heralded a new era. Little is known about the Dasyu civilization which the Aryans destroyed save that archaeological evidence suggests that it was an urban civilization, with a highly developed and differentiated society in which good water supplies and sanitation received much attention. Elsewhere in India, to the east and in the Dravidian south, other old civilizations flourished in the midst of a host of smaller peoples and tribes divided from each other not only by natural barriers of mountains, rivers, jungles and deserts, but also by social barriers such as restrictions on marriage and eating. (*See* also India: *The People*.)

In contrast to the defeated Dasyus, the conquering Aryans were rude barbarians possessed of an open-class society and a religion and customs (as in the Rigveda) very different from those in modern India. Their three social classes (*varna:* symbolic colours or complexions) were the warrior-rulers (Kshatriya; *q.v.*), the priests (Brahman; *q.v.*), and the commonalty (Vaishya), and any man could aspire to rise in class either by his own wisdom or prowess, or by favour of the rulers. The Aryan men were beef eaters and mighty drinkers of a potent liquor called Soma, the secret of which is lost in antiquity; their women were relatively emancipated and free to bestow their favours in a way which would be unthinkable today. Their religion was a simple and loving worship of the gods of the elements and of ancestor spirits, and their ritual included blood sacrifice of many creatures. There was no hint in their early hymns of any belief in the transmigration of souls nor of ideas concerning purity and pollution comparable to those of modern Hinduism.

As the centuries passed there was a gradual fusion of cultures. Rulers and ruled became assimilated into a common system, each borrowing, or being forced by circumstances to accept, the beliefs and customs of the other. The open-class system of the Aryans, which fitted ill with the closed-group system of the indigenous peoples, was first modified and finally changed beyond recognition. The first of these modifications was the stabilization of the order of precedence of the two upper classes. Ritual triumphed over the sword; the Brahman priesthood gained an ascendancy over the Kshatriya rulers and established itself in the position of class supremacy which it has retained ever since. Meanwhile, a fourth class appeared at the bottom of the list below the Vaishya, a class of artisans (Shudra), of a completely new kind, distinguished from the three upper classes by the fact that its members were not permitted to perform the *upanayana* initiation rite which gave to members of these upper classes the proud title of *Dwija*, the "twice-born." This fact and the absence of evidence that the Aryans had achieved any marked economic differentiation prior to their conquest of northern India suggest that the Shudra class was composed of artisan groups from the conquered Dasyus (*Dasa varna*, the enemy race, as opposed to *Arya varna*, the Aryan race) who had become assimilated into Aryan society through economic interdependence.

At the beginning of the Christian era the caste system as it is today was taking shape, though it was to remain possible, over many more centuries, for kings and princes to raise or debase the status of individuals and groups. Groups rather than classes had become the locus of status; the belief in a process of metempsychosis already validated differences in status; the sanctity of the cow had been established; diet restrictions were associated with ideas about purity and pollution; the dangers of internal pollution were already evident in the status assigned to the children of *anuloma* as opposed to *pratiloma* marriage. The children of *anuloma* marriage, in which the mother is of equal or slightly lower status than the father, retain the status of their father in a degree proportionate to the difference in status between the two parents. The children of *pratiloma* marriage, in which the mother is of higher status than the father, are outcast, since the mother is defiled by her lowborn mate.

All this development in theories about the universe and about the nature of man—perhaps the most profound philosophical tour de force of all human thinking—took place in isolated seats of learning in a country which was itself divided up into numberless kingdoms, principalities and chieftainships large and small. Few areas of the world's surface have seen more bloodshed and rapine, more external aggression and internecine strife, more movement and intermixture of peoples, more comings and goings of policies, religions, creeds and customs, than the Indian subcontinent. Rulers rose and fell, nations flourished and disappeared into the limbo of the defeated, languages ebbed and flowed with the tides of racial movement. Above all this turmoil and confusion only one thing remained constant—the Brahman priesthood and Brahmanical teachings. Though physical isolation and individual interpretations led in the end to numerous philosophical interpretations of the Vedic scriptures and several schools of law, there was enough consistency in their major premises to constitute a broad basis of agreement upon which the philosophical and spiritual validation of the caste system could be built. Slowly but surely Brahman teaching penetrated downward through all the multifarious peoples of India, creating a common bond which no secular authority could provide, interlinking their diverse beliefs into a consistent pattern, laying the foundation stones of a yet far-distant nationhood. It is this process of infiltration of ideas from various Brahman centres of learning into the mass of different peoples and tribes of India—each with its own ancient traditions, customs and religious beliefs—that accounts at once for the uniformities and for the diversities of the Hindu caste system. The teaching of some Brahman schools spread more widely than others; the cultures of some peoples proved more resistant than those of others; particular characteristics of these cultures differed in the way in which external pressures changed or modified them. As a result, there are exceptions to every rule of Hinduism and to every interpretation of caste.

When the British assumed control in India, caste restrictions had perhaps reached their zenith. J. H. Hutton records a number of extracts about south India, from the writings of British officials of the 19th and early 20th centuries, which contain elaborate distance tables laying down limits of approach within which the mere presence of the lowborn was held sufficient to pollute their betters. For example, a Nayar (*q.v.*) might safely approach a Brahman within a few feet, but could not touch him without defiling him. The presence of a Tiyan toddy-drawer was enough to pollute a Brahman at a distance of 36 paces, and that of a Pulayan at no less than 96 paces. As late as 1932 an Indian newspaper reported the presence in Tinnevelly (Tirunelveli) of a caste group, called the Purada-Vannan, so degraded by its occupation—that of washing the clothes of untouchables—that it was classed as unseeable and compelled to live a nocturnal existence.

The caste taboos of south India cannot be taken, of course, as representative of the situation throughout India—since there is a progressive diminution in the severity of these taboos from south to north—but they do afford the sharpest illustration of what has become, in modern times, a pressing political problem. These restrictions upon touching, approaching and even seeing, which divided the highborn from the lowborn, resulted in a wide range of practical steps to see that they never met if it could be avoided. The lowest caste groups—the so-called untouchables (*q.v.*)—were forbidden to enter temples and schools used by their betters; they had to draw water from different wells and often to use different paths; they had to live in separate hamlets remote from the villages they served as menials. Thus not only were their daily actions woefully restricted, but their children were prevented, by the ban on school entry, from securing the very education through which alone they could hope for social betterment.

The role of the British in this situation was very confused. As individuals, to whom freedom of thought and action was the breath of life, they protested vigorously against immutable caste barriers. As Christian missionaries, they preached the gospel of equality before the Lord, and took into the Christian fold many who wished to escape the restrictions of caste. As industrialists, they brought to India an immense economic development: new industries and hence new classes of employment; new economic desires and new means of satisfying them; new horizons and the road, rail, sea and air transport necessary to reach them. As administrators, however, they held aloof from the struggles for power and status within the caste system on the grounds that these were, in the main, religious matters in which it was not proper for an administration to intervene. While, therefore, they laboured on the one hand to further the social and economic emancipation of the people at all levels, on the other they resolutely refused to take any official part in an assault upon the very citadels of mystical belief which checked that emancipation at every step.

Meanwhile the vast increase in both economic and physical mobility which stemmed from new industries and better transport led to great movements of people: the Telegu- and Tamil-speaking caste groups to the rubber plantations of Burma and Malaya and to dock labour at many Asian ports; the central Indian hill tribes to mine work and to the tea plantations in Assam; the Uriyas to track maintenance on railways throughout India; the Biharis to Calcutta mills and factories, and people from all over India into pilgrimages to the Hindu holy places. Moreover, the use of public transport and the difficulty of distinguishing between high and low caste strangers made it impossible for even the most fastidious to escape touch pollution. At the same time work in factories, long-distance travel and residence in crowded kitchenless tenements in the big cities made it increasingly difficult to maintain the traditional food taboos. Fortifying these tradition-destroying influences, and receiving strength from them, was the yeast of political ferment which the British introduced into India with education and democratic local government. In time the forces of tradition and emancipation ranged themselves into powerful political parties, with the traditionalist Hindu Mahasabha on the one hand and the associations representing the scheduled castes of untouchables at the other.

The government of independent India, greatly daring, pronounced untouchability illegal (1949), threw open the temples and other holy places, and declared itself unequivocally opposed to the social barriers of caste. Few who know India would say, however, that the battle against caste has been won. The bitterness of the opposition to reform—a bitterness which resulted in the martyrdom of the national hero Mahatma Gandhi—is deeply rooted in beliefs which have withstood alike the assaults of Aryan nature worship, of Islam and of Christianity. Moreover, as will be shown, there is a positive as well as a negative side to caste, great advantages to the ordinary man as well as disadvantages for the underprivileged. These positive advantages take the form of reciprocal co-operation at all levels of the caste system, the provision of help in the building of houses, in the tilling of fields, in the meeting of life crises such as birth, marriage and death, in economic and financial transactions, and in sickness and injury. The creation of an Indian welfare state may lift from the caste groups the burden of responsibility for many of these aspects of social co-operation, and a developed trade unionism may take over many of the economic duties which now fall upon them. In the meantime these positive advantages of the caste system are a force which cannot lightly be dismissed from calculations about the future.

The Nature of the Hindu Caste System.—Among the causal principles which together give uniqueness to the Hindu system are beliefs concerning: (1) the nature of the universe; (2) the relation between status, purity and pollution, and the process of metempsychosis; and (3) the relation between the Absolute Power and lesser gods, ancestor spirits and sprites which haunt hill and dell.

Associated with these causal principles are a number of modal principles governing the ways in which the units of caste society are composed: patrilineal, matrilineal, and bilineal descent; unilineal, bilineal and local exogamy; local group and kin group endogamy; commensality; polygamous marriage (now illegal), hypergamous marriage (marriages between lineages of different status, the higher of which will take wives from but not give daughters in marriage to the lower), widow marriage and even concubinage. A necessary first step toward an understanding of the Hindu caste system is, therefore, a brief statement concerning the interrelationships among the structure of Hindu social groups, the principles and practice of stratification within the system and its validation by mystical beliefs.

The Hindu social order is founded upon a number of basic units common to all wider groups of which they form part, and a number of other units which are to be found—in differing combinations—in some but not all of these wider groups. The basic units are: (1) the nuclear family, consisting of father, mother and their children; (2) the joint family, a two- or three-generation segment of a lineage (*i.e.*, grandfather and grandmother, their married sons and their wives and children, or, much more rarely, a group of brothers and their families), which uses resources in common, and often feeds and resides in common; (3) the lineage, a group of nuclear or joint families linked by known or putative descent (which may be patrilineal or matrilineal) from a common ancestor; and (4) the endogamous group, the all-important *jati*, composed of a number of intermarrying lineages whose members must marry within the group.

The other and more variably distributed groups are: (1) the polygamous family, which may be a polygynous group consisting of a man and his wives and their several children, or a polyandrous group consisting of a woman, her children, and the several husbands by whom she bore them; (2) the exogamous group, which may be a lineage or part of a lineage, a bilineal group of relatives on both paternal and maternal sides of the house, a *pravara* group (*i.e.*, a group of people who, though not closely related, regard intermarriage as repugnant because they come under the protection of the same personal saints, usually three), or a local group such as a village; (3) the commensal group, which may be coterminous with an endogamous group or may contain several endogamous groups which regard themselves as sufficiently equal in status to justify interdining; (4) the caste association, which may contain several commensal groups (though not necessarily all those which claim putative descent from a common ancestor, since there may be differences in status too wide to bridge) with enough economic or political interests in common to justify co-operation in certain aspects of social life; and (5) the class of caste groups (*e.g.*, the four *varna* of Sanskritic scriptures, and the *Duija*, or "twice-born," class of caste groups which are entitled to wear the sacred thread).

There are special activities to be performed, or special privileges to be enjoyed, at each of these levels of caste society. The nuclear and joint families are concerned with the day-to-day economic activities and with household ritual; the local lineage segment is brought in to lend its help and advice at births, marriages and deaths, and in the judgment of minor breaches of custom; the whole lineage, or the appropriate exogamous section, is taken into account when new marriage ties are considered; the wider endogamous group is consulted when major breaches of custom are judged or when disputes arise with other caste groups; the commensal group is concerned with some breaches of custom, with all attempts to modify caste status and with the feeding arrangements at big festivals; the caste association is brought into being to meet political ends and so on. There are few hard and fast rules, however; each minor situation is met by an *ad hoc* gathering of kinsmen equal to dealing with it, each major crisis by the summoning of an appropriate wider group.

Differences in ways of tracing descent and creating ties through marriage and exogamy result in a bewildering range of variations in the composition of endogamous groups in the Hindu system. Nevertheless these internal structural differences have little effect upon the social function of endogamous groups, since they are the principal locus of caste status, and it is from this fact that they derive their great importance in Hindu society.

Lesser groups within endogamous groups may vary in status according to primacy of descent and other reasons, but variation in the kind of group status generally associated with caste begins at the level of the endogamous group. Whatever the structure of such a group—whether it is composed of patrilineal or matrilineal lineages or of kin groups formed by polygynous, polyandrous, parallel- or cross-cousin marriage—its relations with other groups follow a uniform pattern. It possesses a status which is recognized as above or equal to or below that of neighbouring groups of the same kind. These neighbouring groups will react toward it in accordance with this status rating, accepting food from its members (even though they will not reciprocate), or eating with it, or refusing to eat with it, in the light of their relative positions in the status system. Status variations within endogamous groups have little significance outside them. Seen from within by one of its own members, such a group might appear to be composed of units of unlike status vis-à-vis each other. Seen from the outside, vis-à-vis members of other endogamous groups, all such units would appear as of one status, that of the endogamous group to which they belong.

The fact that caste status is located in endogamous groups rather than classes stems from a belief in retributive metempsychosis (*karma; q.v.*) and in an ordered universe in which animate creatures are arranged in a hierarchical order with humanity above all other forms of life and orthodox Brahmans above all other forms of humanity. *Karma* is regarded by some authorities (*e.g.*, J. H. Hutton) as a process of automatic retribution and by others (*e.g.*, S. Radhakrishnan) as "not a mechanical principle but a spiritual necessity. It is the embodiment of the mind and will of God. God is its supervisor—*karmadhyaksah*." It is a mystical law of retribution of which the machinery of execution is the caste system, and by virtue of which each man reaps what he sows. Status at birth is determined by the status of the endogamous group into which he is born. But the locus of reincarnation—in the person of a child of high or low degree—is determined by behaviour in previous existences. Those who behave well in one life achieve a higher status at rebirth, those who behave badly suffer a fall in status. An important point here is that goodness and badness of behaviour are judged not in terms of absolute moral values but, as will be seen later herein, in terms of attention to certain rules of life (*dharma*) which vary from one status level to another.

The relative status of endogamous groups in the Hindu social system is fixed by reference to several criteria, of which by far the most important is behaviour in relation to a corpus of beliefs which have been labeled (by H. N. C. Stevenson) as the Hindu pollution concept. Each endogamous group follows its own particular pattern of behaviour in this respect, and individuals are made to conform to these patterns by a variety of sanctions. Some of these sanctions are vested in the councils (*panchayats*) of endogamous groups and derive their force from the ultimate sanction of expulsion from the group. Others are vested in civil courts and in local councils such as the village *panchayat* and derive their force from Brahmanic law.

These group behaviour patterns impose upon individual members both positive duties and negative prohibitions. The birth of a child, initiation, menstruation, marriage and death are all occasions which give rise to actions circumscribed by beliefs concerning pollution. Daily life, too, is similarly circumscribed, since the pollution concept governs the kinds of occupation appropriate to various status levels, the kind of food or drink that may be consumed and even the ways in which water may be drunk or pipes smoked or food cooked. It is the interrelationship between beliefs about the universe, about pollution and purity, and about stratification of kinship groups occupied by people passing through a process of metempsychosis that gives to the Hindu caste system its unique character.

The Hindu Pollution Concept.—It has been shown by Stevenson that the status of endogamous and commensal groups in the Hindu caste system (and hence of their individual members) is mainly dependent upon behaviour patterns which conform to, or infringe, certain rules of purity and pollution. There are a great number of such rules, but many are of minor importance and affect the status of only a limited number of caste groups. The really important rules—those, for example, which demarcate the touchable from the untouchable caste groups—are as follows: (1) that destruction of the Life Principle for a living (as in oilseed crushing, bird trapping, fishing) is polluting—a rule which accounts for the fact that the oilseed-crushing section of the Teli (oilman "caste") is of very low status, whereas the oil-selling section is of relatively high status; (2) that death and decay are polluting, and therefore all occupational association with them is polluting—a rule which accounts for the low status of all groups whose duties include officiating at funerals (*e.g.*, the low-caste Mahabrahmans) or the removal of the carcasses of dead animals; (3) that all human emissions are polluting, and therefore occupational association with these, too, is polluting—a rule which accounts for the low status of washermen, barbers, midwives and lavatory attendants; (4) that the cow is sacred above all other animals, and that killing it, flaying it, dealing in its skin, doing leatherwork, or eating its flesh is sinful, and therefore polluting—a rule which accounts for the low status of shoemakers and all the beef-eating caste groups; (5) that the drinking of alcohol is polluting—a rule which accounts for the fact that liquor selling has come to be almost exclusively a low-caste occupation; and (6) that marriage is a binding sacrament, and therefore the remarriage of widows is polluting—a rule which accounts for the continued ban on widow marriage.

A survey of the Indian census reports of the 20th century, many of which give information concerning efforts made by caste groups to achieve a rise in status, shows clearly that it is wrong behaviour in the light of the above-mentioned rules that looms largest in Hindu eyes. All such status-raising attempts commence with the holding of a meeting of the endogamous group or commensal group concerned, at which proposals are put forward, for example, to give up eating beef or drinking alcohol or marrying widows. The pattern of action then follows one of three lines: the whole group may accept the proposals and alter the pattern of group behaviour; the whole group may reject the proposals and continue to adhere to the traditional behaviour pattern; or more or less equal proportions may be for and against the proposals, resulting in fission of the group into two endogamous groups, one of which will follow the new pattern of behaviour and one the old, the former usually claiming a higher status than the latter and ceasing all social intercourse with it. When a whole group adopts new behaviour, or a breakaway group does so, their first step is to take a new name to indicate their changed status. Usually they will hyphenate their old caste name with that of a higher caste—a common choice being Rajput (*q.v.*)—and after the lapse of some generations, when the low-caste associations are fading into the past, they will drop the old half of the double name and retain only the new. Often they succeed, through time, in assimilating themselves completely to the higher status group by a series of marriages, which will be hypergamous in the first instance, but equal as their status rating rises. Many strenuous efforts were made by reforming caste groups to secure immediate recognition of their changed status, a later example being the Satnamis, but all failed. It is held that inbred group pollution cannot be voted away in a flash; it must be bred out by generations of improved behaviour.

There is a remarkable consistency about the way in which these rules concerning purity and pollution operate in different social situations. One example is the rule concerning human emissions. Every kind of human emission is polluting; breath, spittle, nasal mucus, semen, menses, urine, feces, sweat or body grease, even glances and shadows fall into this category. Direct occupational contact with any of these is polluting, but so, too, is secondary contact. For example, any caste group which eats the flesh of domestic pigs is of as low a status as a caste group which cleans latrines, because pigs are village scavengers and feces eaters. On the other hand, caste groups which eat only wild pig are not downgraded, because these are held to be clean feeders. As another example of consistency may be cited the relationship between external and internal pollution. External pollution, which can be removed by washing, is regarded as far less serious than internal pollution, which entails a purification ceremony involving the drinking of a cleansing agent such as Ganges water or *Panchgavya* (the five products of the cow—milk, ghee [clarified butter], curds, urine and feces). Hence we find that the left hand, traditionally used to wash the body after defecation, is never used for eating because it might cause internal pollution; a man may have coitus with a low-caste concubine—provided he bathes after so doing—but may not eat food touched or cooked by her; a high-caste man having coitus with a low-caste woman can be cleansed by washing, whereas a high-caste woman having coitus with a low-caste man is internally polluted and therefore outcast; porous containers for food and water, such as earthenware pots, are regarded as more easily polluted than nonporous metal pots; almost any water may be used to bathe in, but drinking water is protected by a wide range of prohibitions because, though water will carry away external pollution by washing, it will also carry internal pollution into the body if accepted from polluted hands or vessels; food may be washed in almost any water, but may only be cooked in unpolluted water, since water penetrates food in cooking and so may pollute it internally; hookah pipes belonging to other people of lower status may be smoked only if the spittle-infected mouthpiece is removed and if the cupped hands are used as a funnel to inhale smoke, since this method obviates any danger of internal pollution. It should be noted that all of these examples concerning internal and external pollution have one important feature in common: they illustrate the way in which ideas about pollution uphold sound sanitary principles and, taken in conjunction with the elaborate sanitary arrangements evident in the ruins of the ancient Harappan cities, they indicate the probable antiquity of the beliefs underlying them.

To summarize this section, it has been seen: (1) that there are a few important and many minor rules concerning pollution that impose restrictions on caste-group behaviour and determine the ritual status of these groups; (2) that groups can change their status, over several generations, by changing their behaviour to conform with these rules; and (3) that these rules are consistent in their effect upon behaviour of many different kinds. The next step is to consider how these rules affect the status and behaviour of individuals.

Status Evaluation.—Status in Hindu society falls into two broad categories—secular status and ritual status (to use the term for mystical status generally used in anthropological literature)—which are derived from different sources and which manifest themselves in different ways and serve different ends. In general, secular status attaches to individuals and classes rather than to groups and is derived from such criteria as wealth, landownership, education, skill and sometimes, as in the case of government servants, from occupation. Its chief function is to provide additional temporal incentives for effort, and some amelioration, for those who find them intolerable, of the inescapable inequalities of ritual status. Ritual status, on the other hand, attaches to both individuals and groups with equal force and is derived from mystical beliefs, particularly those noted in the previous section, which have been described by many authorities, notably S. V. Ketkar, as "the chief principle upon which the entire [caste] system rests."

There is an important difference in the ways in which the ritual status of the individual—as opposed to the ritual status of groups—affects both individual and group behaviour. Every Hindu possesses two kinds of ritual status, one kind deriving from his individual behaviour and the other from the behaviour pattern of the endogamous group into which he is born. It has been shown that group-derived ritual status cannot be raised during the lifetime of an individual, since the upgrading of group status involves generations of effort. Individual ritual status, on the other hand, is variable both upward and downward, and in this two-directional variability lies the key to advancement in status through the process of metempsychosis. By raising or lowering his individual ritual status above or below the level of his group-derived ritual status a person is able to project his soul into its next life at the level of individual ritual status acquired before death. The individual-status finishing point of one life is the group-status starting point of the next life. The advancements of individual ritual status gained in each lifetime are the steps up which the soul mounts into rebirths at higher group-status levels.

There are three pathways by which a person can proceed to raise his individual ritual status: (1) Dharma Marga, the path of duty or service; (2) Bhakti Marga, the path of devotion to the gods; and (3) Jnana Marga, the path of knowledge through realized experience.

Dharma Marga, the path of duty, is of the greatest sociological significance since it provides the mystical validation for the sanctions which uphold the rules of caste. Observance of *dharma* (the right way of life) is not a question of following some absolute standards of right behaviour; it implies, to each Hindu, following the rules of his particular endogamous group. Even if group behaviour demands what one could call sinful behaviour, such as the robbery practised by some criminal caste groups or the ritual murder of the Thugs, it is the duty of every Hindu to adhere to this group pattern, for it is ordained that he should do so and suffer whatever consequences befall. The proper achievement of the four main ends in life—*dharma*, or right living; *artha*, or wealth; *kama*, or artistic and cultural fulfillment; and finally *moksha*, or spiritual release—is only possible when wealth and happiness are sought in the context of *dharma*, which means the context of caste rules. There is no escaping this—"Each man is said to have his own specific nature (*svabhava*) fitting him for his own specific function (*svadharma*), and changes of *dharma* or function are not encouraged." The belief in Dharma Marga, therefore, is a powerful buttress to the Hindu status system, and to its rules and sanctions. It enforces upon the individual the duty of following the very patterns of behaviour which fix the position of his group in the status hierarchy and so enchain him. It rewards him for so doing by making adherence to duty a pathway to higher status in the next worldly life.

Bhakti Marga, the path of devotion, has no such divisive function; on the contrary, it binds people together through links of worship and benevolence. It involves the showing of devotion to the gods by attention to the appropriate ceremonies and festivals, by the performance of benefactions such as the building of shrines, temples, rest houses, wells, and (in later years) schools and hospitals, and by pilgrimages to Hindu holy places such as the Ganges river.

All of these activities, while raising the individual ritual status (*punya*) of those who perform them, also give pleasure, sustenance, shelter, or employment to others, thus maintaining the pattern of ancient rituals and creating new ones, welding together the discrete specialist groups and regions of Hinduism and giving a sense of oneness to the entire Hindu polity.

Jnana Marga, the path of knowledge or wisdom, has yet other effects. It involves the renunciation of social life and the withdrawal into asceticism, or meditation in the wilderness; it is for the individual to follow, not the group, and of all the paths it is the quickest route to that blessed final release (*moksha*) from the wanderings so earnestly desired by every Hindu soul. The merit acquired through the discipline and suffering on this path is enormous, enough not only to gain veneration in this life but also to secure release from several worldly existences in the round of metempsychosis. It is the element of renunciation in the path of knowledge that accounts for the paradox that whereas a low-caste man living a normal social life is despised, the same man, living the life of an ascetic, would be revered. Status is associated with privilege; hence status acquired in the context of social life constitutes a threat to the established privileges of higher status groups and is therefore strongly resisted. The ascetic withdrawn from social life, however, competes with no man for wealth, power, position or wives; hence his status constitutes no social threat and can, therefore, be conceded without demur. Improved communications led to vastly increased potentialities of pilgrimage, and as a result many thousands of charlatans have appeared at holy places masquerading as holy men. Nevertheless, genuine holy men soon become known, for even in rural India it is only possible to deceive some of the people some of the time.

The three paths to higher individual status, each in their different ways, serve to consolidate the caste system. The path of duty emphasizes and validates the division between status groups; the path of devotion emphasizes the unity of the system as a whole and links diverse groups in common worship and benevolence; the path of knowledge provides an escape from the chains of status for those who have the tenacity and physical fortitude, and underlines the important fact that throughout the system as a whole high status is linked with austerity and low status with licence.

The interaction of secular status and ritual status, and between individual and group-derived status, is complex in the extreme and has been much confused by overstressing the importance of group-derived status. There has been very little research into this important aspect of Hindu life, and all that may be said with assurance is that (1) individual ritual status fixes the position of the individual in relation to his afterlives; (2) group-derived ritual status fixes his position in the context of society; and (3) secular status modifies its impact on daily behaviour either by deepening status divisions, as when poverty coincides with low ritual status, or by reducing them, as when wealth or high temporal office comes to a man of low-caste status (the political leaders of the so-called untouchables providing a good example of this).

In concluding this section on status evaluation, mention must be made of the distinction between temporary and permanent pollution. The group-derived ritual status acquired by an individual at birth is permanent insofar as it cannot be raised within the context of group life. This permanence is, however, unidirectional; though it cannot be raised, it may be lowered by wrong actions. If, for example, a person commits sins of commission or omission concerning caste rules he may become temporarily polluted and suffer banishment until he has been purified by appropriate ritual. If his sin is such that his own group will not readmit him, or if he refuses to perform rites of purification, then his temporary pollution may become permanent. He—and his family if they do not abandon him—will have to seek new associates among similar outcasts or, as often happens, enter some established group so low in relative status as to be indifferent about who joins. Thus the outcast enters a new group relationship, and in so doing acquires a new and lower group-ritual status which will be inherited by his children. Similarly a whole endogamous group may lose relative status by wrong actions, carrying all its individual members down with it.

In practice, these ideas about purity and pollution have led to the creation of a particular kind of social mobility—that is, a group mobility—which is distinct from that found in any other society. Ritual status is linked to behaviour traits which can be changed, and groups change their ritual status by changing their behaviour pattern. In this milieu the position of the individual is very different from that of an individual in western society.

In the west—despite the fact that traces of ideas about purity and pollution somewhat similar to those found in Hindu India are discernible in the attitudes of certain white persons to Negro peoples—ritual status has little significance in social life. If a western individual raises his secular status by, for example, securing promotion, that advance in status will be reflected throughout the whole context of his social life. He will move in higher circles, become a member of more exclusive social and recreational groups and may well marry his children into better-class families. The Hindu individual is not so fortunate. To him ritual status is as important as secular status, but he cannot usually raise them both at the same time. To raise his secular status he must remain within the context of social life and exert himself to gain wealth or power or prestige, but in so doing he emphasizes the restrictions of ritual status, for over a wide field of social activities, including, for example, marriage and interdining, it is his ritual rather than his secular status which will determine the attitudes of others toward him. If his ritual status is relatively very low, increasing secular status may simply bring an added sense of frustration and unhappiness. On the other hand, if he wishes to raise his individual ritual status, the Hindu must relinquish social life altogether. Whereas a lowborn western man can aspire to an exalted state of grace and a high secular position at one and the same time, the lowborn Hindu must choose between one or the other. If he chooses high ritual status, he must cut himself away from kith and kin and become an ascetic—a social isolate.

The linking of the group mobility in the status system to behaviour patterns associated with the Hindu pollution concept had one all-important sociological consequence. It bridged the racial, cultural, linguistic and spiritual gulfs which divide the multifarious groups of India and slowly but surely brought them all, no matter what their colour, creed or class, within one all-embracing frame of status reference. In so doing it created an awareness of a wider social unity which, together with political unity, made possible the sense of nationhood which animates all Hindus.

Status and Occupation.—Contrary to popular belief in other lands, few Hindu caste groups of any size can be classed as occupational groups: the most that can be said is that some groups have a traditional lien on particular occupations and ritual tasks which their members may exercise if they so desire. The Indian census tables of the 20th century make it clear that for many decades a large proportion of the members of every caste group—in some cases as high a figure as 90%—follow occupations other than those specifically associated with their own group. Even among Indian writers there have been wide differences of opinion about the true relationship between caste and occupation. For example, S. V. Ketkar claimed that a man could take up any occupation save that of shoemaker or scavenger without losing caste status, but there is ample evidence that other occupations, such as that of washerman or barber, would also have this effect. G. S. Ghurye, with greater caution and accuracy, was content to state that agriculture, trade and military service are open to all caste groups without loss of status.

It appears, in actual fact, that the vast development of economic opportunity, which started during the British regime and continued thereafter with gathering momentum, created a situation in which two processes of change began to take place simultaneously. On the one hand, older caste groups such as the barbers and washermen are breaking down into smaller units because so many of their members no longer follow the traditional occupation and tend to despise those who do. On the other hand, new caste groups are being formed around new occupational specialisms —skilled mechanical work, semiskilled dock and plantation work and so on—because caste affiliations are used, all over India, to facilitate labour recruitment. Once a caste group has attached itself to a particular kind of work it soon increases its hold by bringing into it only fellow members of the same group. The system of providing a substitute (*badli*) of their own caste group to replace all who are away from work through sickness or holidays ensures that no other group is able to penetrate the economic preserve thus created. If the new occupations taken over in this way are markedly higher in status than the traditional occupation of the groups concerned, those who follow them may break away from the older groups as soon as they are sufficiently well established to do so, and from new endogamous or at least hypergamous units. If, as is often the case, there is no significant difference in status, the old caste groups will remain intact, acquiring a lien on new occupations without relinquishing their lien on the traditional one.

Status and Commensality.—Some authorities regard the practice of commensal restrictions as the keystone of the Hindu caste system. Unlike the restrictions of endogamy, which are wholly divisive in their effect upon Hindu society, commensal rules deriving from the Hindu pollution concept are at once divisive and unifying. They are divisive because they emphasize different degrees of purity and pollution. They are unifying because, unlike the rules of endogamy, which exclude all outsiders whether of high or low degree, commensal restrictions usually work in one direction only. All Hindu caste groups are arranged in a loose hierarchy, which varies in minor details from one region to another and in which groups of high status may give food to but will not take food from groups of lower status. Thus, while this type of commensality emphasizes the status distinctions between groups, it also emphasizes the fact that all are parts of a wider system; in other words, it emphasizes the unity of Hindu society as a whole. A good deal of misunderstanding about commensal rules has arisen because it has been assumed, quite wrongly, that they refer only to the act of giving or taking food, or to the act of eating together. In fact they refer also to the method of preparation and presentation of food and vary according to the kind of food and the means used to cook it. A guest may eat in the house of a person of lower status provided that the food is cooked and served by a person of equal or higher status, which explains why Brahman cooks are so popular in many parts of India. Uncooked food, such as fruit, may be accepted from anyone, since washing it in water will remove any pollution. Food cooked in water is highly vulnerable to pollution and may not be accepted if cooked by anyone of lower status than the recipient. On the other hand, food cooked in ghee, which is a powerful purifying agent, may be accepted from persons much lower in status, and so too may food such as popcorn, which has passed through the purification of fire.

Commensal restrictions deriving from sources other than the pollution concept take different forms. Tribal commensality, for example, which is often based upon the belief that only those under the protection of the same tribal gods should eat together, is usually two-directional, interdining being forbidden with all outsiders, high and low alike. This is why the acceptance of one-way instead of two-way commensal restrictions is one of the most important tests of assimilation of exterior tribes into the caste system. Then there is the kind of small kin group commensality derived from beliefs about the sanctity of the hearth, which is the resting place of lineage spirits. Thus, in some caste groups, families will join in feasts prepared by the caste authorities but will refuse to allow even their married daughters to cook for them in the family hearth, on the grounds that marriage has taken them away from the protection of the spirits of their natal lineage and placed them under that of the spirits of their marital home.

Status and Religion.—An important feature of Hindu ideas about purity and pollution is that they cross both religious and sectarian boundaries. Social behaviour is evaluated for ritual status purposes by a single standard—that of the Hindu pollution concept—regardless of the religious group to which the people belong. Religious beliefs are evaluated in relation to a different criterion, the degree of understanding of the Ultimate Truth concerning the nature of the Absolute Power. All religious beliefs are held to be partial revelations of the Ultimate Truth. Persons who worship the avatars, or incarnations of the Absolute Power—Vaishnavites, Shaivites, Buddhists, Christians—are regarded as superior to those who worship nature spirits. Those who through meditation and devotion receive a revelation of the Absolute Power are further advanced than the devotees of the avatars. Understanding of the Absolute Power is an aim to be achieved, but the way to achievement is different from that by which status in society is achieved.

In Hindu eyes it is possible for a person or a group to be advanced in understanding even though they may be degraded in behaviour, and vice versa, and thus all the main religious divisions of India have been invaded by status evaluations based upon the pollution concept. Converts to these religions, unless they change their behaviour pattern as well as their faith, retain their Hindu ritual status. They tend, therefore, to form commensal and endogamous or at least hypergamous subgroups based upon this status as, for example, the Muslim Ghosi and Kingariya, who do not eat beef and limit their interdining to those among the Muslims who observe this Hindu restriction. Sectarian divisions within the Hindu fold, such as that between the followers of Vishnu and Shiva, have little effect upon ritual status unless they impose such differences in behaviour as the strict vegetarianism of some groups of the Jain sect.

Caste-Group Government.—The observance of caste rules and the maintenance of caste discipline are secured through a quasi-jural system of councils which are appointed by, and operate through, kinship and commensal groups and local sections thereof. It is common to find the officials of caste groups labeled with the titles of the old Indian princely courts—*munsif, diwan, sipahi* and so on, "all the way down from vice-president to orderly." Over a large part of India the symbol of the council is its mat, and that of its chairman or headman a turban. Where official posts are permanent they are usually hereditary, subject to mental fitness and good behaviour.

The primary task of these councils (*panchayat*) is to preserve the traditional ritual, the marriage and inheritance laws and the behaviour patterns associated with the pollution concept, which give to each caste group its particular social identity and status. They have also a number of secondary tasks of considerable importance, among which are: (1) the protection of the "trade union" rights of the caste groups and the settling of disputes among their members about such questions as the inheritance or sale of good will; (2) the licensing of activities which by custom require such permission from a caste-group authority; (3) the initiation of co-operative effort, such as the provision of scholarships at schools and universities, the building of temples and so on; and (4) the negotiation of agreements for caste-group members with local authorities such as the village council, with members of other caste groups and with the central government authorities.

Lower councils in the system are located at the level of (1) local brotherhoods (*biradari, bhaiband*), that is, the members of a lineage segment who live in the same village ward or village and who are able, therefore to co-operate effectively in daily life; and (2) local groups of intermarrying lineages who live in contiguous clusters of villages. The size of the units controlled by these lesser councils varies according to the practical possibilities of the local situation rather than any traditional rules. Where villages are small, all members of a lineage will come under one council; in large villages and in towns, where lineage segments may be widely dispersed, there may be more than one brotherhood council. Similarly, where villages are close enough together to make contact and consultation easy, local sections of endogamous groups, that is, the lineages which have established marital ties with each other in neighbouring villages, may establish a local council to deal with affairs of particular interest to them.

It is difficult to determine where the ultimate authority in caste matters lies because of the overlapping jurisdictions of different courts administering differing codes of law. At the base of the jural pyramid there is the custom of the kinship and commensal groups of caste society and the customary law of the unassimilated tribes. Overlapping part but not all of this area of custom are different systems (*e.g.*, the *Makkathayam* and *Marumakkathayam* variants) of Brahmanic law. Overlapping both custom and Brahmanic law there is state law. Above the level of the caste courts there is a hierarchy of state courts, each level of which acts as a court of first instance in some matters, and, in others, as a court of appeal against the judgments of the next lower court. A strongly disputed case concerning the custom of a caste group may go on appeal to the various levels of caste council until a final decision is reached at the top level, or, on the other hand, the case may be taken to a state court at some stage in the proceedings. Much depends on the nature of the case and the power of the caste-group councils. For example, a charge of breach of pollution rules brought before a weak caste council is sometimes answered by a countercharge of defamation in a state court. In contrast, caste-group councils are sometimes in a strong enough position to forbid their members to give evidence in state courts even about such serious matters as murder and robbery, and in such circumstances no appeal would be made to state courts against caste-council decisions.

In ancient days the kings and princes of India exercised appellate rights in caste matters and had the power not only to overturn the decisions of caste-group councils but also to raise or lower the status of the caste groups themselves. In the 20th century the position changed, mainly, it is claimed, because the British in India exercised such care not to interfere with local custom if interference could be avoided. It appears probable, however, that in practice the princes of old interfered less with caste custom, despite their powers, than the British who tried so hard not to do so. An ancient convention, which governed the actions of all prudent princes in those perilous times, laid down that, where local custom conflicted with Brahmanic law, local custom should prevail, provided only that no outrageous sin (such as, for example, the killing of cows) went unpunished. This convention, coupled with the tolerance of diverse ritual and beliefs inherent in the Hindu religion, was sufficient to preserve caste-group customs almost intact up to the advent of the British. Under British-Indian rule, too, there was a convention that such caste customs as were not repugnant to natural justice should be left untouched; but the greater power of the government, and its desire for administrative and judicial efficiency and uniformity, led to interpretation of this convention in a very different way. The application of western legal, social and moral principles, so different in many ways from those of Hindu India, caused far-reaching changes in administrative and judicial procedures which in themselves altered beyond recognition the balance of rights, duties and privileges of caste-group membership.

A single example will suffice to demonstrate the depth of these changes: the example of the Indian Evidence act. Cases coming before caste-group councils are discussed in open meetings in which all adult males of the group concerned are entitled to take part. Accuser and accused, together with all their witnesses, gather before the appointed elders and give their evidence in the presence of the opposed parties and of the assembled members of the caste group. In considering the likelihood of the offender's having committed the offense of which he is accused, the council will take into account every item of evidence that can be produced by either party, or by the onlookers, or even from the personal knowledge of the members of the council. The past histories of the contending parties, their moral excellence or turpitude, the state of their health and of their bank balances, and their relationship as kith, kin or business associate with those concerned will all be examined to see whether or not they have some bearing on the probabilities of the affair. In effect, even though these precautions do not obviate injustices altogether, they do at least lessen tensions and enable people to live together without an undue sense of frustration. Everyone is able to say everything he wants to say; every hidden influence, every cherished loyalty and carefully nurtured spite is exposed to the gaze of the whole caste group. If there are undercurrents too strong to be overcome, everyone knows what they are and why the council can do nothing about them.

The application of the Indian Evidence act to the procedure of the state courts of law created a situation almost diametrically opposed to these traditional processes of justice. Not only is the trying judge or magistrate often innocent of any knowledge of the caste customs of the parties concerned and of their local, kinship and business affiliations, but he is expressly forbidden, by criteria of relevance derived from an alien culture, to call for evidence which by rural standards (and Hindu India is four-fifths rural) is vital to the issues under discussion. Under the circumstances judgments are passed—with the best will in the world—which in the eyes of humble people, who have no understanding of the reasons underlying them, are a travesty of natural justice. The ignorant and bewildered peasantry, conscious only of their abysmal innocence of all things legal, have fallen completely into the hands of the hordes of third-rate pleaders, writers and interpreters who throng the courts, because wealthier men, conscious of the advantages of taking cases to courts where they can employ more skillful lawyers than their opponents, bypass caste-group and village courts whenever possible. The primary result of this development was twofold. On the one hand, it weakened the power of caste government throughout India, since wealthy offenders could escape more easily the consequences of wrongdoing: on the other hand, it brought the state judicial processes into disrepute. In this tug of war between custom and law each undermined the disciplinary influence of the other, a reversal of the old pattern of Hindu society, in which each buttressed the other and in so doing fortified itself.

Caste government in the widest sense begins, of course, at the level of the nuclear family. As husband, a man has almost complete control over the actions of his wife, a control backed by the sanction of corporal punishment if and when necessary. As member of a lineage, the performer of ancestor rites and spokesman for those among whom the children of the family hold rights of succession and inheritance, the father, or mother's brother where matrilineal descent prevails, is vested with disciplinary rights over these children, to enable him to see that they conform to caste custom. It is at this level that responsibility rests for seeing that children are brought up in full knowledge of the ways of the caste group; it is here that they must be taught what they may or may not eat and drink, what occupations they may follow, what clothes and ornaments are appropriate to their station, how they must comport themselves toward other members of the caste group and toward outsiders and so on.

The next level of caste authority is found in the head of the joint family, where these exist. In joint families it is usually the eldest male who exercises—subject, naturally, to his being in full possession of his senses—the functions of manager of the group resources, arbiter in disputes between nuclear families within it and spokesman for it in dealings with the world outside it. Unfortunately, for it had helped to mitigate the pernicious influence of land subdivision and had conserved resources of all kinds, the joint family is steadily disappearing from the Hindu scene under the pressure of economic mobility, improved communications and widening opportunities of work for both men and women.

Then comes the council of the local brotherhood, smallest of the representative bodies in caste government, consisting of the heads of joint or nuclear families of a single lineage. The size of these brotherhood councils and the duties they perform depend largely upon such practical questions as the physical distance which divides the co-operating families, the kinds of task or ritual in which they co-operate, their numbers and the degree of agreement between them. Since lineages and often segments of large lineages are exogamous, observance of the rules of exogamy is one of the most important matters with which brotherhood councils have to deal; other important matters are succession, inheritance, the findings of bride price or groom price as their custom may demand, and trade-union activities. Precedence in brotherhood councils usually depends upon primacy of descent within the lineage, but every independent unit, whether joint or nuclear family, is entitled to representation, and every male has the right to attend meetings and have his say.

Next comes the most important level of caste government—the council of the endogamous group. Stress has been laid herein on the fact that the deepest division of status in the caste system is that which divides one endogamous group from another, and it is this fact which gives to endogamous group councils (or subcaste councils as they are often, and loosely, termed) their unique place in Hindu life. It has been seen that the boundaries of intermarriage are fixed largely by behaviour patterns associated with the pollution concept, and it is the maintenance or, if possible, the betterment of these behaviour patterns that is the main concern of these councils. Since endogamous groups tend to be fairly widely dispersed over a number of contiguous villages and towns, meetings of their councils are usually held only when a social occasion such as an important wedding or one of the annual festivals brings all members of the group together. Disputes are held in abeyance until such occasions, and if any serious breaches of taboos occur in the intervening periods, the offenders are temporarily outcast and denied all social intercourse with the group until their case has been tried and a decision reached. It is only on rare occasions that the councils of endogamous groups intervene in matters concerning employment, and then their intervention usually takes the form of supporting the strike of a local brotherhood by withholding all replacements of labour. Disputes over employment do occur between brotherhoods, but the little evidence that exists seems to indicate that these are settled by negotiation between the parties concerned and rarely reach the level of the endogamous group council.

Although village councils or *panchayat* are primarily local authorities rather than caste authorities, they play an important part in caste government. Every Indian village contains sections of many caste groups. Some of these, such as, for example, the Brahman priests, the washermen, musicians and sweepers, play a traditional role in village ritual and on many social occasions. All are economically or socially interdependent in some degree, and hence disputes in one caste group tend to spread to others as partisans take sides. For this reason the village council is always interested in caste affairs, and where the villagers are united and friendly, it is often called in to act as a court of arbitration when a caste council fails to reach a settlement that will restore peace.

The penalties inflicted by caste group councils vary according to the kind of offense committed. If the offense is against the rules of a particular caste group, as when a member of a vegetarian group is found eating meat, the penalties would include a purification ceremony to remove the internal pollution accruing from this act and also an order to pay a fine or give a feast to a specified number of caste brethren or Brahmans. If the offense is against values held in common by Hindus as a whole, as when a Hindu kills a cow, the penalties would include not only a severe purification ceremony and heavy penalties but also a penance to remind all in the neighbourhood of the folly of such ways. The penance may involve a pilgrimage to a holy place or a shameful circumambulation of the neighbouring villages dressed in dust and ashes with, perhaps, the tail of the martyred cow dangling from the neck. Execution of judgment is achieved by the simple process of suspending the offender from all group contacts until he has done what he was ordered to do. Of course some stubborn people do resist, and then much depends on the strength of the hold which the caste group has over them. Sometimes the battle of wills ends in the offender being thrown out of his caste group forever; sometimes he is able, by persuading a number of caste brethren to upset the suspension order by taking a meal with him, to force a reconsideration of the matter and perhaps a lighter sentence. Punishment for offenses against the general values of Hinduism is more difficult to escape, as in this case all the caste groups of the neighbourhood are united in condemnation, and the offender's own caste group would be ridiculed if it showed any weakness. In most cases the power of suspension is strong enough to achieve its end; indeed the social and psychological effect upon the individual is often sufficient to lead to suicide. Caste penalties, like caste commensality, are at once divisive and unifying. The penalties imposed for offenses against particular caste-group laws emphasize the difference between groups, and the penalties for offenses against the common values of all Hindus emphasize the underlying unity of the whole of Hindu society.

Incidentally, all caste-group councils up to and including the councils of endogamous groups are called *panchayat*, the usual term for a judicial body. The committees of wider associations in the caste system, on the other hand, are labeled *sabha*, and this difference in title emphasizes an important difference in function. *Sabhas* are advisory, not supervisory, at least insofar as behaviour taboos are concerned. Commensal groups composed of several endogamous groups of equal status will sometimes convene meetings of committees representing all concerned to discuss behaviour reforms, but, having come to agreements, these committees must leave implementation to the councils of the endogamous groups. If some of these lesser groups agree to carry out the new policy and others do not, fission will occur and two new commensal groups will be formed, each adhering to the behaviour pattern agreed upon by its component groups. Nevertheless, there are certain matters in which the *sabhas* of commensal groups and caste associations can take positive action and among these, in modern times, are the provision of urban housing, both for workers and students, and of scholarships and bursaries to the universities. The subdivision of agricultural holdings and increased industrial opportunities in the larger towns and cities has led to a great flow from the land which in turn has created serious housing difficulties. In many cities these have been overcome by the building of tenements by caste associations for letting to members of the associated groups. These co-operative activities engender a certain rivalry between caste associations but have not resulted in any noticeable diminution of status differences between the endogamous groups of which they are formed.

A noticeable feature of caste government is the association of certain kinds of authority with different broad levels in the caste system as a whole. In general, permanent caste councils are associated with low status, and *ad hoc* councils, or a complete absence of formal caste government, with high status. There are several possible reasons to account for this, other than the oversimplified popular explanation that lower caste groups, being of coarser fibre, need stronger discipline. In the first place the highest caste level—that of orthodox Brahman groups—is the source from which flows the main body of Hindu law used in the courts of civil law. This law is recorded in the Vedic scriptures and in the commentaries made through the centuries by savants. A grounding in it is given to all orthodox Brahmans during their period of studenthood, and all are therefore capable of understanding what breaches of the law entail. Moreover, the Brahman priestly lineages, being linked by ties of ritual with the lay lineages to whom they administer, are widely dispersed over the length and breadth of India. They would find it almost impossible to summon a lineage council, let alone that of an endogamous group of lineages. In these circumstances it is not surprising to find that orthodox Brahmans, conscious of their eminence in society and of the fact that all important people know their law, allow public opinion to discipline their offenders, or when this fails, turn to the state courts for redress. Again, the Rajput lineages which practise hypergamous marriage do not form endogamous groups, for the very reason that their lineages differ in status, and therefore one finds that the highest level in their caste government is that of the exogamous group council. In short, the nature of caste government in groups of high status depends more upon their physical dispersion, marriage customs and other such criteria than on any correlation between high status and good behaviour. Nevertheless, there is no doubt that the absence of the more normal caste *panchayat* at the higher levels in the caste system is becoming accepted as a criterion of high status—an aim to be achieved by all those caste groups which have social ambitions—and this may have far-reaching effects upon the whole future of caste government.

It is interesting to speculate about the influence of British rule on the development of large-scale caste associations and such committees as caste *sabhas* and the Hindu Mahasabha. The British introduced the notion of large-scale democracy into a social system in which, in spite of its inequalities and rigidities, there existed already a high degree of small-scale democracy which was both well organized and articulate. From the beginnings of municipal elections in British India, politicians of all parties, including those, such as the Communists, who opposed status division, made full use of the caste structure as a potential machine. Its convenience in this respect may be of some importance to its continued survival in an era of state-wide democracy. (*See* also Indian Law.)

The Assimilation of Tribal Groups.—Much was written about the plight of the numerous hill tribes living on the fringes of Hindu society, and many fears were expressed that assimilation into the caste system would lead to their ultimate degradation. Attention was concentrated, however, on changes in the pattern of tribal worship, and on the economic consequences of such governmental actions as the closing of forests to hunting and shifting cultivation. No writer pointed to the fact that these tribes have in their own hands the key to assimilation at a respectable status level. So long as they remain outside caste society, living isolated and self-sufficient lives, their pattern of social behaviour is their own affair. As soon as they become enveloped in Hindu society, however, they come within the purview of the pollution concept. Such habits as premarital intercourse, marriage at maturity, divorce, widow marriage, the eating of domestic pork, fowl flesh, beef and other banned foods, all of which are common customs among these hill peoples, will no longer be tolerated as the whim of groups outside the system. They are regarded as sins against the Hindu behaviour pattern and, as such, automatically downgrade the offending groups. This is why so many once proud tribes have found themselves, after assimilation, "at the bottom of the caste ladder," even though they have given up their tribal gods and taken to the worship of Hindu gods in their efforts to please their neighbours. They discover too late that it is not the gods they worship that matter in status evaluation, but the way they eat, drink and make merry.

Assimilation of tribal groups follows the same general lines in all parts of India. The first feature of tribal society to come under pressure in Indian as in British-Indian days is its political structure. Central government laws are applied; central government officials take over many of the functions of the tribal leaders and councils. By this process of attrition tribal power is ground away until all that remains is the right to judge such offenses against tribal customs as do not fall within the competence of civil and criminal courts. The process is accelerated by the infiltration of caste groups of artisans—weavers, smiths, basketmakers, musicians and the like—who settle among the hill peoples and introduce functional specialism into their erstwhile unspecialized economy. These incomers, not being tribesmen, do not come under tribal law; they govern themselves under caste custom, as the tribesmen govern themselves under tribal custom, subject only to the central government laws. Thus the tribes soon find themselves living in a stratified society in which they, the original landholders, have become outcasts because they still follow traditional behaviour patterns. Under these pressures the better-class families react in much the same way as better-class families in rising Hindu caste groups. They begin to copy the behaviour of high-caste groups. They give up degrading customs and attempt to persuade their cotribesmen to follow suit. If this is not possible, they break away in much the same way as sections of endogamous caste groups do when fission occurs. The reforming families cease interdining with those who refuse to follow their lead. They reduce marital links with them first by introducing hypergamous marriage by taking daughters from but refusing to give daughters to the "low-behaviour" lineages, and finally establish themselves as a self-governing endogamous and commensal group similar in every important respect to a Hindu caste group. Instances of such changes in status are to be found in every tribe.

The Future of the Caste System.—India's leaders have introduced many legislative, administrative and social measures in what is often described as the "war" against caste customs. Yet it was still possible in 1955 for a gathering of eminent Indian savants to record that "there is no sector of our life, private or public, that it [caste] does not permeate." Caste practices are not dying easily. The system still seemed, in the early 1960s, too flexible, too easily adaptable to changing conditions—as its application to electioneering and job preservation has shown—to be destroyed overnight. The greatest danger was that reformers might press on with change for political reasons before research had shown what ought to be preserved. It would be a tragedy if, through lack of understanding, the opponents of caste should destroy what was good in their efforts to eradicate its evils, or if, in their efforts to save what was good, its defenders should find themselves defending what ought to be destroyed.

See also references under "Caste (Indian)" in the Index volume.

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(H. N. C. S.)

CASTELAR Y RIPOLL, EMILIO (1832–1899), Spanish statesman, who was a powerful and consistent champion of republicanism in Spain in the second half of the 19th century, was born at Cádiz on Sept. 7, 1832. He was educated at Madrid university where he subsequently became professor of history. Active in politics, he soon achieved fame as an orator and notoriety for his speeches against the monarchy. When, for political reasons, he was deprived of his chair (April 1865), there were serious disturbances in Madrid. After the abortive republican rising of 1866, he was sentenced to death but escaped to France. Returning after the revolution of 1868, he entered the *Cortes* as a delegate for Saragossa, at the same time resuming his chair at the university. His campaign for a federal republic was successful after King Amadeo's abdication (Feb. 1873). Castelar entered the new government as minister of state, but disorder was so rife that the president of the executive, Estanislao Figueras, fled the country. The doctrinaires Francisco Pí y Margall and Nicolás Salmerón failed to control the situation; and Castelar, representing the extreme right, became president in September. He suspended the sittings of the *Cortes* and imposed a virtual dictatorship, but pursued a conciliatory policy, aimed at the restoration of law and order. Castelar's conservatism, however, alienated the extreme republicans; and at the end of 1873 it was evident that, if the *Cortes* reassembled, he would be deprived of the presidency. To avoid this, Manuel Pavía, captain-general of Madrid, proposed to him that he should dissolve the *Cortes*. Castelar refused and was defeated on Jan. 3, 1874. Thereupon Pavía staged a *coup d'état*, and the federal republic came to an end. Castelar returned from exile after the monarchy had been restored in the person of Alfonso XII, was elected to the *Cortes* as deputy for Barcelona and continued to advocate the establishment of a republic by peaceful means. As leader of the opposition, he championed religious toleration, universal suffrage and the abolition of slavery in Puerto Rico. Estranged from the extreme republicans, particularly in the period 1886–91, he often found himself on the side of P. M. Sagasta, the Liberal leader. He died at San Pedro del Pinatar, Murcia, on May 25, 1899. Castelar left more than 90 works, including novels, memoirs, historical writings and voluminous collections of political speeches. (J. C. J. M.)

CASTEL GANDOLFO, village and castle in Roma province, Latium region, Italy, is situated in the Alban hills, 1,398 ft. above sea level, 13 mi. from Rome on the edge of the ancient crater that forms Lake Albano (*q.v.*). Area 5½ sq.mi.; pop. (1951) 4,899. The castle belonged to the ducal family Gandolfi in the 14th century. It became the inalienable domain of the Holy See (1604) and afterward the summer seat of the pontiff. Within its precincts is the vast Apostolic or Papal palace which was erected at the instigation of Urban VIII (pope from 1623–44) and later enlarged and modified by popes Alexander VII, Clement XIII and Pius IX. Two architects collaborated in its construction, Carlo Maderno, who designed the face of St. Peter's, and Giovanni Lorenzo Bernini. The walls of the reception hall are covered with precious marble, brocades, and splendid tapestries and display panels by Carlo Dolci, Paolo Veronese, and Salvator Rosa. The palace, which has extraterritorial privileges, is surrounded by a magnificent terraced park built on the ruins of the villa of the Roman emperor Domitian.

After 1936 the famous Vatican observatory, founded by Gregory XIII (1572–85), was housed in the former Villa Barberini. In the square opposite the castle is the church of S. Tommaso da Villanova, the work of Giovanni Lorenzo Bernini. Castel Gandolfo possibly occupies the site of ancient Alba Longa (*q.v.*).

(M. T. A. N.)

CASTELLAMMARE DI STABIA, a seaport and episcopal see of Campania, Italy, in the province of Naples, is 17 mi. S.E. by rail from the city of Naples. Pop. (1957 est.) 61,788 (commune). It lies in the southeast angle of the Bay of Naples, below the ruined castle from which it takes its name. This was built by the emperor Frederick II. In 1310 Robert of Anjou built the Casa Sana, "House of Health" (a name corrupted to Quisisana), now a hotel; its park was used by Boccaccio as the background for some of his *Decameron* tales. Because of the sea and mineral water baths (12 different springs) and its attractive situation below Punta Lattari, the town is a favourite summer resort. It has a large shipyard where the bathyscaphe used by Auguste Piccard for marine exploration was built. Nearby was the ancient Stabiae (*q.v.*), destroyed by an eruption of Vesuvius in A.D. 79.

(M. T. A. N.)

CASTELLÓN DE LA PLANA, a city of eastern Spain, is the capital of the province of the same name, which is the northernmost of the three forming the ancient kingdom of Valencia. The city lies 4 km. (2½ mi.) from the Mediterranean coast and 67 km. (42 mi.) N.N.E. of Valencia by road. Pop. (1960 est.) city 60,287; province 337,548. Area of province 6,669 sq.km. (2,579 sq.mi.).

The city of Castellón was first founded on top of the La Magdalena hill. In 1233 James I conquered it from the Moors and in 1251 authorized its removal to the plain (*plana*) on petition by the inhabitants. The town was then called Castellón de Burriana and later Castellón de la Plana. It was made the provincial capital in 1833 and in 1873 given the status of a city—the only one in the province.

The capital lacks direct communications with central Spain. The only connections by rail and main road are those of the Barcelona-Valencia route. There is a good network of bus services, a mining railway at Ojos Negros and a narrow-gauge line between Onda and El Grao (the port of the city) which clears about 600 vessels annually, mainly exporting fruit.

The province of Castellón is situated on a fertile plain, watered principally by the Mijares, or Millares, and by the Palancia; the other rivers are short and often run dry. There are a number of small interior mountain ranges, derived from the Ibérico sistema, which occasionally reach the coast. Alternating with these ranges are the coastal plains, broken up by areas of ancient volcanic activity. The Columbretes Islands off Castellón are volcanic remains of submerged craters. The coast is generally steep but with beaches at Benicarló and Vinaroz. The most notable natural regions are: the inhospitable Maestrazgo, with the city of Morella; the Tierra del Cid, centred on Lucena del Cid; and the valleys of the Mijares and Palancia.

Evergreen oaks, cork trees and pines predominate in the mountains. Dry farming is extensive, covering most of the province except the irrigated areas and lowlands of the coastal zone, where oranges, almonds, figs and pomegranates are grown. There are few minerals and little industry except the manufacture of ceramics (tiles) at Onda, Alcora and Villarreal, and of shoes at Vall de Uxó. About 200 small factories make hemp sandals. Fishing (sardines, mullet, anchovies) is centred on the ports of Burriana, Vinaroz and Benicarló.

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CASTELNAU, MICHEL DE, Sieur de la Mauvissière (*c.* 1520–1592), French soldier and diplomat who was the author of remarkable *Mémoires*, but whose long and obscure career in the royal service was otherwise typical of that of many such younger sons of minor noble families without much money or influence. Born in Touraine, he visited Mediterranean countries and then took military service in Piedmont with Charles, cardinal de Lorraine, and later in Picardy with the duc de Montmorency, constable of France. After the peace of Câteau-Cambrésis (1559) he entered the royal service and was sent in 1560 on diplomatic missions to England, Germany, Savoy and Rome. In 1561 he accompanied the widowed Mary Stuart back to Scotland, where he stayed for a year.

In 1562 Castelnau interrupted his diplomatic career to return to soldiering in the king's army, fighting against the Huguenots in Brittany and Normandy. In 1572, however, Charles IX sent him to England, Germany and Switzerland to appease the anger aroused by the massacre of St. Bartholomew's day. In Sept. 1575, he was sent by Henry III as ambassador to Elizabeth I of England. He stayed there until 1585, but failed to negotiate a marriage between Elizabeth and Henry III's brother, François, duc d'Alençon.

The last years of his life were difficult. Refusing to join the League at the time when it dominated France, he was excluded from official appointments. His château of La Mauvissière had been destroyed in the previous warfare. Henry IV gave him a military command, but Castelnau died in poverty at Joinville in 1592.

Castelnau's *Mémoires* were written during his embassy in England, with an eye to the moral instruction of his son. Covering the years 1559–70, they provide a well-informed account of the beginnings of the religious wars. First published in France in 1621, they were re-edited during the 18th century. Castelnau also translated into French a Latin work of Petrus Ramus, the *Traicté des façons et coustumes des anciens Gaulois.*

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CASTELNUOVO-TEDESCO, MARIO (1895–), Italian composer whose style is essentially romantic, was born in Florence, April 3, 1895, and studied composition there with I. Pizzetti. On the eve of World War II he immigrated to the U.S. and settled in Hollywood. He appeared as soloist in his second piano concerto and also wrote three violin concertos, a cello concerto and a concerto for guitar and orchestra. His orchestral works include an interesting series of overtures to 12 plays by Shakespeare, whose sonnets and poems he has frequently set to music. He also composed two Shakespearean operas, *The Merchant of Venice* (1956) and *All's Well That Ends Well* (1957). His chamber music is scored for a variety of combinations; his piano pieces are conceived as miniature symphonic poems; his songs retain the melodiousness of the Italian school; and his harmonies are opulent and often complex. (N. Sy.)

CASTELO BRANCO, CAMILO (1825–1890), the most prolific Portuguese novelist and a master of the Portuguese language. He was born in Lisbon on March 16, 1825, the illegitimate son of Manuel Botelho, and of a family afflicted with a hereditary tendency to insanity. He was left an orphan when still very young and was brought up by relatives living in the Trás-os-Montes region in northern Portugal. He studied in Oporto, where he also engaged in journalism and shared in the Bohemian *café* life. As a result of a religious crisis he entered a seminary for a time. His chequered love affairs culminated in his conquest of Ana Plácido, the wife of an Oporto businessman. The two lovers were imprisoned (1861), an event which gave notoriety to a man who had already won repute as a writer, but in 1864, after the death of the lady's husband, they settled in the village of Seide in the Minho region. Camilo wrote unceasingly, producing, in addition to some verse of indifferent quality, plays, works of erudition and hard-hitting polemical writings, scores of novels of unequal merit. Suffering from ill health, almost blind, beset by misfortune and melancholy recollections of the past, he ended his life by his own hand at Seide on June 1, 1890.

A romantic by temperament and background, Camilo put much of his own life into his work. He wrote for the provincial middle-class, especially the womenfolk, who read avidly stories of thwarted love in which the rights of passion were defended against narrow prejudice. The incidents of his plots, which at times are on the level of the popular serial but at others have a truly tragic quality, are narrated with conciseness and vigour (*cf., O Romance d'um homem rico,* 1861; *Amor de perdição,* 1862, a famous novel representative of Portuguese sensibility; *Amor de salvação,* 1864; *O Retrato de Ricardina,* 1868). He did strive, however, to be natural, following the example of Balzac (*cf., Onde está a felicidade?* 1856; *Vingança,* 1858), and his novels faithfully reflect an age of transition, in which a decaying nobility was in conflict with a victorious middle class, the latter being caricatured in the figure of the ridiculous *brasileiro*, the type of Portuguese who has grown rich in Brazil. A man of extremes, switching rapidly from the lyrical to the sarcastic, with a view of life dominated by the concepts of sin and redemption through suffering, although at times rebellious and blasphemous, Camilo was nevertheless capable of a healthy good humour (*cf., Coracão, cabeça e estômago,* 1862; *A Queda d'um anjo,* 1866). Interested in relics of the past, he wrote historical novels (*Lucta de gigantes,* 1865; *O Santo da montanha,* 1866). His style, based on a great wealth and precision of vocabulary, reveals his close acquaintance with the Portuguese classics and with the people of the countryside whom he depicted so well.

In the *Novelas do Minho* (1875–77) he turns toward naturalism, joined to that spontaneous, dramatic yet sober realism already evident in some passages of the *Amor de perdição*. But, annoyed by the change in public taste, he parodied the new naturalist school in *Eusébio Macário* (1879) and its sequel *A Corja* (1880). He assimilated, however, with no hostile satirical intent, the impressionism in descriptive writing of Eça de Queirós and his followers, as can be seen in *A Brasileira de Prazins* (1882).

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CASTELO BRANCO, a city of central Portugal, is situated in Beira Baixa province, 337 km. (209 mi.) N.E. of Lisbon by road. Pop. (1960) 66,020 (mun.). The city has Roman remains and is dominated by a castle. It is still partly enclosed by ancient walls. There are three wide main avenues: Nun' Alvares, Marshal Carmona and 28 de Maio. The main buildings are the cathedral, episcopal palace and the modern Turismo hotel. Castelo Branco is on the railway from Abrantes to Guarda. It manufactures cloth, including the traditional Castelo Branco counterpanes, and has a flourishing local trade in cork, wine, olive oil and cheese. The administrative district of Castelo Branco lies in the southeastern part of the province of Beira Baixa. Pop. (1960) 325,800; area 6,703 sq.km. (2,588 sq.mi.). (J. A. da C.)

CASTELO MELHOR, LUIZ DE VASCONCELOS E SOUSA, Conde de (1636–1720), Portuguese royal favourite who, as effective governor of the kingdom from 1662 to 1667 during the reign of Afonso VI, was responsible for the successful prosecution of the war against Spain, which led, in 1668, to Spanish recognition of Portugal's independence. Shortly after Afonso VI's coming-of-age in 1662, the king appointed Castelo Melhor his secret notary (*escrivão da puridade*), a position in which the favourite was able to exercise the functions of first minister. Castelo Melhor overcame the difficulties which had hitherto beset Portugal in the war against Spain, reorganizing the troops (now reinforced by an English contingent by virtue of the English king Charles II's marriage to Catherine of Braganza) and entrusting their command to competent generals. Consequently the war entered a victorious phase for Portugal (1663–65) and Spain began peace negotiations. Agreement proved difficult to attain and meanwhile the internal political situation in Portugal deteriorated. The king was obliged to dismiss Castelo Melhor on Sept. 9, 1667, shortly before he himself was deprived of power. Castelo Melhor went into exile in Paris and then London, but in 1685 he was permitted to return to Portugal and, two years after that, to court. On the accession of John V (1706) he was appointed a councilor of state and he continued to occupy a position of distinction until his death on Aug. 15, 1720. (Da. A. P.)

CASTI, GIAMBATTISTA (1724–1803), Italian satirical poet and one of the first writers of comic opera librettos, was born at Acquapendente, Italy, Aug. 29, 1724. He entered the Church but abandoned the career of an ecclesiastic for that of a pleasure-seeking poet at the courts of Germany, Austria and Russia. At the court of Maria Theresa he attracted attention with his amusing *Novelle Galanti* which were later to be imitated in France. He became a favourite of Catherine II who inspired his satirical *Poema Tartaro* (1787). In Paris, where he settled in 1798, he championed the democratic cause. Casti's enduring work is *Gli Animali Parlanti* (1802; Eng. trans., *Court and Parliament of Beasts*, 1819), an ironic version of the social conflicts thrown up by the French Revolution. He also wrote librettos for comic operas by Giovanni Paisiello and Antonio Salieri. He died in Paris on Feb. 5, 1803.

CASTIGLIONE, BALDASSARE (1478–1529), Italian diplomat and author of *Il Cortegiano*, a famous Renaissance treatise on courtly manners, was born at Casatico, near Mantua, on Dec. 6, 1478, and educated in Milan at the humanist school of Giorgio Merula and Demetrius Chalcondyles. While at the court of Ludovico Sforza ("il Moro"), he learned the art of chivalry. In 1499 he entered the service of Francesco Gonzaga, marquis of Mantua, and in 1507 that of Guidobaldo da Montefeltro, duke of Urbino. He remained at Urbino until 1513, and after Guidobaldo's death (1508), continued to serve his successor, Francesco Maria della Rovere. In Urbino he met Pietro Bembo, Bernardo Bibbiena, Giuliano de' Medici, l'Unico Aretino (Bernardo Accolti), Ludovico da Canossa, Ottaviano and Federico Fregoso, who eventually became the interlocutors of his *Cortegiano*, and there he composed most of his minor works: including, besides Latin and Italian verses, the eclogue *Tirsi* (1506) and the prologue to Bibbiena's *Calandra*. He was sent to England in 1506 to receive the order of the garter on behalf of Guidobaldo. In 1509 he followed Della Rovere, commander of the papal army, in the war against Venice; in 1511 he took part with Julius II in the siege of Mirandola. For his services he was made count of Novilara, near Pesaro. As ambassador of the duke of Urbino he went in 1513 to the court of Leo X in Rome; in 1516 he was back in Mantua, where he married Ippolita Torelli (d. 1520). In 1524 he was appointed apostolic prothonotary and in 1525 he was sent to Spain as papal nuncio to Charles V. After the sack of Rome by the Imperialists (1527) he was accused by Pope Clement VII of not having foreseen it, but he succeeded in proving his innocence of treacherous intention. He died in Toledo on Feb. 2, 1529, a year after the publication of his *Cortegiano*, which had been written in Rome and Mantua between 1513 and 1518.

The treatise, written in dialogue form, deals with the perfect courtier, the noble lady, and the relationships between the courtier and the prince. The courtier envisaged by Castiglione symbolizes the highest moral aspirations of the Renaissance. From the literary point of view the *Cortegiano* is one of the outstanding books of the century. It found immediate favour outside Italy and was translated into many languages. Sir Thomas Hoby's English version, *The Courtyer* (1561), was one of the most influential prose works of its day.

See B. Maier (ed.), *Il Cortegiano, con usa scelta di opere minori di B. Castiglione*, which includes a bibliography of earlier studies (1955). (G. A.)

CASTIGLIONE, GIOVANNI BENEDETTO (1616–1670), called in Italy Il Grechetto, and in France Le Benédette, Italian painter and printmaker of the Genoese school, was born in Genoa. Castiglione was a highly productive painter who left portraits, historical pieces and landscapes, but he excelled in fairs, markets and rural scenes with animals. He studied under Giovanni Battista Paggi, and Giovanni Andrea de Ferrari. In his etching he imitated the Netherlandish school. The prints of Van Dyck probably were the greatest stylistic influence upon him. He also knew some of Rembrandt's work intimately, but his style was closer to that of Jan Lievens. He was the first known practitioner of the monotype (*q.v.*). In his closing years he lived in Mantua, painting for the court, and died there in 1670. His brother Salvatore and his son Francesco studied with him and perpetuated his manner.

See A. Blunt, *The Drawings of G. B. Castiglione . . . at Windsor Castle* (1954).

CASTIGLIONE, BATTLE OF, was fought on Aug. 5, 1796, between the French under Napoleon Bonaparte and the Austrians under D. S. von Wurmser, in northern Italy. Bonaparte, having occupied Milan and Lombardy, was investing Mantua when Wurmser marched against him from the Tirol with 47,000 men. Bonaparte's 45,000 (of whom 10,000 were at Mantua) were at first dispersed over a front of 50 mi., but Wurmser failed to defeat them in detail, partly because he sent 17,600 men under P. V. von Quosdanovich to the west of Lake Garda while he himself led 24,300 down the Adige. On July 29, the Austrians' appearance above Rivoli and advance on Brescia caused Bonaparte to order his troops to concentrate south of Lake Garda, where the Austrians would unite and where he would occupy a central position. On July 30 he suspended the siege of Mantua, sacrificing his siege train to enjoy temporary numerical superiority. Wurmser entered Mantua on Aug. 1, but detachments of Quosdanovich's force were worsted at Salo and Lonato on July 31 and at Brescia on Aug. 1. Seeing his error, Wurmser sent his vanguard to Castiglione, which he took, but lost to Augereau on Aug. 3. Wurmser's 25,000 men now held an over-long front, from Solferino to Medole, which Bonaparte could attack with 31,000 when Sérurier's troops arrived from Mantua. Neglecting the danger of Sérurier's division's turning his weaker flank at Medole, Wurmser extended his line toward Quosdanovich near Lonato, a movement that Bonaparte encouraged by pulling back the French left wing, so that Wurmser's reserves were to the north when Bonaparte's reinforcements outflanked the Austrian left wing. The advance of Augereau and Masséna in the centre prevented an Austrian change of front and brought on the collapse of the whole Austrian line. Decisively defeated, the Austrians withdrew to the Tirol, having lost 16,000 men (2,000 on Aug. 5) in a nine days' campaign. The French resumed the siege of Mantua. (J. H. N.)

CASTILE, the name of the central region which comprises more than one-quarter of the area of peninsular Spain, represents the limits reached at the end of the middle ages by the kingdom of Castile proper, and by the Moorish kingdom of Toledo, which had been annexed to the Castilian crown at the end of the 11th century. The former, known as Old Castile (Castilla la Vieja), contains the modern provinces of Ávila, Burgos, Logroño, Palencia, Santander, Segovia, Soria and Valladolid. After the middle ages the name New Castile (Castilla la Nueva) was given to the former kingdom of Toledo. It consists of the modern provinces of Ciudad Real, Cuenca, Guadalajara, Madrid and Toledo. The Sierra de Guadarrama forms the approximate dividing line between the two.

The name Castile—probably meaning "land of castles"—is first found in 800, when it was applied to a small district at the foot of the Cantabrian mountains in the extreme north of the modern province of Burgos. This territory expanded during the 9th century but remained broken up into petty counties, whose rulers were nominated by the kings of Asturias and León, until these counties were united by Fernán González (*c.* 923–*c.* 970), the first count of all Castile. With him the history of Castile as a political entity really begins. He contrived to make the new county hereditary in his family, and thus secured a measure of autonomy for it under the kings of León. In the time of Fernán González the capital of the county was established at Burgos, where it was to remain, and expansion southward into Moorish territory occurred. Under counts García Fernández (*c.* 970–1005) and Sancho García (1005–17) the territory of Castile reached as far as the Douro (Sp. Duero) river. Relations with the kings of Léon, still nominally suzerains of Castile, were frequently bad.

The urge toward independence shown by the counts and people of Castile from the beginning has been variously explained. It seems likely that the regions conquered by the counts of Castile from the Moors were generally repopulated by emigrants from Cantabria, who had scarcely been affected by Arabic culture and custom, whereas in León there was a large immigration of Mozarabs from the Moorish areas further south, thus establishing marked social and other differences between the two regions. The kingdom of León was deeply conscious of its position as successor to the Visigothic empire of Hispania, but the county of Castile rejected the ancient Visigothic legal code (*Forum Judicum*), the basis of Leonese law, in preference for local customary law. Small, free proprietors were prominent among its people, and a considerable number of minor nobles (*infanzones*), rather than the traditional magnate families of León, made up the Castilian nobility. Later, however, the Castilians came to think of themselves as truer representatives than the Leonese of the Visigothic tradition.

In 1029 Castile lost its autonomy and passed into the hands of Sancho III (the Great) of Navarre. (*See* SANCHO [kings of Navarre].) On his death (1035) he left it, as a kingdom, to his son, Ferdinand I. Under Ferdinand it was first united with León (1037–65), though the seniority of León in the partnership was still recognized. Castile was again united with León (1072–1157) under Alfonso VI and Alfonso VII (*see* ALFONSO, kings of Asturias, León and Castile) but thereafter the two kingdoms once more separated. The political and military hegemony of Castile over León was established by Alfonso VIII of Castile (1158–1214) who, in 1188, forced the king of León to do homage to him. By now, Castilian rule extended far south of the Tagus river and eastward to the modern frontiers of Aragon. The Leonese kings, however, never accepted the claims made by Castile to suzerainty and Alfonso IX of León refused, in consequence, to support Alfonso VIII in his wars against the Almohads. Castilian pursuit of political hegemony over León, therefore, partially weakened the Christian front against the Muslims. In 1230 Ferdinand III, already king of Castile, succeeded to the Leonese throne and both crowns were finally united under Castilian leadership.

An attempt by Castile to annex Portugal by force in 1383–85 failed, but a Castilian prince, Ferdinand of Trastámara, was successfully placed on the Aragonese throne, partly as a result of Castilian financial support and military force, in 1412. This move foreshadowed the personal union of the two crowns under Ferdinand and Isabella. The kingdom of Navarre was annexed by Castile in 1515.

Castilian political hegemony in Spain was an accomplished fact from the middle of the 12th century, and the chanceries of European courts in the later middle ages frequently identify Castile with Hispania. The final conquest of most of Andalusia was carried out by Castilian armies in the time of Ferdinand III. The literary language of Spain after its unification was the Castilian vernacular, and the centre of political and administrative power since then has always been in Castile. Nevertheless, opposition to the political hegemony of Castile from the other regions, which enjoyed complete or partial independence in the middle ages, has always remained strong and is still a live political issue, especially since the centres of modern industrial strength in Spain are now largely outside Castile, which, for geographical reasons, is an economically backward area. It has been claimed that medieval Castile was, in all respects, a more progressive kingdom than its neighbours, with a more developed sense of the unity and destiny of Spain. Some of these claims seem exaggerated. Castilian separatism undoubtedly weakened for several centuries the capacity of the kingdom of León to recover Moorish territory. After the close of the middle ages, at least, Castile and its people were, in many respects, markedly hostile to any departure from tradition. The real reason for the dominating part which Castile has played in Spanish history may well have been the superior martial spirit and military organization of its people. *See* also SPAIN: *History*. (P. E. R.)

CASTILHO, ANTÓNIO FELICIANO DE (1800–1875), Portuguese poet and an influential literary figure, was born in Lisbon, Jan. 28, 1800. He lost his sight at the age of six, but the devotion of his brother Augusto, and a retentive memory, enabled him to become an accomplished classical scholar. His first important work, *Cartas de Eco e Narciso* (1821), belongs to the pseudoclassical school but a more romantic note is sounded in the sentimental lyrics of *Amor e melancolia* (1828); full-blown romanticism is dominant in the melodramatic poetic legends, *A Noite do Castelo* and *Os Ciúmes do Bardo* (both 1836). Thereafter, while producing some verse in which the romantic tones are much modified, Castilho undertook much translating of the classical poets and wrote on social, political, pedagogical and literary themes. His lack of strong individuality and over-great respect for authority prevented him from achieving original work of real merit. Castilho died in Lisbon, June 18, 1875.

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CASTILLEJO, CRISTÓBAL DE (1490?–1550), Spanish poet, remembered as one of the last to use exclusively the Spanish medieval metres, and for his protests in vigorous verse against the Italianate innovations of Boscán and Garcilaso. Castillejo was born at Ciudad Rodrigo, Spain. When quite young he entered a Carthusian monastery, but in 1525 became secretary to Charles V's brother, Ferdinand of Austria, in whose service he spent the rest of his life, mostly outside Spain. He died at Vienna, probably on June 12, 1550.

His love poetry, addressed to an impressive number of ladies, is neat and free from artificiality; his satirical work is light and lively. His *Sermón de Amores* (1542), which uses sacred phrases in profane contexts, was in part suppressed by the Inquisition.

See C. L. Nicolay, *The Life and Works of C. de Castillejo* (1910). (C. C. SH.)

CASTILLON, BATTLE OF, the last battle of the Hundred Years' War, was fought on July 17, 1453. The English had been expelled from Gascony by the French in 1451, but after the arrival of an army at Bordeaux in Oct. 1452 under John Talbot, earl of Shrewsbury, parts of western Gascony, including the town of Castillon-sur-Dordogne, had returned to English loyalty. On July 13 or 14, 1453, the French arrived to besiege Castillon. Expecting an English attack, they first constructed a defensive position, enclosed by a ditch and earth rampart, east of the town. Shrewsbury hurried to relieve Castillon with 5,000–6,000 men, 1,000 of them mounted, and on July 17 surprised an enemy outpost. He then made a disastrous mistake: though his foot soldiers were still some way behind, he ordered an attack on the camp, apparently believing that the French were withdrawing. When the English horsemen found the camp defenses lined with soldiers and with cannon, Shrewsbury impetuously ordered a dismounted attack, and for an hour (during which some of the foot arrived) there was hard fighting, in which the cannon claimed numerous victims. At length a French sortie put the English to flight. The majority escaped, but many, including Shrewsbury, were killed or captured. Castillon surrendered on July 18. Gascony had now lost its only army, and the surrender of Bordeaux in October ended the war. The tactical importance of Castillon lies in the successful employment of cannon, which France had first used in the field at Formigny (1450).

See A. H. Burne, *The Agincourt War* (1956); G. Du Fresne de Beaucourt, *Histoire de Charles VII*, vol. v (1890). (J. W. SE.)

CASTILLO SOLÓRZANO, ALONSO DE (1584–1648?), Spanish novelist and playwright, whose ingenuity expressed itself best in his short stories, was born at Tordesillas (Valladolid). It is uncertain where and when he died. His stories are usually of adventure, but treated with wit and sophistication. Many of his tales are strung together by an artifice, or are arranged, in indirect imitation of the *Decameron*, within a framework. Examples are: *Jornadas alegres* ("Daytime Entertainments," 1626) and *Noches de placer* ("Evening Amusements," 1631). Of Castillo's novels the most important are *Las harpías en Madrid* (1631), *La niña de los embustes: Teresa de Manzanares* ("The Girl of Many Wiles: Teresa of Manzanares," 1632), *Las aventuras del Bachiller Trapaza* (1637) and its sequels: artificial, entertaining, picaresque novels which make much of the female *picara* ("rogue") as protagonist or adjutant. As a dramatist Castillo was overshadowed by more brilliant contemporaries, but plays are included in his miscellanea which seem to have been influential abroad. (I. L. MC C.)

CASTING. The process of giving shape to or reproducing an object by pouring its material in liquid form into a mold.

See DIE CASTING; FOUNDING; METALLURGY; SCULPTURE TECHNIQUE; *see* also Index references under "Casting" in the Index volume.

CAST IRON, a wide range of iron-carbon-silicon alloys containing 2% to 4% carbon (much more than ordinary steels) along with varying amounts of silicon, manganese, sulfur and phosphorus. Cast iron, of which pig iron is a crude form, was the first of the ferrous metals to be cast. The Chinese are generally recognized to have produced the first objects of this metal, dating back to 513 B.C., while the first iron foundry in England is recorded to have been in Lincolnshire in A.D. 1161. Cast iron has occupied a place of great importance in the industrial world since the 18th century, but it was not until well after the close of the 19th century that iron founding (*q.v.*) became more of a science than an art.

Gray Iron.—The essential characteristic of cast iron is that much of the carbon is present as flake graphite, which gives it a gray-coloured fracture when broken and accounts for the name gray cast iron. Although gray iron is not as strong as steel, it does possess the very definite metallurgical advantages of lower melting and pouring temperatures, excellent fluidity and superior machinability. Gray iron is readily melted in a vertical-shaft, coke-fired furnace called a cupola. These and other attributes have led to its widespread use for many industrial purposes, including automobile motor blocks, agricultural and machinery parts, soil and pressure pipe, stove and furnace parts, hollow ware and ingot molds.

The strength of cast iron is most affected by its carbon content, since excess carbon is present in free flake form which weakens the steel-like matrix material. Hence the first means of increasing the strength of cast iron is to melt it with lower carbon levels. As this is done, the hardness increases until eventually the material loses its good machinability. It is at this point that alloys such as nickel, chromium, copper, molybdenum, vanadium and titanium are used to refine the graphite flakes and strengthen the matrix while still maintaining a hardness level that permits satisfactory machinability. Alloy contents, in addition to strengthening and toughening the iron, also increase its stiffness, pressure tightness, metal-to-metal wear resistance, and corrosion and heat resistance. In general they permit cast iron to be used in many services previously considered too demanding for this type of metal. Gray cast irons are usually catalogued in terms of tensile strength within a commercial range of 20,000 to 60,000 lb. per square inch (p.s.i.), the high side of the range often being in the form of alloyed irons.

The alloy content of ordinary cast iron generally does not exceed 3% to 4%. Special types of corrosion-resistant iron are made with greater alloy contents, for example, 11% to 17% silicon, 25% to 30% chromium or 20% to 30% nickel. The high-nickel types of iron possess an austenitic matrix structure (one with a solid solution of carbon or iron carbide in iron) and, in addition to corrosion resistance, possess many special properties such as being nonmagnetic and having thermal expansion characteristics either much lower or much higher than is the case for normal gray iron (*see* also ALLOYS: *Mechanical Properties*). The special properties developed by these highly alloyed types of cast iron have led to their widespread use.

White Iron.—The silicon content of gray cast iron is normally 1.5% to 3.0%. When this element is substantially lower a new type of cast iron is produced. It is called white iron because it shows a white fracture when freshly broken. The reason for the change is that with little silicon (0.3% to 1.0%) the compound iron carbide, or cementite (Fe_3C), present in all irons does not decompose into flake graphite and iron upon freezing and cooling to room temperature. Iron carbide is a very hard, brittle material and changes the nature of the iron drastically from its gray iron counterpart. White iron is very hard, stiff and unmachinable. It is widely used to resist wear and abrasion for such parts as grinding balls, chutes, mill liners and pulverizing elements, but its use is limited by its lack of toughness and relatively low strength.

By careful adjustment of silicon content and by the use of metal chillers placed in the sand mold to produce fast freezing at specific surfaces of a casting, it is possible to produce iron castings that are hard and white in part of their cross sections and gray and machinable in the balance. This process produces abrasion-resistant castings which can still be shaped by machining in certain areas. Such castings, usually called chilled iron castings, are used as freight car wheels and brake shoes, plowshares, pulverizer equipment parts, and rolls for steel mills.

The white and chilled varieties of cast iron are frequently alloyed with up to 1% chromium to prevent the breakdown of iron carbide into graphite. For withstanding extreme abrasion, white iron castings are often alloyed with up to 4.5% nickel and 2.0% chromium to produce very hard martensitic irons. These castings possess in the mold-cooled condition hardness equivalent to that of heat-treated steel. This type of white iron is widely used for steel-mill rolls and abrasion-resisting parts in the cement, ceramic, power and mining industries.

Malleable Cast Iron.—While cast iron possesses the advantages of being easily melted and readily cast into intricate shapes, it is a relatively brittle material because its matrix structure is interlaced with flakes of graphite. The first advance in overcoming this lack of toughness was the development by the French physicist René Antoine Réaumur (1683–1757), who in 1722 introduced malleable iron. This iron is made by lowering the carbon content of cast iron to 2.5% to 3.0% and casting it in the white condition; that is, free of flake graphite. These castings are then packed in hematite iron ore and given an extended heat treatment of five or six days at a bright red heat. The purpose is to remove most of the carbon by oxidation. This product, which is made in Europe, is called white heart malleable. It is stronger than ordinary cast iron and, more akin to steel, possesses considerable ductility and malleability because of the absence of flake graphite.

Another type of malleable iron, called black heart malleable, was developed in the United States by Seth Boyden about 1826. The manufacturing process is based upon casting the iron white, using lower carbon and silicon levels than in gray iron, and then annealing it at a red temperature so that the iron carbides are decomposed into temper carbon (clusters of finely divided graphite). The result is a metal that has excellent strength and toughness since it is not weakened by flake graphite. It is widely used for a great variety of small or thin-walled industrial castings such as automotive, agricultural machinery and railroad equipment parts, electrical and small pipe fittings, hardware and small tools. Black heart malleable iron requires an appreciably shorter annealing time than the white heart variety.

Ductile Iron.—This variety of cast iron also is known as nodular iron and spheroidal graphite (or S. G.) iron. Both white and black heart malleable iron represented a distinct advance in eliminating the greatest drawbacks of gray iron—lack of toughness and inability to be deformed. However, they too possess the disadvantage that castings are limited to relatively thin shapes with the bulk of production in castings being under $\frac{3}{4}$ in. in thickness. Substantially heavier castings are apt to possess flake graphite which would persist after annealing and destroy the iron's ductility. The extended high-temperature annealing treatment also is costly and time-consuming.

In 1948 H. Morrogh in England and K. D. Millis, A. P. Gagnebin and N. B. Pilling in the United States revealed methods of producing cast iron that was ductile in the as-cast condition. Morrogh based his discovery on the addition of cerium to molten iron, and his process is limited to high-carbon irons, over about 3.3% in most cases. The U.S. method introduced magnesium into the casting and can be used with cast iron of all carbon levels. The change in the nature of cast iron to produce ductile iron is brought about by replacing flake graphite with graphite in the form of tiny balls or spheroids, hence the alternate names nodular and spheroidal graphite iron. Of great importance is the fact that this graphite structure is developed in the as-cast condition, completely independent of any heat treatment. The method that has been most widely accepted by foundries throughout the world for producing ductile iron has been that incorporating magnesium, using a patented process available under license from The International Nickel Company, Inc., and affiliates.

This means that for the first time the gray-iron foundryman is able to treat what might normally be a low strength, brittle cast iron with an agent that transforms it into a material having strength superior to malleable iron and akin to cast steel. For instance, it is not unusual to treat an iron which would have a strength of 20,000 p.s.i. with flake graphite and produce a strength of over 100,000 p.s.i. with spheroidal graphite. Of great significance is the fact that this product still retains the important attributes of cast iron—namely, low melting point, good fluidity and castability, and ready machinability—combined with the engineering advantages of steel in the form of strength, toughness and ductility. Whereas malleable iron is limited to relatively thin castings, ductile iron can be produced in sections from as thin as ⅛ in. to as thick as 48 in. Whereas steel castings present difficult or insurmountable problems when made in complex shapes, ductile iron castings can be made quite readily in very intricate designs.

Ductile irons are really a whole family of irons, just as are flake-cast irons and, like the latter, can be heat-treated and alloyed in various ways to produce special mechanical properties and superior corrosion, heat and wear resistance. Ductile irons are widely used in pipe, valves, gears, dies, machinery frames, automotive crankshafts, pump and compressor bodies, metal-working rolls, agricultural equipment parts and a host of other products. The development of spheroidal graphite cast iron opened a whole new vista for the iron foundryman and the designing engineer and represented a significant step forward in the history of metals. *See* also ALLOYS; METALLURGY: *Iron and Steel; see* also Index references under "Cast Iron" in the Index volume.

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(K. A. DE L.)

CASTLE, a fortified residence, generally the stronghold of the king or lord of the territory in which it stands. The word is sometimes applied to prehistoric earthworks, as Maiden castle, Eng.; and, in modern times, in the various national forms of "castle"—*château, castello* or *Burg*—to princely mansions or countryseats. The word is derived from the Latin *castellum,* a diminutive of *castrum,* "a fortified place"; medieval writers often used such words as *castrum, castellum, oppidum* and *municipium* indiscriminately. In all cases of medieval usage the fundamental factor was fortification applied to a town, a private residence or a tower. It is in the more general meaning of a medieval stronghold, at once a private residence and a fortress, that the word is used here.

Early Medieval Castles.—Fortifications as built by the ancients were for communal defense. Cities were surrounded by several lines of walls, one within the other, with the citadel occupying the highest or most advantageous position. The Greeks and Romans generally followed the communal concept in their fortifications; but the Byzantines, on the conquest of north Africa by Belisarius (A.D. 533–534), built throughout Algeria and Tunisia not only walled towns but also, in isolated sites commanding a valley or important pass, strong forts and towers in all respects like the castles built in western Europe during the 13th and 14th centuries. Aïn Tounga, guarding a pass in Tunisia, with its walls, corner towers, gate and keep, or donjon (*i.e.,* the strongest tower), is a striking instance.

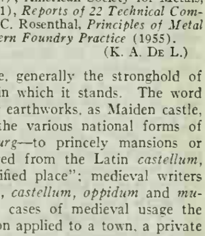


FIG. 1.—PLAN OF AÏN TOUNGA, NEAR TESTOUR, TUNISIA, 6TH CENTURY

During the dark ages, progress in the development of military architecture was confined almost entirely to the Byzantine empire, the western nations having no opportunity for such works; but from the 9th century onward progress in western Europe was rapid. Fortifications built in France in the 10th century often included a high mound encircled by a ditch and surmounted by the leader's particular stronghold, as at Blois and Saumur. Later, one or more wards, or baileys (grounds between encircling walls), were enclosed at the foot of the mound. During the 11th century this type of private fortress, known as the "motte (mound) and bailey" castle, spread over western Europe. Excavations carried out in 1949–50 at Abinger, Eng., revealed a small castle of this type. The mounds were hillocks, either natural, partly natural and partly artificial, or wholly artificial, according to the nature of the sites they occupied. If a natural hillock was at hand, and stone was plentiful in the neighbourhood, the round shell keep on the top, which contained the residential quarters, was built of stone, as at Launceston, Eng. If the hillock was only partly natural, the keep was often also of stone, the foundation being carried down to the firm soil; when the hillock was wholly artificial and timber was plentiful, the residential quarters were first built of wood.

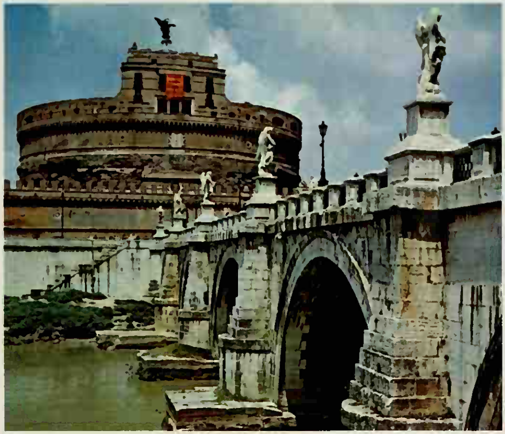
Many of the early Norman castles built in England were of stone, as the outer shell of the Round tower of Windsor castle, built *c.* 1075; the shell keeps at Launceston and Totnes, both *c.* 1080; and the rectangular White tower of the Tower of London, also *c.* 1080. In all cases the foundations were carried down to the natural soil. Many castles of later medieval periods, in districts where stone was scarce, were built of brick, as the round Château de Montaner, Hautes-Pyrénées, Fr. (*c.* 1380); the castle at Marienwerder, Ger. (Kwidzyn, Pol.), about the same period; and Kirby Muxloe, Waynflete and many other examples in England. In many cases the finely toned brickwork of the walls was decorated with a diaper of darker bricks.

The thickness of castle walls varied largely according to the natural strength of the sites they occupied, often varying greatly at different points of the site; in Britain they were generally from 6 to 7 ft. thick, but they ranged from 5 ft. at Eynsford to 15 ft. at Caernarvon. The walls of fortifications on the continent of Europe and in the east were often much thicker: those of Pompeii were 65 ft.; those of the medieval forts of India were from 15 to 50 ft.; the walls of Peking were 75 ft.; and those of ancient Babylon (as finished *c.* 600 B.C.) were more than 85 ft. thick.

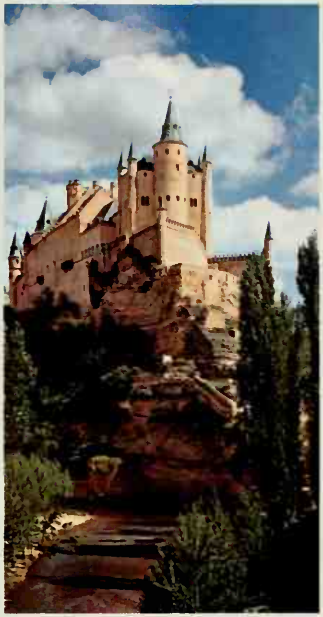
The windows of the living rooms during the early Norman period were small lights from 12 to 18 in. wide by 4 ft. high; toward the end of the 12th century they were often of twin lights, each 1 ft. 10 in. wide by 4 ft. 8 in. high, still closed by wooden shutters, as at Conisborough. At later periods they developed considerably in size until they reached the magnificent proportions of those of the great hall of Kenilworth castle. These windows were not so vulnerable as they appear to be today, for they were all protected by powerful iron grilles. Toward the end of the 13th century, glass began to take the place of wooden shutters, but it was still an expensive item and sparingly used.

The defense of the *enceinte,* or outer wall, of the castle was generally by means of one or more lines of moats, the moats being crossed in front of the gateways by drawbridges; *i.e.,* bridges which could be drawn back or raised from the inner side in order to prevent the moats being crossed. The gateway was often protected by a barbican, a walled outwork in front of the gate; and the passage through the gateway was defended by portcullises, doors and machicolations. Portcullises were generally made of oak, plated and shod with iron, and were moved up and down in stone grooves, clearing or blocking the passage. Machicolations were of two kinds, some being openings in the roof of the passage through which missiles were thrown on enemies forcing their way through, and others projecting out on corbels from the parapets of walls and gates through which lethal missiles could be thrown on the enemy below.

The baileys, or wards, at the foot of the mound were enclosed by palisades and later by walls and towers of masonry. Almost at the same time that the shell keep was being erected in western Europe, the rectangular keep, a more compact form of citadel, was also being built. Examples are the donjon at Loches, Fr., built

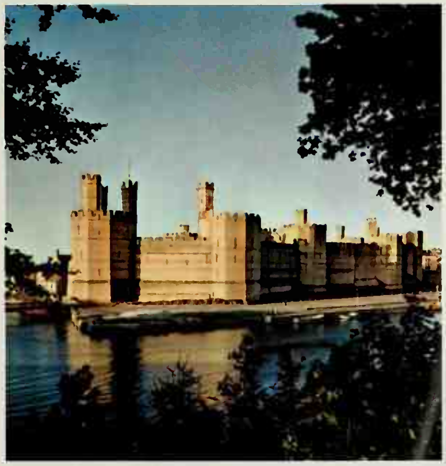


Castel Sant' Angelo (Hadrian's tomb), Rome. Originally constructed as a mausoleum in the 2nd century, it was rebuilt during the middle ages to serve as the citadel of Rome

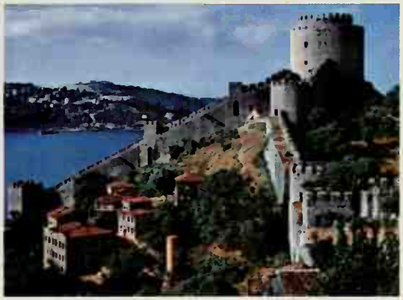


Alcázar at Segovia, Spain, built in the 15th century for Henry IV of Castile. Placed on a high narrow plateau, this Romanesque-style fortress served as the king's residence as well as the stronghold of the city walls

FAMOUS CASTLES



Caernarvon castle, Wales. Built during the latter part of the 13th century for Edward I, it was the most important of six fortresses erected for the subjugation of the Welsh. Although little remains of the interior residential buildings, Caernarvon is one of the best-preserved castles in the British Isles



Tower and walls of the castle of Rumeli Hissar, Turkey, built on the shore of the Bosporus opposite Constantinople by Mohammed II in 1453 to guard the straits

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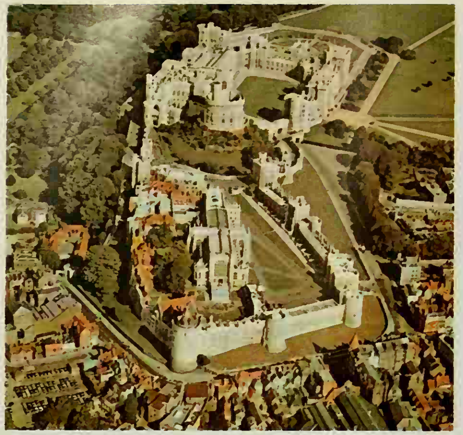
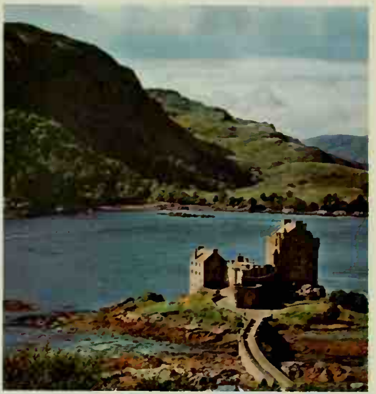
CASTLE

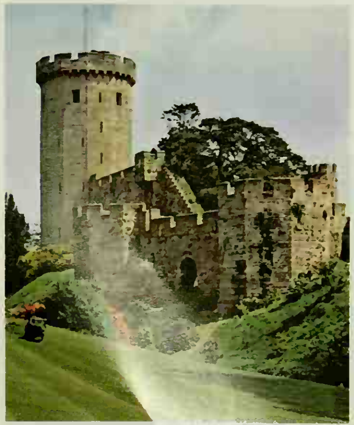


Windsor castle, principal residence of the British monarchs since the time of William the Conqueror. The round tower (in the centre) is chiefly the work of Edward III. St. George's chapel (foreground) was built between 1473 and 1507

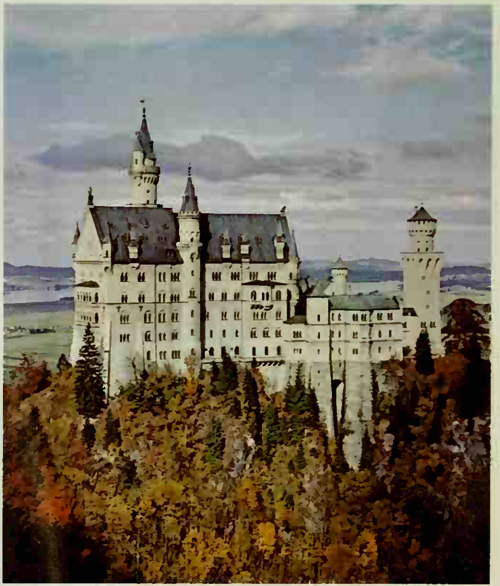


Eileen Donan castle, Scotland, home of the MacKenzies, earls of Seaforth from 1623 to 1716. The original castle was destroyed by gunfire in the early 18th century, restored in the 20th

WINDSOR AND OTHER FAMOUS CASTLES

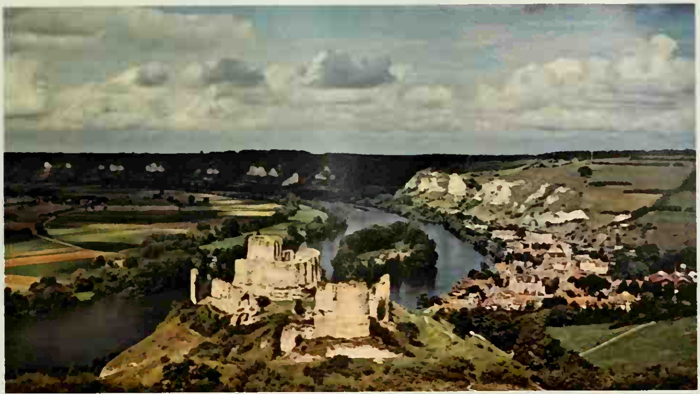


Warwick castle, originally built by Aethelflaed, "lady of the Mercians," in 914, enlarged by William the Conqueror who was at Warwick in 1068. William de Beauchamp's grandson, Thomas, began building the present castle about 1330



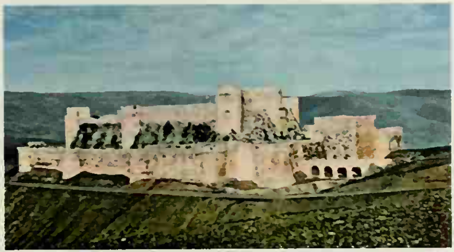
The Bavarian royal castle of Neuschwanstein. Although built in the late 19th century, it accurately represents the type of castle developed in the hills of Germany during the middle ages. A product of the German romantic movement and the extravagances of Ludwig II of Bavaria, it was built to rival the castle of Wartburg

PHOTOGRAPHS (TOP LEFT) EUROPEAN (TOP RIGHT) PE[illegible] (BOTTOM LEFT) BERNARD G SILBERSTEIN FROM RAPHO-GUILLUMETTE (BOTTOM RIGHT) DUNCAN EDWARDS FROM FPG

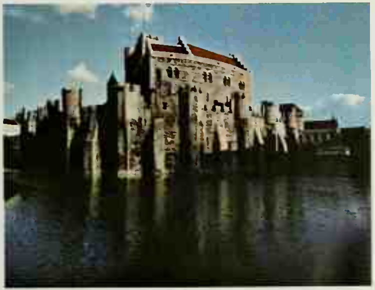


Ruins of the Château Gaillard, Les Andelys, France. Built by Richard I of England in 1196–98, it stands at the top of a precipitous cliff overlooking the Seine river, 300 ft. below

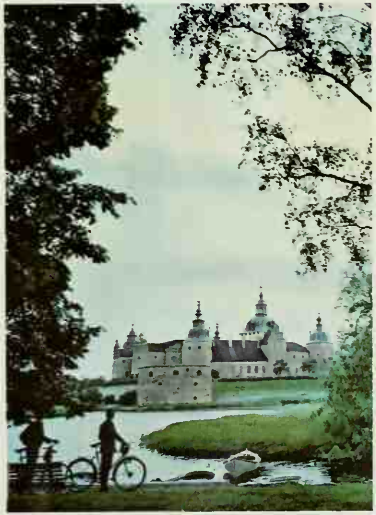
CASTLES IN EUROPE AND SYRIA



Krak des Chevaliers, Syria. The most powerful and imposing of all the crusader castles, it was principally built by the Knights Hospitallers, who held it between 1142 and 1271



Castle of the counts of Flanders, Ghent, Belgium. It was built in 1180 and modeled after the castles of the crusaders in Syria



Kalmar castle, Sweden. An island-fortress dating from the 12th century, but principally from the 16th and 17th, and containing the beautiful chamber of King Eric XIV (d. 1577)

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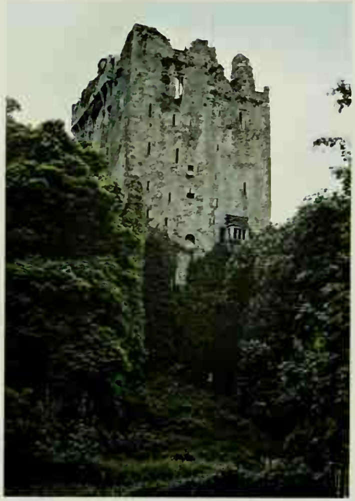
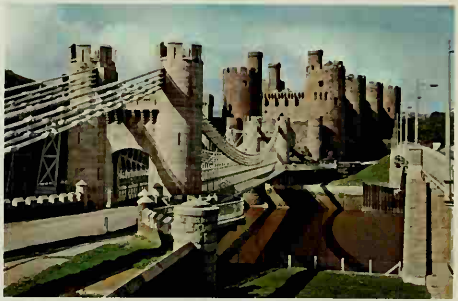
CASTLE

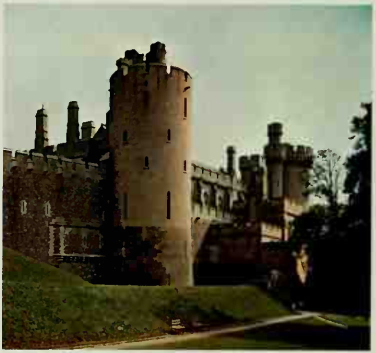
BRITISH AND IRISH CASTLES



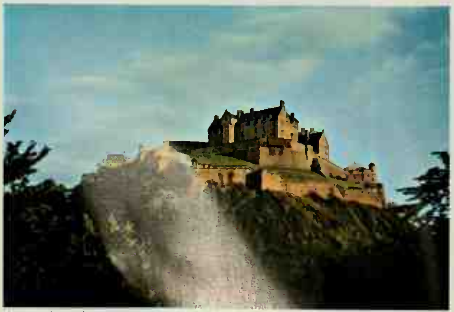
One of the towers of Blarney castle, Republic of Ireland. Built about 1446 by Cormac Laidhiv McCarthy, lord of Muskerry, its walls are 18 ft. thick



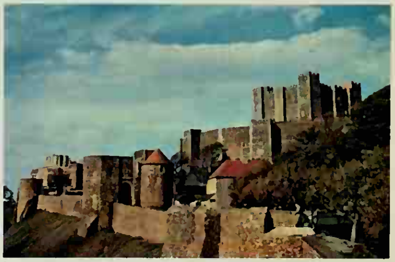
Conway castle, Wales, guarding a narrows in the Conway river. The castle was built about 1284, the bridge in the 19th century



Arundel castle, Sussex. Begun in the 11th century, it was repaired and improved by successive dukes of Norfolk



Edinburgh castle, Scotland. The oldest parts of the castle date from the time of Queen Margaret (d. 1093), but important additions ware made subsequently



Dover castle, England, overlooking the Channel. The keep is Norman, built during the reign of Henry II, but remains of Roman and Saxon buildings are still present within the walls

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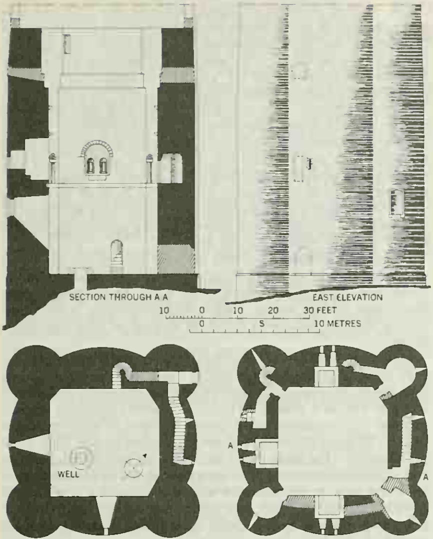


SIDNEY TOY

FIG. 2.—PLAN OF THE DONJON, CHÂTEAU DE HOUDAN, HOUDAN, FRANCE, 1130

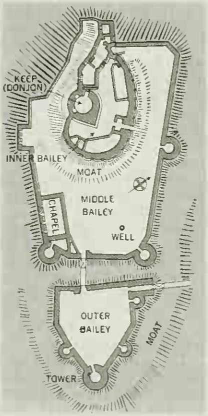
about 1020; the White tower in the Tower of London, *c.* 1080; and the keep at Rochester, Eng., *c.* 1130. (*See* Tower of London.)

The keep was the focal point of the castle, to which, in time of siege, the whole garrison retired when the outer works had fallen; it was therefore the strongest and most carefully fortified part of the defenses. It had a well, contained the private apartments, offices and service rooms, and held all the appointments necessary to sustain a long siege. Often the keep stood in line with the outer line of the defenses, so that while one side looked toward the bailey (or succession of baileys) commanding the operations of the defense there, the other side commanded the field and the approaches to the castle. The side of the keep exposed to the field also presented a line of escape.

Rectangular keeps were strongly built, had thick walls, generally buttressed, and were from two to four stories in height; often each story was divided into two or more compartments by partition walls. The entrance doorway was usually on the second story and was reached by a stairway built against the side of the keep, the stairway being contained in and protected by a forebuilding. From the entrance floor, access to the floors above and below was by means of mural stairways that either passed straight up within the walls or ascended spirally at one or more of the corners. The great hall was generally on the entrance floor and often had a mural gallery around the walls at a level high above the floor. Mural chambers and latrines opened off the hall; the passages to the latrines had right-angle turns for sanitary reasons. Fireplaces were formed either in the outer walls or in the partition walls. There was generally a chapel within the keep or its forebuilding; at Dover there were two chapels, both in the forebuilding. In the keeps at both Newcastle upon Tyne (built 1172–77) and Dover (built 1181–87), in addition to the drawing place in the chamber at the wellhead, water was conveyed from this chamber to other drawing places in various parts of the keep through lead pipes buried in the walls.

Appearance of Circular Keeps.—Rectangular keeps had the great disadvantage of presenting vulnerable corners to the sapper and the battering-ram, since the enemy could be attacked from one side only and was sheltered by the corner against attacks from the other side. In the Levant the towers were often circular or multiangular and therefore presented no screen to the enemy at any point. On the other hand, a rectangular plan is much more convenient for the disposition of the rooms. It was not until the return from the third crusade at the end of the 12th century that round keeps were built generally. Meanwhile, keeps of transitional character, having the advantages of both forms, were being raised, as at Houdan, Provins, Gisors and Étampes, all in France, and at Orford, Longtown and York in England. That at Houdan, built *c.* 1130, is a good example: there are two stories, each of great height, the ground floor, containing the wellhead, being the storeroom; and the upper story the great hall, with chambers formed in turrets opening off from it. Internally the plan is square with slightly splayed corners; externally the body of the keep is circular with four round turrets protruding at four points an equal distance apart; the whole exterior surface could therefore be enfiladed from the battlements on the turrets as well as swept from those on the main body. When the custom arose of building the main private and service apartments in the bailey, as at Château Gaillard, Fr. (built 1196–98) the keep became a purely military structure forming the last line of defense. It is circular with a projecting prow at the Château Gaillard, and circular without any projection at Pembroke.

In the Levant, Byzantine traditions were followed during the 11th and 12th centuries; and with the powerful fortifications which fell into their hands as the result of conquest, the Saracens were able to defend themselves for long periods against the armies of the first crusade (1096–99), as at Nicaea, Antioch and Jerusalem. Following the conquest of Jerusalem in 1099 and the establishment of the Latin kingdom and principalities, powerful castles were raised in great numbers from Antioch in the north to the Gulf of Aqaba on the south. Fine examples of these castles are those of Saone, Margat and Krak des Chevaliers; the last, built in the 12th and 13th centuries, was the most powerful and imposing of all the crusader castles, and is the best preserved.



SIDNEY TOY

FIG. 3.—A PLAN OF THE BAILEY, CHÂTEAU GAILLARD, NEAR LES ANDELYS, FRANCE, BUILT 1196–98

Importance of the Castle's Site.—On their return to western Europe from the third crusade (1189–92), the crusaders proceeded to give effect to their experiences. They had observed the good qualities of Byzantine work, as well as the great execution wrought by the powerful siege engines then in use on both sides, and the dire effects of sapping and mining. The site now chosen for a new castle, where such choice was possible, was the summit of a precipitous hill, the citadel being backed against the cliff. The main defense was concentrated in the direction of approach, and here there were often two or three lines of advance fortifications: Château Gaillard and Pembroke castle in Wales (*c.* 1200) are typical examples. The living quarters, with the hall, domestic offices and chapel, were now all built in the court of the inner bailey. The keep (often no longer the residence but the last line of defense) was smaller than those built previously but of more powerful design.

Château Gaillard, near Les Andelys, stands on a precipitous cliff 300 ft. above the Seine river. Built by Richard I of England, it was one of the most powerful castles of the day. It consisted of three baileys arranged in line; the outer bailey (triangular in plan, with the apex pointing toward the field) was completely surrounded by a moat, and there was another moat between the middle and inner baileys; in lieu of wall towers, the wall around the inner bailey was convolved on the outer face. The donjon, standing on the edge of the cliff, was circular except that the outer face, on the side most open to attack, was brought to a point like the prow of a ship, to increase the difficulties of sapping and to deflect missiles hurled at it.

In the Upper Palatinate of Bavaria, Ger., are some castles built on a natural pile of huge boulders, as at Falkenberg, dating *c.* 1290. This castle stands on a massive pile of rocks at the end of a promontory overlooking the Waldnaab river, the promontory being cut through in two places at the line of approach; the curtain follows the contour of the pile of rocks, and the donjon stands within a small courtyard. In mountainous countries the castle often consisted of a single tower, as at Troyenstein in the Austrian Tirol, built in the latter part of the 14th century. In Scotland and in the border counties between England and Scotland are many castles which consist, or consisted, only of a fortified tower or residence and a walled courtyard.

The Feudal Castle Till the Appearance of Firearms.—Apart from the question of defense and the ever-increasing aspiration for superior domestic amenities in design, there were powerful political issues involved in the rapid spread of castles, and they soon became a menace to the central authority. Because of the inroads of the Normans into France, Charles the Bald in 862 ordered the construction of fortresses at all points to resist the invaders; but the multiplication of private strongholds became so great a menace to the authority of the crown that two years later he issued the Edict of Pistes ordering the destruction of all those which had been built without a royal licence. However, the inability of the central government to cope with the disorders of the period led to the introduction of feudalism, one of the main features of which was that a freeman provided the noble with the military services of himself and his retainers in exchange for the tenure of land; it also led to the further spread of private fortresses.

After Frankish feudalism was introduced into Britain by the Normans, castles of the types described above were built everywhere. The power of these widely dispersed and well-situated strongholds of trusty nobles to subdue and hold in subjection whole districts was of great value to a strong king like William I of England; but the nobles in their fastnesses were quite ready to defy a weak or greatly embarrassed ruler. During Stephen's disturbed reign, "adulterine" castles (those which had not received the royal licence) sprang up, only to be destroyed after the treaty of 1153. For more than two centuries after the Conquest, castles played an important role in English political struggles.

The reign of Edward I of England was a brilliant period of military architecture, during which some of the most powerful castles of any age or country were built in Britain. Considerable attention was still paid to outworks, but the general tendency was to concentrate the defense on a foursquare castle enclosed by one or two lines of walls and having a strong round tower at each corner of the inner line. Powerful gateways took the place of keeps; the difficulties of investment were increased by extensive outworks; and greater facilities for bringing in supplies and for escape in case of necessity were provided. Caerphilly and Harlech (both in Wales) are examples. Conway and Caernarvon (also in Wales), each built as part of the fortifications of the town it dominates, though not of the square plan, embody these principles. In the 15th century, imposing residential tower houses, designed on elegant rather than on defensive principles, were built within the castles, as at Warkworth and Tattershall in England and at Vincennes and Pierrefonds in France. The disposition of the domestic quarters within the castle followed the general principle throughout the whole medieval period, though from time to time the desire for better amenities and more space led to the elaboration of the system, the great hall still remaining the focal point (*see* HALL). The military quarters were adjacent to the entrance gate.

The fortified positions in Russia, castle or city, followed generally the lines of development pursued in western Europe, except that timber was more extensively used until the 15th century. Moscow may be taken as an example of the later works. The Kremlin (the Russian word for "citadel") at Moscow, in the heart of the city; its existing fortifications were built in the 14th century, with later additions. It is triangular-shaped with sides about 750 yd. long and stands on rising ground at the junction of the Moskva river with its tributary Neglinnaya, the south side running along the river bank and the east side facing Red square. It is surrounded by a powerful wall, built of brickwork, varying in thickness from 15 ft. to 20 ft. and in height from 30 ft. to 70 ft. The wall is strengthened at intervals by large towers, has an embattled parapet and is pierced by four gateways and a postern, the postern having a secret passage to the river.

Prominent examples of castles in Great Britain are the Tower of London and the castles of Windsor, Caernarvon, Conway, Edinburgh and Stirling; in Ireland, Trim castle and Blarney castle. Some large modern houses, such as Balmoral castle, have no defensive features but are so called on account of their castellated design.

Medieval India.—The medieval castles of India form a distinct class. The greatest number of them, and they are profuse throughout that region, are perched on precipitous hills and include a city as well as a citadel. They are of great extent and are surrounded by formidable, often numerous, lines of walls with bastions at frequent intervals and powerful gates on the main roads of approach. The main gates are richly decorated with paneling and sculptured ornament, and the gateways are of great height to allow the passage of elephants with their howdahs and mounts. A special defense is heavy teak doors studded with many rows of sharp iron spikes to prevent their being forced open by elephants in time of attack.

The Effect of Firearms.—Development in the use of firearms was so rapid during the 15th and 16th centuries as to require a radical change in military architecture. In 1494 French troops marched through Italy, and with their guns reduced castle after castle with astonishing rapidity. The age of the medieval castle came to an end and the era of modern military fortification opened. The break with the past did not occur suddenly but extended over many years. During the reign of Henry VIII in England an interesting transitional type appeared in the form of coastal castles or forts, with semicircular bastions, that were built along the south and east coasts, as at Walmer, Deal, Camber and St. Mawes.

The principle governing the design of the new forts, constructed all over Europe, was that the whole building should be concentrated in one compact block. Its low walls could be defended all around by artillery, the guns being mounted on pointed bastions and redans, as in France, Italy, Rhodes and Malta. From this period there was a complete break between military and domestic architecture; the former became a fort under the military control of the monarch, the latter an unfortified palace, mansion or hotel. (*See* FORTIFICATION: *Influence of Gunpowder.*)

The Siege of Château Gaillard.—The whole purpose of medieval defenses is best understood by perusal of the very vivid descriptions given by contemporary chroniclers. In 1203 Philip II of France marched toward the castle of Château Gaillard, then held for King John of England by Roger de Lacy. He took the town of Les Andelys at the foot of the hill on which it stood and laid siege to the castle above. Having regard to the strength of the castle, Philip decided to reduce it by famine; with this end in view he dug two lines of trenches running up the hill from the water on one side and down to the river on the other. Philip's troops then sat down for about three months to await events; and there ensued one of the most terrible episodes in the history of the middle ages.

Some 1,400 persons from the town below had taken refuge in the castle. As supplies diminished, 1,000 of them departed and were allowed to pass the French lines. Later 400 others were sent forth. These latter were not allowed to pass through the lines but were condemned to pass a severe winter in the open, subsisting on such herbs as they could find in the valleys. Dogs which were driven out of the castle were seized and eaten. Before the winter was over, nearly all the refugees had perished.

In the spring of 1204 Philip set up his siege engines on the high ground to the southeast and began his assault on the castle. His engines included *petrariae*, mangonels and a very high siege tower; he also built a long penthouse for the protection of those engaged in filling the castle ditches. To his attack the garrison replied vigorously with stones from their own engines, causing considerable loss to the besiegers. The French then began sapping operations, under the protection of their shields. The outer bailey was taken, and the French proceeded to attack the remaining works. They searched along the river bank for the outlet of the drain from the latrines, and after finding it they crawled up through the drain, penetrated into a building within the middle bailey, and succeeded in lowering the drawbridge between the outer and middle baileys so that the French troops could enter; and the middle bailey was taken.

Then the French, under the protection of one of their machines, proceeded to undermine the wall of the inner bailey; but by countermining on the other side, the garrison broke into the French tunnel and drove them out. By now the wall, weakened by being undermined on both sides and battered by a powerful *petraria* throwing enormous blocks of stone, was fractured; and the French, rushing through the breach, entered the inner bailey. Even then, none of the garrison surrendered, but all fought as long as it was possible to do so.

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CASTLEBAR (CAISLEÁN AN BHARRAIGH), a market town in Connaught province, Republic of Ireland, lies 54 mi. S.W. of Sligo by road. Pop. (1961) 5,482. Castlebar is the capital of County Mayo and stands at the head of Lough Castlebar or Lanach virtually in the centre of the county. In the late 1950s the Castlebar Anglers' association, which organizes the annual World Trout Fly Fishing competition on Lough Mask, 12 mi. S., co-operated with the Inland Fisheries trust in clearing and restocking the adjacent waters. The settlement that grew up around Castlebany, the castle of John Bingham, was incorporated in 1613. The "Castlebar Races" was the rout and pursuit (1798) of Gen. John Hely-Hutchinson's troops by invading French forces under Gen. J. R. M. Humbert. The French were later defeated by Gen. Gerard Lake (*q.v.*) at Ballinamuck. (D. V. O'D.)

CASTLE DOUGLAS, a small burgh, Kirkcudbrightshire, Scot. Pop. (1961) 3,253. It lies at the north end of Carlingwark loch, about 8 mi. S.W. of Dumfries. It is the chief business centre of east Galloway and its sheep and cattle sales are the largest in the southwest of Scotland. Until 1765 it was a village known as Causewayend (named for an old causeway in the loch) and afterward Carlingwark, but the discovery of marl in the lake brought it prosperity and it was bought in 1792 by Sir William Douglas and renamed after him. On one of the islets in the loch is a crannog, or ancient lake dwelling. Threave castle, the Douglas stronghold (1369–1455), 1½ mi. W. on an island in the Dee, was given to the National trust in 1948.

CASTLEFORD, a municipal borough in the West Riding of Yorkshire, Eng., 10 mi. S.E. of Leeds by road. Pop. (1961) 40,345. It was extended in 1938 to include Whitwood, Ferry Frystone, Glass Houghton and part of Allerton Bywater, and incorporated in 1955. There are collieries and large glass bottle and chemical works. It stands where Ermine street crosses the Aire river near its junction with the Calder and on the site of the Roman Legiolium. In 948 the name appeared as Ceasterford.

CASTLE GUARD, an arrangement under the feudal system by which the duty of finding knights to guard royal castles was imposed on certain baronies and divided among their knights' fees. The greater barons provided for the guard of their castles by exacting a similar duty from their knights. In both cases the obligation was commuted very early for a fixed money payment, which, as "castle-guard rent," lasted down to modern times.

See J. H. Round, "Castle-Guard," in *Archaeological Journal*, vol. lix, and "Castleward and Coinage," in *The Commune of London* (1899); S. Painter, in *American Historical Review*, vol. xi, pp. 450–459 (1935); F. M. Stenton, *The First Century of English Feudalism*, pp. 190–215 (1932).

CASTLEREAGH, ROBERT STEWART, VISCOUNT: *see* LONDONDERRY, ROBERT STEWART, 2ND MARQUESS OF.

CASTLE RISING, a small village of Norfolk, Eng., 4½ mi. N.E. of King's Lynn. Pop. (1951) 255. The fine Norman castle stands within a 12-ac. enclosure, formed by artificial ramparts of earth, and a dike, which is crossed by an ancient bridge. The keep is square and massive, and the Norman carving, especially over the entrance, is very rich. The foundations of a small chapel were discovered outside the castle. The village of Castle Rising is the remnant of a town of past importance. It is mentioned in Domesday Book and was later granted to William de Albini, whose son built the castle. It passed to Isabella, queen of Edward II, in 1332 but was exchanged for Brest castle by Richard II. It reverted to the crown in the 14th century and so remained until Henry VIII exchanged it for other lands with Thomas Howard, duke of Norfolk. A mayor is first mentioned in 1343 and a borough existed in the 15th century. A survey of 1589–90 declared that Castle Rising was an ancient borough by prescription. Castle Rising became a parliamentary borough in 1558, but was disfranchised in 1832, although a mayor was elected for special purposes until 1883. Its fairs and markets were formerly important.

The church of St. Laurence is late Norman, with rich ornamentation; it shows traces of considerable alteration in the Early English period. The Bede house, founded in 1614 by Henry Howard, earl of Northampton, is an almshouse for elderly ladies, who still occasionally on Sundays wear the high hats and red cloaks of Stuart times.

CASTLETON, a village of north Derbyshire, Eng., 11 mi. N.E. of Buxton by road, lies about 600 ft. above sea level, closely surrounded by limestone hills rising to heights of 1,400 to 1,700 ft. Pop. (1951) 711. It is visited for its caves and mines and for Peveril castle, now a ruin, perched on a cliff above the village. Penetrating this cliff is the Peak cavern, which from the 16th century has served as a workshop, rent-free, to families making rope and twine. The Blue John cavern, source of a beautiful fluorspar known as Blue John, has fine stalactitic formations, as also has Treak Cliff cavern. Treak Cliff hill is said to be the world's only remaining known source of Blue John spar, specimens of which are in the Vatican library in Rome and at Chatsworth house in Derbyshire. The Speedwell cavern, ¾ mi. W. of the village, affords a boat trip along a subterranean canal whose waters reappear in the village stream.

Peveril castle owes its fame to its dominating position and to Sir Walter Scott's novel *Peveril of the Peak;* the fabric has been well repaired by the ministry of works. Before the Norman Conquest the site was held by Gernebern and Hundinc, and earthworks can still be traced. It was granted by William I to William Peveril, who built the castle. In 1216 William Ferrers, earl of Derby, took it from the rebellious barons and was made governor by Henry III, who in 1223 granted a charter for a weekly market. King Edward III settled the castle on his son John of Gaunt, and it thus became part of the duchy of Lancaster. Often used as a prison, it was almost impregnable. (J. R. WD.)

CASTLETOWN, the ancient capital of the Isle of Man (in Manx called Balla Cashtal), 8½ mi. S.W. of Douglas. Pop. (1951) 1,749. A small tidal harbour is formed by the outflow of the Silverburn into Castletown bay. Castle Rushen, in the centre of the town, is said to have been founded in 947–960 by Godred the Dane. The present building is essentially Norman, largely rebuilt in the 14th century with additions in the 16th. Until the 18th century it was the residence of the lords of Man. The massive keep is square and is surrounded by an outer wall with towers and a moat. The council chamber and courthouse were built in 1644. Near the castle is the old House of Keys, where the Manx parliament met until the removal of the seat of government to Douglas in 1862.

King William's college (endowed in 1668, founded in its present form in 1833), 1 mi. N.E. of Castletown, is the principal school in the island. Beyond Derbyhaven, adjoining Castletown, is the Ronaldsway airport.

CASTOR AND POLLUX (the latter, in Greek legend, POLYDEUCES) were the children of Leda who, having consorted with Zeus (who had approached her in the form of a swan), laid an egg from which these two and their sister Helen (and Clytemnestra?) were hatched. There is some ancient confusion as to their paternity. Some hold that they were not the sons of Zeus but of Tyndareus, Leda's husband, with whom she had lain the same night. Others maintain that Castor was the son of Tyndareus, and thus a mortal, while Pollux was the son of Zeus.

The Twins, or Dioscuri, as they were also known, were inseparable and became renowned for their athletic ability, Castor for horsemanship and Pollux for boxing. Among their exploits were participation in the Caledonian boar hunt, sailing on the Argo, and rescuing Helen, who had been carried off by Theseus. They came into strife with their cousins Idas and Lynceus by carrying off their brides-to-be. Either this or a dispute over stolen cattle led to bloodshed among them. The details of the fight are variously recorded, but authorities agree that Castor, being mortal, was slain. Pollux did not wish to outlive his brother and refused immortality in which Castor had no share. Touched by such devotion, Zeus allowed them to remain together alternately in the heavens and the nether world. Later he transformed them into the constellation Gemini.

As deities they succored shipwrecked sailors and received sacrifices for favourable winds. They were associated with the luminous optical phenomenon occasionally observed at sea and later known as St. Elmo's fire. In Greece they were especially revered, probably originally as national heroes, by the Dorians, and particularly at Sparta where Tyndareus had been king.

The introduction of their cult at Rome (where Castor assumes a greater importance than Pollux) goes back traditionally to 484 B.C., and the building of their temple in the Forum followed a vow of Aulus Postumius at the battle of Lake Regillus. According to legend the Dioscuri fought on the side of the Romans and carried the news of victory to Rome. The present remains of the temple, of which three standing columns are a well-known landmark of the Roman Forum, date from a rebuilding in the Augustan era.

In art the Twins are represented as two youths, usually horsemen, holding spears. They wear egg-shaped helmets, symbolic of their origin, crowned with stars, commemorating their apotheosis.

See G. Wissowa, *Religion und Kultus der Römer* (1912); L. R. Farnen, *Greek Hero-Cults and Ideas of Immortality* (1921).

(R. B. Lo.)

CASTOR BEAN, the seed of the castor-oil or castor-bean plant or palma Christi (***Ricinus communis***), a single variable species belonging to the spurge family (Euphorbiaceae; *q.v.*). Originally African, it is now widely grown in tropic regions and warm temperate regions especially for the seeds, which yield the castor oil (*q.v.*) of commerce. In the tropics the castor-bean plant is a tree often reaching 40 ft. in height; but elsewhere, grown as an annual herb, it rarely exceeds 15 ft. The typical plant has large, smooth, five- to ten-lobed leaves, often three feet across; petalless flowers in one- to two-foot panicles; and brown, spine-covered capsular fruit containing three large and variously marked seeds, which contain, besides castor oil, the toxic principle ricin. There are numerous varieties of castor-bean plant, many of which make bold foliage displays in the garden. They are easily grown from seed planted in spring in any well-drained sandy or clay loam soil.

(J. M. BL.; X.)

CASTOREUM, an oily, viscid glandular secretion contained in two pairs of membranous sacs between the anus and external genitals of both sexes of the castor beaver, of which there are two types, the Siberian (*Castor fiber*) and the Canadian (*C. canadensis*). It is yellow or yellow-brown in colour, of a butterlike consistency, and has a highly disagreeable odour due to the presence of an essential oil. After the death of the animal, the sacs are removed and dried in smoke or in the sun; drying darkens and hardens the castoreum and reduces its odour. Castoreum is soluble in alcohol and is prepared for use as a tincture. In this form castoreum has a pleasant scent and is used in the blending of perfumes.

(E. L. Y.)

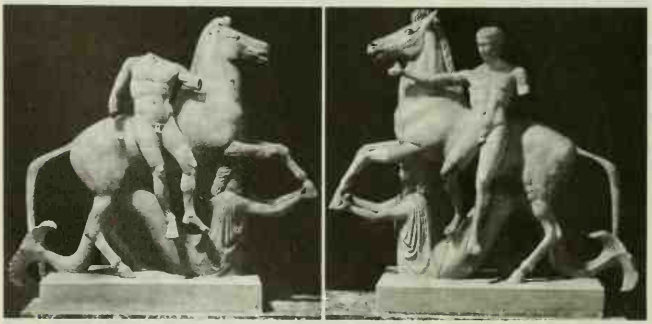
CASTOR OIL, the fixed oil obtained from the castor bean (*q.v.*). The beans, besides containing 35%–55% oil, contain also a very toxic protein, ricin, for which an antiserum has been produced by immunological methods.

Castor oil, obtained from castor-bean seeds by pressing or by solvent extraction, is clear and light coloured with a faint characteristic odour, and has a bland but slightly acrid and usually nauseating aftertaste. It consists almost entirely of triglycerides, the portion of minor constituents being small. The fatty acids of castor oil consist of ricinoleic acid, 91%–95%; linoleic acid, 4½%–5%; and oleic acid, dihydroxystearic acid and saturated fatty acids, slightly more than 1%. The oil is only partially soluble in petroleum ether but dissolves readily in alcohol, glacial acetic acid and chloroform.

India and Brazil produce 55%–65% of the estimated world production of castor beans and oil; the United States uses more than 50% of the world production, largely in industry.

Processing of castor oil for the preparation of useful derivatives involves several type reactions. Blown oils (oxidized oils) are prepared by bringing air or oxygen into intimate contact with the oil at temperatures of 176°–266° F. (80°–130° C.). Hard, waxlike fats are obtained by hydrogenation (chemical combination with hydrogen). Turkey red oil, long used as a dyeing aid and a forerunner of modern synthetic detergents, is produced by reaction of the oil with sulfuric acid. Materials useful in perfumes, and dibasic acids useful in the synthesis of resins and plasticizers, are produced by the decomposition of castor oil by heat or by heat coupled with exposure to alkali.

Materials most useful for drying oils are produced by de-



ALINARI

ANTIQUE SCULPTURE DEPICTING CASTOR (LEFT) AND POLLUX (RIGHT). IN THE NATIONAL MUSEUM, NAPLES hydration without breaking the carbon chain.

The principal uses of castor oil, on the basis of tonnage consumed, are for the production of paint, varnish and related products (in the form of dehydrated castor oil), plasticizers (as esters or blown oils) and dibasic acids. Castor oil or its derivatives are also used in such items as cosmetics, hair oils, fungistatic preparations, printing inks, nylon plastics, all-purpose greases and hydraulic fluids, dyeing aids and textile finishing materials.

Medicinally, castor oil has been used as a cathartic (formerly its chief use); ricinoleic acid, a gut irritant, is liberated from the oil by gastric juices in the intestines. It acts in about five hours after ingestion, increasing peristaltic and segmenting movements in the small intestine and allaying the normal "antiperistalsis" in the large bowel. It should not be used in cases of chronic constipation since it aggravates the condition while relieving the symptoms, and can cause congestion of the pelvic organs. *See* also OILS, FATS AND WAXES. (L. R. DN.)

CASTRATO, a male soprano or contralto voice of great range, flexibility and power, produced as a result of castration before puberty (*see* SINGING). The *castrato* voice was first introduced while women were banned from church choirs and the stage. In 18th-century Italian opera the majority of male singers were *castrati* and over 200 of them sang in churches in Rome alone. The most famous of them all was Farinelli (*q.v.*). The roles created for them, *e.g.*, by Gluck and Mozart, are now sung by women.

See A. Heriot, *The Castrati in Opera* (1956).

CASTRÉN, MATTHIAS ALEXANDER (1813–1852), Finnish ethnologist and philologist, was born at Tervola, Kemi, on Dec. 2, 1813. After journeys through Lapland and Russian Karelia and a third journey that extended as far as Obdorsk (now Salekhard), he published his *Elementa grammatices Syrjaenae* and *Elementa grammatices Tscheremissae* (1844). He then undertook an exploration of Siberia, which resulted in a vast addition to previous knowledge, but seriously affected his health. The first fruits of his collections were published as *Versuch einer ostjakischen Sprachlehre* (1849). In 1850 he published a treatise *De affixis personalibus linguarum Altaicarum* and was appointed to the new chair of Finnish language and literature at Helsinki, becoming chancellor of the university in 1851. He was engaged on a Samoyedic grammar when he died on May 7, 1852. Five volumes of his collected works appeared from 1852 to 1858.

CASTRES, a town of southwestern France in the Tarn *département*, lies on the Agout river, 72 km. (45 mi.) E. of Toulouse by road, to which it is also connected by rail. Pop. (1954 census) 26,759. Churches (in baroque style) and other public buildings remain as evidence of the town's prosperity under Louis XIV. These include the church (former cathedral) of St. Benoit, and the *hôtel de ville* (former bishop's palace), designed by Jules Mansart, which houses a fine collection of Spanish paintings from the Goya museum, as well as the Jaurès museum and a public library (28,000 volumes). There are three technical colleges including Jean Jaurès lyceum.

Castres has been an active textile centre since the 13th century; about 9,000 workers are engaged in spinning, weaving and the hosiery trade. Castres machine tools are world famous.

The town came into being about 647 on the site of a Gallo-Roman camp, where a Benedictine monastery was founded (a Romanesque tower survives); the medieval city expanded round the monastery until 1317, after the Albigensian crusade, when Pope John XXII created a bishopric there which lasted until 1790. Guy de Montfort, brother of Simon de Montfort, handed down the seigneury in 1519, but from the middle of the 16th century the Reformation became established in the town and historians even styled it a Protestant republic. It was subdued under Louis XIII. The revocation (1685) of the Edict of Nantes jeopardized the economic life of the town and forced the most eminent Protestants to leave the country; but Castres took on a new lease of life under Louis XIV. (VA. B.)

CASTRO, EUGÉNIO DE (1869–1944), Portuguese poet, who introduced Symbolism into the literature of Portugal, was born in Coimbra on March 4, 1869. The son of a professor of mathematics at Coimbra university, he was at first educated in Coimbra and later attended the Curso Superior de Letras in Lisbon, completing his studies there in 1888. He then entered the diplomatic service and was appointed an attaché at the Portuguese legation in Vienna. He soon abandoned diplomacy, and for a time went to live in France where he frequented the café literary groups and was a witness of the impassioned gatherings associated with the Symbolists. In 1889 he returned to Coimbra, where by this time there were two student reviews, *Bohemia Nova* and *Os Insubmissos*, which rivaled each other in championing the cause of French Symbolism. Castro, who until then had remained faithful to the Portuguese lyrical tradition, collaborated in the second of these reviews and became the standard-bearer of the Symbolists.

Castro's first verses, *Cristalizações da Morte* and *Canções de Abril*, had been published in 1884, when he was 15, and had been traditional in style. In 1890 he published his *Oaristos* and, in 1891, *Horas*, which established him as the outstanding Portuguese representative of Symbolism, in its purely formal or decadent aspect. The preface to *Oaristos* is a manifesto of the new school, in which he says that he means to abandon the railway line along which what he calls the "mixed goods and passenger train" of Portuguese poetry had run hitherto and join "the express train of originality." A little later, he and Manuel da Silva Gaio, the movement's leading critical writer, founded the review *Arte* (1895–96), the organ of Portuguese Symbolism. International in character, the review contained work by some of the French Symbolists, among them Paul Verlaine. In 1903 Castro was appointed professor in the Industrial School of Brotero, and in 1914 he was elected to the chair of French literature in the University of Coimbra. He was already a member of the Lisbon Academia das Ciências. He died in Coimbra on Aug. 17, 1944.

After 1891 his works reveal a gradual departure from Symbolist aesthetic standards—called by him *nefelibata* ("cloud-treading"), a term often used later to define the more formal phase of Portuguese Symbolism. They include: *Belkiss*, *Silva*, *Interludio* and *Tiresias* (1894); *Sagramor* (1895); *Salomé e outros Poemas* and *A Nereide de Harlem* (1896); *O Rei Galaor* (1897); *Saüdades do Céu* (1899); *Constança* (1900); *Depois da Ceifa* (1901); *Paesias Escolhidas* (1902); *A Sombra do Quadrante* (1906); *O Anel de Polícrates* (1907); *O Filho Pródigo* (1910); and *O Cavaleiro das Mãos Irresistiveis* (1916). In his last phase, which began with *Camaféus romanos* (1921), Castro abandoned the "express train of originality" and accepted the standards of a kind of academic Parnassianism, which links him with his forebear, Sá de Miranda (*q.v.*). As well as many other volumes of poetry, he also published in two volumes (1926–27) a collection of articles written for the Argentine journal *La Nación*. A faultless artificer of verse, Castro is one of the most polished and frigid poets in early 20th-century Portuguese poetry.

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CASTRO (RUZ), FIDEL (1927–), Cuban revolutionary leader who overthrew the regime of Fulgencio Batista in Jan. 1959, was born Aug. 13, 1927, in Oriente province. He was educated in Santiago and Havana and received his law degree from the University of Havana in 1950. During his university years Castro was active in student agitation and even in national and international political ventures. On July 26, 1953, he led a desperate and unsuccessful attack on a Santiago army barracks, intended to begin the overthrow of Batista, who had seized power in 1952. After being released by amnesty in 1955 he went to Mexico and began organizing an invading force of Cuban exiles. With a band of 82 men he landed in Cuba on Dec. 2, 1956, but most of the force was quickly killed or captured. Castro then began a guerrilla campaign in the Sierra Maestra mountains against Batista and took the name "26th of July movement" from the date of his 1953 attack. The movement gradually built up force until Batista was forced to flee Cuba on Jan. 1, 1959. Castro thereafter dominated the new government and became its prime minister in Feb. 1959.

In mid-1959 he forced out his hand-picked president, Manuel Urrutia, and supplanted him with Pres. Osvaldo Dorticós.

From the beginning of 1959 Castro undertook a dramatic and extreme program of social and economic revolutionary reform, characterized by summary executions of Batista followers and a considerable hatred of foreigners. His antipathy was directed especially against the United States, and as Cuban relations with that government deteriorated those with the U.S.S.R. and its satellites improved. In 1961 he was awarded the Soviet Union's Lenin peace prize. Castro's dramatic actions aroused intense interest in Latin America and, at least at first, great support and enthusiasm in Cuba. Some of the support of other Latin-American states, however, was tempered in 1961 by Castro's announcements that there would be no more elections in Cuba and that he had been a Marxist for years but had concealed the fact in order to further his revolutionary aims. (*See* also Cuba: *History.*)

Castro wrote *Pensamiento político, económico, y social de Fidel Castro* in 1958.

See R. Brennan, *Castro, Cuba and Justice* (1959); J. Dubois, *Fidel Castro* (1959); G. Rodriguez Morejón, *Fidel Castro* (1959). (R. H. Fi.)

CASTRO, INÊS DE (d. 1355), mistress, before his accession, of Pedro I of Portugal, and famous because of her tragic death, was an illegitimate daughter of Pedro Fernández de Castro, a Galician noble. She went to Portugal about 1340 with her cousin Constança, who shortly afterward married Afonso IV's eldest son and heir Dom Pedro. But Pedro was soon attracted to the beautiful Inês, and a violent passion sprang up between them. After the death of Constança (1345), they lived together and had several children. However, the influence of Inês and her two brothers over Dom Pedro aroused hostility at court and when, in 1354, Pedro declared himself pretender to the throne of Castile, Afonso IV decided to have Inês executed. On Jan. 7, 1355, after a dramatic interview at Coimbra, the king abandoned her to the assassins. After Pedro's accession (1357), her body was moved to a magnificent mausoleum at Alcobaça. Legend has it that Pedro caused the corpse to be crowned and made the courtiers kiss the hand of the dead Inês. Much has been written about Inês' love and tragic end; the story is related by Camões in *Os Lusiadas*, by Luis Vélez de Guevara in his play *Reinar después de morir* and by Henri de Montherlant in his play *La Reine morte.* (V. R. R.)

CASTRO, JOÃO DE (1500–1548), viceroy of Portuguese India, who made important contributions to the science of navigation, was the son of Alvaro de Castro, governor of Lisbon. After 20 years' service in north Africa he went to India in 1538 and was at the relief of Diu in that year. He sailed with the fleet up the Red sea to Suez (1540–41) and, returning to Europe two years later, he campaigned against the Muslim pirates. In 1545 he again commanded a fleet in India, where his operations relieved Diu and Malacca. He was appointed viceroy in 1548 but on June 6 of the same year died in the arms of St. Francis Xavier at Goa.

De Castro was a pupil of the celebrated mathematician Pedro Nunes. His observations of magnetic variation discredited the association of longitude with variation and he was the first to note the deviation of the ship's compass needle created by the magnetic effect of iron objects. He recorded his scientific observations in three *Roteiros* (pilot books), compiled on his voyages from Lisbon to Goa, from Goa to Diu and from Goa to Suez. Editions of the three *Roteiros* were published respectively at Lisbon, 1882; Oporto, 1843; and Paris, 1833.

See Jacinto Freire de Andrade, *Vida de Dom João de Castro* (1651), Eng. trans. by Sir Peter Wycbe (1664); Diogo do Couto, *Decadas da Asia*, vol. vi (1616). (R. A. Sk.)

CASTRO, JUAN JOSÉ (1895–), Argentine composer and conductor, one of the foremost exponents of South American modern music, was born in Avellaneda, March 7, 1895. He studied in Paris with Vincent d'Indy; returning to Argentina, he appeared as conductor of symphony orchestras and opera. In 1959 he was appointed dean of the Puerto Rico conservatory in San Juan. He won (1951) an international competition for the Verdi prize of La Scala, Milan, with his opera *Proserpina y el extranjero.* His works include a ballet *Mekhano* (1937), *Sinfonia Biblica* (1932), *Sinfonía argentina* (1936) and *Corales criollos* for orchestra (1954). (N. Sy.)

CASTRO, ROSALÍA DE (1837–1885), Spanish poet, the most outstanding modern writer in the Galician language, was born in Santiago de Compostela in Feb. 1837. In 1858 she married the historian Manuel Murguía (1833–1923), a champion of the Galician Renaissance. She died in the village of Padrón, near Santiago, July 15, 1885. Although she was the author of a number of novels (*Flavio*, 1861; *Ruinas*, 1864; *El caballero de las botas azules*, 1867; and *El primer loco*, 1881), she owes her immortality to her poetry, contained in *Cantares gallegos* (1863) and *Follas novas* (1880), both written in her own language, and *En las orillas del Sar* (1884), written in Castilian.

Part of her work (the *Cantares* and some of the poems in *Follas novas*) expresses with sympathetic power the spirit of the Galician people: their gaiety, simple wisdom and folklore, their resentment of Castilian domination, their love of their homeland and the sorrows of poverty and emigration. About 1867, however, Rosalía began to write more personally, describing in verse her own deepest feelings—remorse, repressed desire, the anguish of living, the desolation of spiritual loneliness, fear of death, the transience of affection, the feeling that everything is in vain. Thus her work, which is distinguished technically by a supremely skilled simplicity, blending popular poetic forms with metrical innovations which had considerable influence on later poets, is of both regional and universal significance. Her *Obras Completas* were edited with an introduction by Garcia Marti (1944); there is no critical edition. Selected poems from *En las orillas del Sar* were translated by Griswold Morley, *Beside the River Sar* (1937).

See Mary Tirrel, *La mistica de la Saudade* (1951); *7 Ensayos sobre Rosalia* (1952). (J. A. do P. C.)

CASTROP-RAUXEL, a mining town of Germany, which after partition of the nation following World War II was included in the *Land* (state) of North Rhine-Westphalia in the Federal Republic of Germany. It is situated in the eastern part of the Ruhr district, 15 km. (9.3 mi.) N.W. of Dortmund and 10 km. (6.2 mi.) N.E. of Bochum. Pop. (1959 est.) 87,628. It has extensive open spaces, on one of which is a racecourse. Chief buildings of interest are the 16th-century moated castle of Bladenhorst; Goldschmieding house, with a Renaissance fireplace of 1597, used as an international guest house by the Society of Moral Rearmament; and the 13th-century Romanesque-Gothic church of St. Lambert. Castrop and Rauxel are separate stations on two different lines of the Ruhr network. The town has docks on the Rhine-Herne canal. Coal mining and chemical works employ 60% of the wage earners. Castrop was first mentioned in A.D. 834 and grew into a town during the middle ages. Until 1609 it belonged to the dukedom of Kleve-Mark, thereafter it was Prussian. Castrop-Rauxel was created in 1926 by the amalgamation of the town of Castrop with 12 country districts. It was damaged during World War II and was captured by the Allies in April 1945. (K. Ha.)

CASTRO Y BELLVÍS, GUILLÉN DE (1569–1631), the most important of a group of dramatists that flourished in Valencia, Spain, at the end of the 16th century. Born at Valencia in 1569, he is notable chiefly as the author of *Las mocedades del Cid* (1599?), the original of Corneille's tragedy. In common with the works of the Valencian school in general, which had developed its own techniques before undergoing the influence of Lope de Vega, Castro's plays are unusual for their period in making no regular or systematic use of the *gracioso* (or comic servant) despite the author's close friendship with Lope himself. Though Castro did not take up residence in Madrid until he was 50, after a military and civil service career of some distinction in Valencia and the Spanish dominions in Italy, he was particularly drawn to the literature of Castille as a source of dramatic themes. Three of his plays are based on the novels of Cervantes, and four on traditional ballads, a number of which, by a remarkably effective *tour de force*, he incorporated into the dialogue of his *Cid.* Castro died at Madrid in 1631.

His works were first published in Valencia in two parts between 1618 and 1625; there is a modern edition by E. Juliá Martinez (1925–27). (F. S. R.)

CASTRUCCIO CASTRACANI DEGLI ANTELMINELLI (1281–1328), Italian despot who ruled Lucca between 1316 and 1328, was born at Castruccio, near Lucca, on March 29, 1281. The Antelminelli, a magnate family of merchants and money-changers owning rich metalliferous mines in Versilia, followed the "White" or Ghibelline interest in local politics and suffered exile when the "Blacks" triumphed in 1300. While his parents, for reasons of trade, settled in Ancona, Castruccio seems to have spent the following years wandering about Italy and abroad, in part at least as a mercenary captain.

When the emperor Henry VII (*q.v.*) descended into Italy from Germany, the Ghibellines took new heart. Castruccio and his fellow exiles, in alliance with the Ghibelline leader Uguccione della Faggiuola, returned to Lucca in 1314. To strengthen his own position there, Castruccio helped Uguccione, already lord of Pisa, to gain power in Lucca as well (June 1314). In Dec. 1314 the commune of Sarzana elected Castruccio "vicar" and "protector" with powers that were confirmed in 1315 by the emperor-elect Frederick of Austria. Castruccio fought beside Uguccione in the defeat of the Florentines at Montecatini (Aug. 29, 1315). Shortly afterward Uguccione was overthrown, and Castruccio took his place as Ghibelline leader in Tuscany. In 1316 the commune of Lucca made him captain-general and *defensor* for six months, a grant later prolonged and finally extended for life in 1320. In that year he was also appointed vicar of Lucca, Versilia and Lunigiana by Frederick. Louis IV the Bavarian, having confirmed the vicariate, together with that of Pistoia, in 1324, created Castruccio hereditary duke of Lucca in 1327. His growing power brought Castruccio inevitably into conflict with the Florentines, on whom he inflicted a crushing defeat at Altopascio on Sept. 23, 1325. His career of conquest ended with his sudden death at Lucca on Sept. 3, 1328.

Castruccio's principality barely survived him, and his family had become extinct in the male line by 1400. The memory of his name and personality inspired Machiavelli to compose a romantic life of him, as one model of a perfect prince.

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(P. J. J.)

CAST STEEL: *see* CRUCIBLE STEEL.

CASUAL LABOUR, a term used to denote irregular employment or the work force subject to or generally accepting such employment. If employment is discontinuous but has a recurring seasonal, weekly or monthly pattern, it is likely to be called seasonal rather than casual. Seasonally variable and even continuous employment may be filled by casual workers, in which instance the term clearly refers to the nature of the labour force or to the unstable character of employer-employee relations. Restaurant dishwashing illustrates continuous work that commonly is performed by casual labour. At the other extreme, casual work may be performed by regularly employed workers such as firemen and public utility repair crews. Thus, casual labour is not exclusively determined by the nature of the work. Employers' policies, the nature of industrial relations and the attributes of the work force also are determining influences.

The term is most often applied to the person whose employment normally, and not only periodically, consists of a succession of short-term jobs in which engagement is by the hour or the day or for the accomplishment of a specified task. His hiring carries no implication of his responsibility to stay or of the employer's responsibility to continue him in the future. He was typified during the late 19th and early 20th centuries by the dock worker. It was on the docks and in the related transport trades that casual labour was notably extensive, and it was here that the most intense and successful efforts at decasualization were made.

The irregularity of cargoes caused daily or weekly variations in the amount of work to be done at any one centre. The demand for dock labour was distributed among a multitude of employers with little co-operation among them. The effects of this varying and fragmented demand tended to be thrown mainly upon the labourers who were hired and discharged at short notice. Each centre of waterside employment required a larger number of men than it could employ regularly or adequately. From this it followed that each employer, in order to be able to call upon sufficient labour to satisfy his peak demand, tended to keep available a pool of potential labour; the aggregate of all these separate pools was much larger than would have been necessary had there been co-operation among the various employers and centres of employment.

From the worker's viewpoint, the element of chance in securing employment was evidently the salient feature. At any centre he chose, he had to compete with a "struggling crowd" the great majority of whom were unknown to the employer or his agent. The effects of this irregular and unpredictable employment upon the individual were commented on by a number of sociologists at the end of the 19th and the early part of the 20th centuries. Speaking of casual labourers at the London docks in the 1880s, William Henry Beveridge said: "The knowledge that any man, whatever his experience, however bad his antecedents, might get a job at the Docks, attracted to their neighbourhood a perpetual stream of blackguards, weaklings, and failures from every other occupation. The experience, soon made, that regular attendance was not necessary to secure selection on days when work happened to be plentiful and the daily alternations of hard exercise and idleness rapidly developed in those who came, if they had it not before, the greatest irregularity of habits and physical or moral incapacity for continuous exertion." (*Unemployment*, Longmans Green & Co., 1930 ed.)

Other major industries, including construction, logging, sawmilling, railway maintenance, agriculture and the service trades, have in places and at times been highly casual. Caterers, hotels, restaurants and clubs hire casual labour for waiting on tables and doing kitchen work at banquets and other social functions; advertisers, theatres, stores and many other businesses employ people for short periods to distribute advertising matter, help load or unload trucks or other equipment, deliver merchandise or do odd jobs.

Casual jobs are accepted by widely differing categories of persons: some are ordinarily in regular employment but seek casual work to tide themselves over periods of unemployment; others are physically or psychologically incapable of steady employment; still others do casual work to supplement their principal source of income. But in the large majority of cases casual work is performed by casual labourers for whom it is their livelihood. Most of them are below par educationally, physically or psychologically; many are the victims of discrimination against race or colour. Patterns of living which depend upon picking up odd jobs are seldom desirable either for the individual or for society.

Decasualization.—Many forces have combined to exert pressure for the reduction or elimination of casual employment: employer realization that a reliable, efficient work force requires stable employment relations and more deliberate personnel policies; with sustained employment, unemployment insurance, vocational rehabilitation and other social services, fewer persons are available for short-term irregular work; collective bargaining has required more formal labour relations and the shifting of some of the burden of employment uncertainty from the backs of workers; and finally, modern governments, especially in wartime, have emphasized effective use of the labour force, including elimination of the wastes associated with casual employment.

During the first 30 years or so of the 20th century, a number of decasualization schemes or plans were set up in various British ports. In 1912 the port employers of Liverpool, the port-workers' trade union, the board of trade and the treasury co-operated to bring into existence the Liverpool dock scheme. Another was set up in Bristol in 1916. The ministry of labour's port labour inquiry committee, appointed in 1930, found 31 plans in operation in various ports. The report stated that by this date all major ports were involved with the exception of Glasgow and the Tyne and Wear ports, and that more than two-thirds of port transport workers were covered. The chief features of these schemes to promote decasualization were that: (1) they were all registration schemes—that is, they involved the maintenance of a register of men who received preference in the selection of labour; (2) they were voluntary, operating without any legal sanction, though generally with the assistance of the ministry of labour, which often provided secretarial or clerical help; (3) the majority were operated jointly by representatives of employers and of workers; (4) generally each plan provided for centralized hiring, though it was stated that in some ports this was found to be impracticable; (5) no provision was made for guaranteed minimum income. The committee considered the question of labour wastage and recruitment—obviously an important feature of decasualization schemes—but reached no very definite conclusions. It found that the registration plans had worked well and had brought into dock work a much better type of employee than was typical at the end of the 19th century; and the members of the committee felt that registration was an essential preliminary to any decasualization system.

During World War II it became imperative to introduce a greater measure of organization into dock work, partly because of the general labour shortage and partly because of the effects of bombing and the need for greater flexibility of the labour force. Statutory port registration committees were set up early in the war; and under the Dock Labour (Essential Work) order (1941) a National Dock Labour corporation, with local boards, was appointed. The order also empowered the minister to make dock labour regulations, the essential points of which were that all port workers were to be registered; that all workers, when not actually in employment, automatically entered a reserve pool and were deemed to be in the employment of the corporation; and that, when in the reserve pool, they had to report to a control point as required, and, if not allocated to jobs, received attendance money. Thus a system of guaranteed pay was a feature of these regulations.

Another phase in the process of dock labour decasualization began when, in 1946, the Dock Workers (Regulation of Employment) act was passed. Provision was made for the setting up of a National Dock Labour board, which succeeded the corporation in June 1947 and became responsible for the administration of the act. In addition, local dock labour boards were to be set up in each port or group of ports. The national board consists of a chairman and a vice-chairman and eight other members, four of these other members representing dock employers and four dock workers. All the members of the board are appointed by the minister of labour after consultation with the National Joint Council for the Port Transport Industry. Local boards also consist of representatives of dock workers and of employers in equal numbers. The chief functions of the national board are to maintain a labour force of a size suitable to the current conditions, to maintain a register of employers and a register of workers and to provide for the training and welfare of dock workers. All these functions, except the first, are also functions of the local boards, and much of the work of the national board is in fact carried on through these local agencies.

Similar decasualization programs have been initiated in Canada, Australia, New Zealand, India, France, the Netherlands, Belgium, Norway and Sweden. These programs vary considerably in detail. It may be said, however, that they all include some method of limiting the number of dockers competing for work by granting to certain of them a priority right in the port concerned. In some of the countries mentioned above the scheme operates under statutory provision: thus in Australia the Stevedoring Industry board was established by an act of 1949 and has the duty of maintaining the labour supply and of organizing and controlling waterside workers. In others, decasualization regulations are included in the collective agreements between employers and unions. The guarantee of a minimum income is embodied in such schemes as those of Australia, France and New Zealand, in which workers receive attendance money and (in New Zealand) a guaranteed minimum wage.

The unionization of U.S. longshoremen, particularly from the early 1930s onward, enabled the longshoremen to prevent easy access to longshore work by refusing to work with nonmembers or requiring nonmembers accepted for employment to have union permits, thus establishing union control over the labour supply. They established "dispatching halls" (hiring halls) in many ports, supervised by a joint committee of employer and union representatives or by the union. The hiring-hall system, which began at Seattle, Wash., in 1939, did much to change the casual labour situation on the docks to a regularized system of employment. The halls enabled the longshoremen to hold the dock work for those who made it their regular occupation and to divide the available work equitably among them. It insured the employers that experienced men would be systematically dispatched to the ships as needed. The system did not work without frictions, disputes and delays in the handling of shipping, but it markedly diminished the casual character of longshore work.

In other industries, the approaches to decasualization have been less formal. Nevertheless, with the advance of collective bargaining, more responsible employer policies and better personnel practices, the demand for casual labour has declined. On the supply side, the dependence on casual work also has declined. Vocational rehabilitation, unemployment insurance and national policies to maintain prosperity are the major forces that have reduced the extent of dependence on casual jobs.

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CASUALTY INSURANCE. This type of insurance covers risks of loss associated with hazards to person and property, including legal hazards as well as those arising from accident and sickness. It offers special protection to individuals, business firms and the professions, and is distinct from life insurance (*q.v.*).

UNITED STATES

The traditional forms of casualty insurance in the United States are automobile liability, workmen's compensation, employers' liability, accident, health, burglary, robbery, theft, glass, boiler and machinery, and general liability. Casualty companies also sell livestock, elevator, nuclear energy, credit, aviation and water damage insurance. There is some trend toward inclusion within a single policy of traditional forms of casualty insurance and property or inland marine insurance. The scope of protection afforded by casualty insurance has grown rapidly since World War II. Its use has been stimulated in the United States by the general economic growth of the nation, increased size of the work force, broadening of the scope of the legal doctrine of negligence, growing tendency to impose legal liability without fault, widespread claims, consciousness of injured and insured, increased use of automobiles and creation of new hazards brought about by developments in technology and the use of nuclear materials.

Accident Insurance.—This type covers hospital, medical and surgical expenses and also includes payments for loss of earnings in case of accident. Although sold separately, it is often combined with health insurance (*q.v.*). Hospital benefits are usually limited to a fixed amount per day and there is usually a maximum length of time for which benefits are payable. Medical benefits cover physicians' calls, both in and out of the hospital, X-rays, drugs and sometimes other hospital expenses. The extent of surgery protection depends upon the schedule attached to the policy listing the amount payable for each operation. Typical exclusions are war or acts of war, accidents while in the armed forces, suicide and aviation accidents. Coverage may include the periodic payment of benefits up to a fixed maximum in case of total disability or partial disability. A stated or principal sum is payable in case of accidental death and a capital sum is payable in case of loss of both eyes or any two limbs. (*See* also Industrial Accidents.)

Travel insurance is a special form of accident insurance that has become popular in the 20th century. Insurance for air travel is one example. It is readily available at airports in varying amounts at small cost to cover a particular air journey.

Liability Insurance.—This is a form of casualty insurance sold by casualty and multiple-line insurance companies. Subject to certain limitations, the company agrees to pay on behalf of the insured all sums he becomes legally obligated to pay as damages to someone else. The company promises to defend any suit brought against the insured alleging damage or injury, including groundless suits. The insurance is designed to reimburse a third party for injury to his person or damage to his property caused by the insured if the insured is under a legal obligation to pay. It is sometimes called "third-party insurance" because payment is made to a third party, not to the insured.

Liability policies often include medical payments clauses providing payment for reasonable medical expenses arising from the accident.

General liability insurance covers both direct and indirect or contingent liability. Direct liability insurance may be divided into personal liability, business liability and professional liability insurance. Contingent liability insurance, which covers the insured when he is indirectly liable, is available in special policies for owners, contractors, landlords, grantors and principals.

Examples of personal liability insurance are comprehensive personal and farmers personal liability insurance. The former provides broad protection against most of the risks of liability at relatively low cost for the insured and his family. Farmers personal liability insurance is similar but applies to farmers and their special liability risks.

Business liability insurance covers owners, landlords, tenants, manufacturers and contractors. Miscellaneous coverage such as elevator liability, which pays for liability arising out of the ownership, maintenance or use of elevators and equipment, is also available. Elevator collision insurance covering direct damage to the elevator is sometimes sold. Products liability insurance protects the insured business against claims for bodily injury or property damage that may arise from the use of its products.

Professional liability insurance covers druggists, physicians, surgeons, dentists, attorneys and other professional people. It pays on the insured's behalf sums which he shall become legally obligated to pay as damages because of injuries arising out of malpractice or mistake in rendering or failing to render professional service.

Contingent liability insurance, commonly called protective liability, is available in special policies for owners, contractors, landlords, tenants, grantors and principals. The insured is protected in case he is found legally obligated to pay sums for damages resulting from the actions or lack of actions of others. As an example, owners or contractors protective insurance pays on behalf of the insured such sums as he is legally obligated to pay because of bodily injury, sickness, death or property damage arising out of operations performed for him by independent contractors under his general supervision.

Automobile liability is a type of insurance by which the company promises to pay all sums that the insured shall become legally liable to pay as damages due to bodily injury or property damage arising out of ownership, maintenance or use of the automobile. In addition, the company defends any suit for damages alleging such injury or damage. (*See* MOTOR VEHICLE INSURANCE.)

Workmen's compensation is a type of insurance that provides for payment to employees of compensation for injuries suffered or disease contracted, the payments being such as are required by the workmen's compensation and occupational disease laws. Employers' liability insurance pays on behalf of the insured the sums he is legally obligated to pay as damages because of bodily injury by accident or disease sustained by any employee and not covered by either the workmen's compensation or occupational disease acts. (*See* WORKMEN'S COMPENSATION.)

Boiler and Machinery Insurance.—Under this heading is found insurance covering the owners of boilers, machinery and power plant equipment against the hazards attendant to the use of such equipment. The basic boiler and machinery policy provides coverage until the policy limit is reached for the following types of losses in the order named: (1) direct damage to the property itself resulting from covered accidents, such as explosion; (2) extra costs of making temporary repairs and of expediting repair of the property, including such items as overtime and extra cost of express and similar transportation; (3) property damage liability; (4) bodily injury liability; and (5) costs of defense, settlement and supplementary payments.

The inspection and loss prevention services of the insurance company are often of as much or greater importance than the insurance protection provided by the policies written under this heading. Most of the premium is for inspection, not insurance. Insurance companies furnish a staff of qualified inspectors who examine the insured equipment at periodic intervals and recommend changes. Pending correction of the defects, the company may suspend coverage by giving written notice to the insured. Some states require that boilers be inspected periodically. Insurance company inspections usually meet these requirements.

Other related forms of coverage include business interruption, residence boiler and machinery, consequential loss, power interruption, furnace explosion and outage insurance. Outage insurance protects for each unit of time, such as an hour, for which the object insured is out of use because of an accident.

Crop Insurance.—Insurance on growing crops is available to cover certain crops against one or more specified perils. Direct loss to crop caused by hail is widely written and is sometimes extended to include windstorm, fire, lightning, livestock and aircraft. The policy describes the kind of crop, the interest of the insured in such crop, the estimated yield per acre, the number of acres, insurance per acre, total amount of insurance and a description of the location of the crop that is insured. The company's liability is limited to a certain amount per acre. The insurance covers the crop while it is in the open on the described location but coverage can also be extended to include instances where the crop is in transit on the described premises as well as to private or public storage. The policy continues through growth and harvest of the crop.

Coverage of growing crops against direct loss from all risks is not generally available. The Federal Crop Insurance corporation has offered a form of crop insurance against certain losses due to crop failure. Some critics have objected that the federal program involves various noninsurance elements and is actually a form of subsidy.

Fire Insurance.—Fire insurance covers the insured against direct loss by fire or lightning to insured property. Insurance allied with fire includes extended coverage, windstorm and hail, explosion, vandalism and malicious mischief, water damage, nuclear energy, earthquake and volcanic eruption, aircraft and vehicle property damage and certain miscellaneous coverages. (*See* FIRE INSURANCE.)

Tornado and Windstorm.—This type of insurance covers direct loss by windstorm and hail. Windstorm is given a sufficiently broad interpretation to include tornado and cyclone. These perils may be protected against by writing a specific windstorm and hail policy, adding an endorsement to the fire insurance policy or through use of the extended coverage endorsement.

Water Damage Insurance.—This type of insurance provides protection against direct loss to the insured property caused by accidental discharge, leakage or overflow of water or steam from within various specified sources including plumbing systems, plumbing tanks used for water storage for the plumbing system, heating systems, elevator tanks and cylinders, industrial or domestic appliances, refrigerating systems and air conditioning systems. In addition, direct loss caused by accidental admission of rain or snow through defective roofs is included. Damages caused by floods, rising waters, backing up of sewers and failure of refrigerating or air conditioning equipment are not covered. This form of insurance is not widely sold; its use is confined mainly to areas where large water damage losses are likely to occur.

Plate Glass Insurance.—This is essentially an "all risks" coverage against glass breakage from any cause except fire, war, a nuclear reaction, radiation or radioactive contamination. Protection is provided against loss from chemicals accidentally or maliciously applied. The policy also pays the cost of repairing or replacing frames when damage makes such repair necessary, cost of temporary plates or boarding up openings, and removing and replacing obstructions. The company agrees to pay the repair cost or replacement cost of the damaged glass. This is a relatively small line of insurance as measured by amount of premiums written. Premium rates depend upon the size, type and use of the glass, its position in the building and the location of the building.

Burglary, Theft, Larceny, Robbery.—These types of insurance provide protection against loss resulting from certain illegal acts against property. These acts are usually specified but some policies are sufficiently broad so as to approach "all risks" coverage. The acts or hazards insured against are defined in the policies and sometimes vary according to the type of property covered. Burglary ordinarily involves unlawful entry accompanied by visible marks upon the exterior of the premises. Robbery involves the felonious taking of property from a person by violence, by putting him in fear of violence, by an overt felonious act committed in his presence or while he is rendered unconscious. Theft and larceny usually mean any act of stealing.

Riot and Civil Commotion.—This type covers direct loss by riot and by riot attending a strike or civil commotion. It includes direct loss caused by acts of striking employees of the owner or tenant of the premises while occupied by the strikers. A riot usually consists of an unlawful action by three or more people against another's person or property, or both. Any direct loss from pillage and looting which takes place at the site of the riot while it is going on is also included in this insurance.

Fidelity and Surety.—Fidelity bonds protect against loss caused by dishonest acts of persons covered by the bond. Surety bonds provide the surety will make good the obligor's default in performance of an obligation. Commonly referred to as bonding rather than insurance, these bonds are usually sold by casualty insurance companies. Many multiple-line insurance companies and bonding companies especially formed for this purpose also engage in fidelity and surety bonding. The activities of all such companies are closely supervised by the insurance regulatory authorities in the various states. (*See* FIDELITY AND SURETY BONDS.)

Multiple-Line Policies.—A multiple-line insurance policy combines within a single contract protection against both property and casualty risks. State regulatory authorities and legislation for many years prohibited such combination but these barriers have been removed and a company may sell both fire and casualty insurance. Life insurance, other than accident and health insurance, is sold only by life insurance companies. Following the grant of combination underwriting powers, multiple-line insurance policies have generally combined into a single policy types of insurance that were formerly found in several different policies and endorsements. Provision of "all risks" protection without specifying the fire and casualty perils, and without stating an individual premium for each peril, has been slower to develop. Multiple-line protection has long been available in inland marine insurance, where floater contracts are used to provide essentially "all risks" type of protection, including both property and casualty perils. Another way of providing multiple-line insurance coverage is to add a casualty insurance endorsement to a fire insurance policy.

Multiple-line insurance is available to cover both personal and business risks. Special personal policies have been designed for homeowners and tenants. Special business policies have been developed for manufacturers, merchants and other businessmen. Such policies provide protection against all risks or against a large number of specified perils subject to stated exclusions in either case. (V. G.)

GREAT BRITAIN AND EUROPE

In Great Britain casualty insurance is more commonly termed accident insurance. It consists of a number of different types of insurance, the origins of which have been associated with the industrial and commercial revolutions of the last 150 years. The main types or sections are: personal accident and sickness; employers' liability; public liability; motor vehicle insurance (*q.v.*); engineering; burglary; and fidelity guarantee.

Accident and Sickness Insurance.—Personal accident insurance normally covers all accidents except those occasioned by mountaineering, winter sports, hunting, racing and other pursuits of a more than usually hazardous nature, which are only insurable on negotiated terms and conditions. The former general practice of excluding air travel is now substantially modified.

Accidents-Only Policies.—The commonest form of policy covers accidents only. It provides for payment of a capital sum in the event of death by accident, or the loss by accident of one or two limbs, or the sight of one or both eyes, and weekly benefits limited to a specified period in the event of temporary disablement. Rates vary according to the degree of risk indicated by the occupation of the proposer. Double benefits are provided if the insured person is killed or injured in certain defined accidents.

Accidents and Specified Diseases Policies.—Such policies are similar to accidents-only policies but provide weekly benefits in addition for certain specified diseases. An annuity is payable if the insured suffers prolonged total disablement, loses completely the sight of both eyes by disease or contracts paralysis in at least two limbs.

Accidents and All-Sickness Insurance.—This form of policy, in addition to granting the normal benefits in case of accidents, provides weekly benefits during any illness necessitating confinement to the house for not less than seven days. The all-sickness provision normally terminates when the insured reaches the age of 60. For the purpose of travel the accident section is world wide, but it is usual to limit cover under the sickness section of the policy to specified overseas territories.

Noncancellable Accident and Sickness Policies.—An ordinary accident or sickness policy is renewable each year at the option of the insurer, who may impose special terms for its continuance. Policies which cannot be so cancelled or revised are available. Premiums are on a higher level than for year-by-year contracts, and acceptance at the outset is subject to medical evidence of health. This noncancellable form of policy has not been adopted by European countries other than Great Britain.

Group Accident and Sickness Schemes.—Commercial policies to provide accident and sickness benefits for employees within certain employment categories are freely granted. Where wages are paid during disability from sickness or accident such a policy enables the employer to recoup these payments and thus to measure in advance his annual commitments in this respect. (*See* GROUP INSURANCE; HEALTH INSURANCE.)

Air Travel.—The growth of air travel had led to a demand for air travel accident insurance. Issued in the form of a travel coupon, personal accident insurance to cover holiday and business trips at home and overseas is now cheaply and conveniently available. Group policies to provide automatic coverage for employees of firms when traveling on business are also granted.

Employers' Liability.—In Great Britain the repeal of the Employers' Liability act of 1880 and of the various workmen's compensation acts led to fundamental changes in employers' liability insurance in the 20th century. Claims formerly falling under these acts were covered under the National Insurance (Industrial Injuries) act, 1946. An injured workman still retained a right of action at common law and such action could be pursued concurrently with a claim to benefit under the Industrial Injuries act.

In France the development of employers' liability has shown a marked similarity to that in Great Britain. Workmen's compensation acts, dating back to 1898, under which insurance against the risks involved had been compulsory, were set aside in 1946 and liabilities were taken over by the state as part of the social security scheme. In Belgium, Italy, Spain, Switzerland and Scandinavia the liability of the employer is governed by compensation acts under which insurance is, in general, compulsory. In some European countries private insurance performs its part in satisfactorily implementing the law; in others this field of insurance is closed to the companies in favour of the state or of concerns under close state supervision.

In Great Britain an employer is personally responsible at common law to use reasonable care in providing safe working conditions for his employees. A breach of this personal duty is actionable and, subject to the defense of *volenti non fit injuria* (available where the employee knew that the working conditions were unsafe and consented to run the risk of injury) and to the plea of contributory negligence (available where the cause of the injury was partly the breach of the employer's duty and partly the negligence of the injured employee), an injured employee can recover full pecuniary compensation for any damage attributable to the breach of duty. The defense of "common employment" formerly open to an employer in respect of claims of his workmen was abolished by the Law Reform (Personal Injuries) act, 1948. The Fatal Accidents acts, 1846–1908, and the Law Reform (Miscellaneous Provisions) act, 1934, also broadened very considerably the common law liability of an employer.

Insurance offers a complete indemnity to the employer of his liability at law for bodily injury to, or disease contracted by, his servants or employees arising out of and in the course of their employment. This indemnity includes claimants' law costs and other costs incurred with the consent of the insurer. In addition, the insurer accepts responsibility for costs and expenses recovered from an insured by a claimant. It is customary for the insurer to indemnify the insured up to but not exceeding a specified sum for any one occurrence, but unlimited as to the amount paid in the aggregate on successive claims in any one year of insurance. Premium assessment is under two main headings: (1) domestic servants' insurance, rated at a premium per capita; (2) trade or business risks, rated at a percentage of the annual wages and allowances, but varying with the nature and extent of the risk. (*See* also WORKMEN'S COMPENSATION.)

Public Liability and Third-Party Risks.—A wide range of third-party liabilities exist. Whereas in Great Britain a liability may be imposed upon a person by the common law or may exist as the result of a statute, in continental European countries a person's responsibility for damage or injuries caused by any animal or object or thing under his control is fully dealt with under the codified laws of the particular country. Atomic energy is destined to affect civilian life in many ways as yet measurably unforeseen and must affect all types of insurance particularly public liability and third-party indemnities.

The liability which an insurer undertakes in this branch of the business is the legal liability of the insured in respect of claims made against him by third parties, arising out of the insured's own negligence, or the negligence of his servants, or possibly from nuisance or breach of contract. Some types of insurance include the third-party risk in the form of a special section of the policy, *e.g.*, motor insurance, where the policy may cover accidental damage to and theft of a vehicle and, in compliance with legislation, provide for third-party claims (*see* MOTOR VEHICLE INSURANCE). The legal liability of a householder is automatically insured under the normal terms of the comprehensive householders' policy, the indemnity applying to accidents happening in or about the buildings, whether or not arising out of defects in the building. In general, accidents caused by fire or explosion are excluded from the cover under a public liability policy, but since each risk is rated according to its particular merits, the risk of fire or explosion can usually be covered by payment of an additional premium.

Changes in the law, such as the Law Reform (Personal Injuries) act, 1948, the Law Reform (Limitations of Actions, etc.) act, 1954, the Hotel Proprietors' act, 1956, the Housing act, 1957, and the Occupiers' Liability act, 1957, have had considerable impact on third-party insurance practice. Case law, too, has had its repercussions and in general has revealed the need for high indemnity limits and for the widest possible protection.

Landlord and Tenant.—The Occupiers' Liability act introduced important changes in the liabilities of landlords and occupiers to third parties. Prior to the act the liability of the landlord was only to the tenant, on grounds of breach of contract, and he was not liable to other persons because he owed them no duty. Now, however, where premises are occupied by a person under a tenancy which puts on the landlord an obligation to that person for the maintenance or repair of the premises, the landlord may be made liable to all persons who, or whose goods, may from time to time be lawfully on the premises.

Professional Indemnities.—The degree of care and accuracy required from a professional person accepting a fee for giving advice on technical matters is of the highest possible standard, and it is the practice of solicitors, accountants, architects, surveyors, estate agents, doctors, dentists and the like to insure against claims arising from error or malpractice. Closely related to professional indemnities are those in respect of treatment risks. Hairdressers may be involved in actions for damages arising out of hair dyeing and the like, while serious claims have been made against beauty specialists.

Food Risks.—Third-party insurance is of equal importance to hotel, inn, restaurant and boardinghouse proprietors and to food manufacturers who may be involved in serious claims if foreign or deleterious matter is contained in food or drink supplied or manufactured by them. Policies issued to hotel proprietors offer indemnity against a wide range of legal liabilities arising from the Hotel Proprietors' act of 1863.

Any bodily injury, illness or damage arising out of any form of product sold or supplied may give rise to claims—often of catastrophic proportions—against the manufacturer, the distributor or the retailer held to be liable. The Sale of Goods act, 1893 (s. 14), deals with implied warranties and conditions concerning the quality or fitness of goods for any particular purpose, and insurance protection is granted under a separate contract, known as a Products Liability policy, or by an extension of a general public liability policy.

Personal Liability.—The common law liabilities of the individual follow him in his private pursuits. A carelessly driven golf ball, the swing of a stick or umbrella, a dropped match or cigarette end, hazards incidental to shooting, horse-riding or angling, the bite of a dog or a collision when walking or cycling are indications of the widespread nature of an individual's third-party liability which may lead to litigation and financial loss. Personal liability insurance grants an indemnity against negligent acts during such private activities. Under the family type of personal liability insurance an entire household, including servants, is protected against liability claims for a nominal premium.

Engineering Insurance.—The use of machinery involves manufacturers in certain special risks which are undertaken by engineering insurance companies. Unlike most other classes of insurance, which are designed to indemnify the insured after he has suffered loss, engineering insurance endeavours primarily to reduce the possibility that loss will occur. To this end, insured machinery is periodically inspected by skilled engineers to ascertain defects before they result in breakdown of plant. A very large proportion of the premiums received is expended upon these services, which enable the insured to receive the advice of experts as to methods of obtaining the utmost economy and efficiency from the plant.

The factory acts stipulate that all boilers under pressure must be periodically inspected by competent engineers. Such inspections are undertaken by the insurers in the terms of the boiler policy, which also indemnifies the insured in respect of claims made against him by third parties for personal injuries and covers damage to surrounding property caused by explosion. Law costs incurred with the consent of the insurers in defending claims are also included.

Policies are not confined solely to boilers but are issued for all classes of machinery working under pressure, *e.g.*, superheaters, calorifiers, hot-water and steam-heating boilers with heating pipes and radiators and other vessels working under steam, liquid air or gas pressure. Breakdown risks of air compressors, steam engines, pumps, oil engines, electrical plant and many other types of machinery are commonly insured and, subject to the exclusion of certain inexpensive parts, the breakage of any part of a machine proper while running, causing a sudden stoppage of the machine and necessitating repair before its work can be resumed, is covered. Periodical inspections of the plant are followed by the dispatch of engineers' reports to the insured containing advice as to its use, although noncompliance with the suggestions made does not invalidate the insurance.

Time-loss policies guarantee the payment to the insured of a fixed daily rate to cover the loss of time consequent upon the breakdown of engines, explosion of boilers or the collapse of flues.

Elevators, Hoists and Cranes.—For the purpose of public liability insurance, elevators are usually classified as either: (1) passenger elevators; (2) goods elevators; (3) service elevators; (4)

coal and coke elevators or hoists; (5) builders' hoists. Elevator insurance covers the risk of liability to third parties for personal injuries due or alleged to be due to defects or to negligence of attendants, in connection with the elevator, its gates, hatchways or shaft. Where elevators are driven by electric or hydraulic power breakdown insurances are often affected. The policy stipulates periodical inspection of the elevator by skilled engineers and, while the insured may select the engineer, subject to the insurers' approval, engineering insurance companies are willing to undertake these services. Policies similar in form to the elevator policy are issued for hoists and cranes, although the premiums required are frequently greater because of the increased possibility of goods falling upon third parties. Cranes of types liable to the risk of toppling and collapse may be specifically insured under a special form of policy.

Burglary, Housebreaking, Larceny, Theft.—In Great Britain, for insurance purposes, burglary is defined as forcible entry, with felonious intent, into a dwelling house by night; housebreaking is forcible entry, with felonious intent, into premises (not necessarily a dwelling house) by day; larceny is theft not preceded by forcible entry, *i.e.*, by persons lawfully on the premises or who have gained access without force; "theft" is a broader term than "larceny," the latter simply being a certain kind of theft meeting statutory requirements. In continental European countries the term "burglary" embraces housebreaking, larceny and theft, and in consequence no specific definitions apply as in Great Britain. In general, however, there is no material demand for this form of insurance on the continent.

Burglary policies fall under two main classifications: (1) private dwelling-house policies that ordinarily cover the risk of burglary, housebreaking and larceny; (2) business premises policies that do not include the risk of larceny and sometimes provide but limited protection in relation to burglary and housebreaking. The usual form of private house policy covers furniture, household goods and personal effects of every description, including gold and silver articles, jewelry and furs belonging to the insured or to members of his family or domestic servants who permanently reside with him. When the proportion of gold and silver articles, etc., exceeds in value one-third of the total value of the property insured, an additional premium rate is charged on the excess amount. Damage for which the insured is liable, caused to the dwelling house as a result of burglary, housebreaking or larceny is included in the cover provided by these policies. (*See* also Fire Insurance.)

Policies issued in connection with business premises are more restricted in their scope than those applicable to private dwellings, and the risks covered are usually limited to those of burglary and housebreaking only. While in general business premises are, for the purpose of burglary insurance, classified according to trade, many varying factors enter into the calculation of the premium rate. The insurer will require details of any burglar alarm system and also the extent to which the premises are, or can be, otherwise protected. The extent of unoccupancy, the adequacy of the sum insured and the highest amount which thieves are likely to take at any one time are other factors for consideration.

Of the risks related to burglary insurance "all-risks" is perhaps the most important. Such insurance provides the fullest possible cover of valuables—gold and silver articles, jewelry, furs, cameras, pictures and the like—against loss or damage by fire or theft, loss in the ordinary meaning of that term or damage by accident of any kind. An all-risks policy usually operates anywhere within a stipulated geographical zone.

Insurance of Money.—The insurance of money under an ordinary business premise burglary policy is normally limited to cash in a safe and small amounts of cash in tills. A specific insurance on "money" extends to bank notes, treasury notes, checks, postal orders, money orders or cash. It protects against loss from robbery, theft or accident, either in or out of a safe on the insured's premises during business hours, and while in transit between the insured's premises and the bank. The premium is calculated from the total estimated carryings in the course of the year, the rate varying according to circumstances.

Glass Breakage.—There are many different kinds of insurable glass, *e.g.*, embossed, silvered, wired, muranese, opalite, marmorite, nonreflecting and also ornamental and lettered glass, often fixed in trade premises as a means of advertisement. The normal glass insurance policy covers "breakage from any cause except fire, explosion, earthquake, war and kindred risks." The policy is essentially an insurance against breakage; mere damage to the glass, *e.g.*, scratching or chipping, is not covered. By a policy condition, frames are not insured against damage unless specifically mentioned as additional cover, and it is provided that no liability exists under the policy for interruption or delay in business or for damage of any kind between the time of the glass breakage and its replacement, and that the liability for taking precautions to avoid damage to persons and property rests on the insured. Premiums are calculated according to the superficial area and type of glass to be insured, or, where this is not practicable, on values. Although the policy provides that the insurer may replace the broken glass or reimburse the insured in money, in practice most claims are settled by replacement.

Fidelity Guarantee.—This is one of the oldest classes of accident insurance. Its object is to provide protection against default by an individual appointed to a position of trust. Suretyship by private bondsmen dates back to the indefinite past, and corporate suretyship, termed fidelity guarantee, has been transacted by insurance companies for well over a century. The three main classes of fidelity bonds issued are: (1) commercial bonds for guaranteeing the fidelity of clerks, cashiers, travelers, managers, secretaries and the like; (2) government bonds applying to servants holding appointments under the crown; and (3) legal bonds for guaranteeing the fidelity of administrators in connection with probate court, receivers and managers in chancery and the like. The rate of premium charged depends largely upon the nature of the duties to be performed, the system of check exercised and the amount of cash under an individual's control. Where there are a number of individuals to be guaranteed, special policy forms, known as collective and floating policies are adopted. In continental European countries, fidelity guarantee business has a much narrower appeal and in the main is concerned with the granting of bonds guaranteeing the fidelity of government and administrative officials.

In the contingency section, bonds are issued in respect of missing title deeds, share certificates, bearer bonds and similar valuable documents; also in respect of missing beneficiaries, defects in title, forged transfers and restrictive covenants; and in connection with variation of a trust, issue risks and many other contingencies.

A public or other authority may, when placing important work in the hands of a contractor, ask for a guarantee that the work will be duly completed or completed within a certain time. In some cases the authority insists that the guarantee be given in the form of a guarantee bond from an insurance company. As in many other classes of casualty business, the premiums depend upon the class and magnitude of work undertaken and the reputation and standing of the proposer and consequently vary considerably. *See* also Aviation Insurance; Marine Insurance.

See *Accident, Fire and Marine Insurance Year Book.* (P. Ss.)

CASUAL WARD, the name given, under the British Poor laws between 1834 and 1948, to a building used for giving temporary shelter to vagrants. Under the Poor law as reformed in 1834, the duty of boards of guardians was to relieve not only destitute persons within their districts but also vagrants (tramps or casual paupers). Any vagrant or unemployed person walking from place to place and seeking work usually obtained an order for the casual ward from the relieving officer. Accommodation was rough and frugal and, in return for food and lodging, tasks such as chopping wood or scrubbing floors were generally imposed.

Under the Poor Law act of 1930, casual wards became the business of the public assistance committees of county and borough councils, and joint vagrancy committees were established throughout the country to bring about a uniform system. The casual was admitted and supervised by trained officials and ordinarily was not allowed to discharge himself before the second morning (excluding Sunday) following admission unless he possessed a document from an employment exchange showing that he had an appointment with a prospective employer. The standard of accommodation was higher than that customary before the 1930 act.

The National Assistance act (1948) reorganized the administration of casual wards, thereafter known as reception centres. They became the responsibility of the National Assistance board, though this body used the local authorities in carrying out its duties. The number of reception centres fell from 215 (July 1948) to 60 (Dec. 1958) and there was an important change in the principles under which they were run: they were regarded as means for rehabilitating those who used them (*e.g.*, by finding them employment) rather than as mere temporary shelters. *See* also Poor Law.

(A. F. Ws.)

CASUARIIDAE, a family of large flightless birds living in New Guinea, northeastern Australia and nearby islands. Their large claws and bills make them extremely dangerous. *See* Cassowary.

CASUARINA, a genus of trees of the Casuarinaceae family containing about 35 species, chiefly Australian, but a few Indo-Malayan. Several species are cultivated in the subtropical parts of the United States, especially the beefwood (*C. equisetifolia*), which has become widely naturalized in Florida. The long whiplike green branches of the casuarina are longitudinally grooved and bear at the nodes whorls of small scale leaves, the shoots resembling those of *Equisetum* (horsetail). The flowers are unisexual.

The staminate flowers are borne in spikes, each flower consisting of a central stamen which is surrounded by two scalelike perianth leaves. The pistillate flowers are borne in dense spherical heads; each flower stands in the axil of a bract and consists of two united carpels flanked by a pair of bracteoles; the long styles hang out beyond the bracts, and the one-chambered ovary contains two ovules. In the fruit, the bracteoles form two woody valves between which is a nutlet; the aggregate of fruits resembles small cones. Pollen is transferred by the wind to the long styles. The pollen tube does not penetrate the ovule through the micropyle but enters at the opposite end. The wood is hard, and several species are valuable timber trees.

From a fancied resemblance of the wood to that of the oak these trees are known as oaks, and the same species has different names in different localities, including she-oak, swamp oak, ironwood and beefwood.

CASUISTRY, as commonly used, is a term of reproach directed against real or alleged abuses of the application of reason to legal and ethical problems. In a more neutral sense, casuistry arises whenever reflective men undertake to determine rules for conduct in the circumstances of everyday life; that is, to resolve cases of conscience. Persons suspicious of the methods and outcomes of the deliberative process often regard the elaborate chains of argument and authority that mark discussions of such matters among the learned as sophistical "rationalization," or, to put the matter in a more traditional way, "casuistry."

Casuistry however has more often grown out of an effort to preserve the law than out of a desire to destroy it. The accommodation to the world that is allowed in casuistry becomes a "hedge around the law," making it proof against assault on the charge of being irrelevant to human needs and changing circumstances. It is not surprising, therefore, that casuistry appears in all complex legal and ethical systems. The Stoics, to whom the Roman law owed so much; the rabbis who composed the Talmud with a view to immortalizing the Law; the Muslim commentators on the Koran; and the Confucian sages—all, in this broad sense, were accomplished casuists.

No civilization, however, has given a greater scope to casuistry than has Christendom. The unique element in the medieval synthesis was the orchestration, sometimes harmonic, sometimes dissonant, of the themes of conscience, casuistry and the cure of souls. The close connection of these three notions, and their associated institutions, is a decisive feature that distinguishes western patterns of cultural and social development from those of both the near and the far east.

The development during the 12th century of an extensive literature on the problems of conscience followed quickly upon the extension of the scope and authority of conscience by Peter Abelard and other schoolmen, and the requirement of regular annual confession by the fourth Lateran council of 1215 provided a vastly expanded public for the literature of casuistical divinity. Among the moral theologians and canon lawyers who prepared theological treatises and alphabetical handbooks of cases of conscience were Robert of Curzon (d. 1219), Raymond of Peñaforte (fl. 1234), John of Freiburg, Angelo da Clavasio and Silvester da Priero. Sustained criticism of the spirit and substance of these works begins with Luther, who cast the so-called "angelic *summa* of the cases of conscience" (*Summa angelica de casibus conscientiae*) of Angelo da Clavasio into the flames, along with the corpus of the canon law. A severer assault occurred in Catholic lands in the 17th century in the course of the conflict over probabilism (*q.v.*). Pascal's mocking exposé in his *Provincial Letters* (1656–57) dealt a profound blow to the system of probabilism and to the sophistical elements in ultraprobabilist casuistry, but the distinctively medieval integration of conscience, casuistry and the cure of souls recovered from the probabilist crisis in the 18th century and still characterizes Catholic societies.

In Protestant countries casuistry has always seemed, as it seemed to the original reformers, a dubious enterprise. As Protestantism came to permeate whole societies, however, the need for moral guidance in cases of conscience appeared again, and Protestant works of casuistical divinity have been written since the middle of the 16th century, the high point occurring in the mid-17th century. In Lutheran Germany the works of J. H. Alsted and others may be mentioned. In England a massive literature is connected with the names of Bishop Joseph Hall, William Perkins, Richard Baxter, William Ames and, above all, Jeremy Taylor. Puritan works in this genre had a profound influence upon the thought and life of the American colonists in the 17th and 18th centuries.

Although the word "casuistry" hardly ever appears in contemporary philosophical or theological discussions, the issue remains alive. A new appreciation of casuistry is implied, for example, in the writings of the school of linguistic analysts, notably in Stephen Toulmin's *An Examination of the Place of Reason in Ethics* (1950) and in J. L. Austin's William James lectures at Harvard, titled *Excuses*. In sharpest contrast to this are the ethical intuitionists, the phenomenologists and the existentialists. Among theologians, the problem of casuistry finds on one side Reinhold Niebuhr, who recognizes both the necessity and the ultimate insufficiency of law and casuistry; and, on the other, Paul Tillich and Martin Buber, who reject casuistry in favour of the "transmoral conscience."

The complaints that have been made against casuistry involve a complex of notions of which the following are perhaps central: (1) Casuistry is a device employed by sanctimonious and greedy priests and judges for ruling over the consciences of gullible men (Boccaccio and numerous medieval and Renaissance authors). (2) Casuistry inevitably involves a sophistical evasion of the "word of God," the "moral law" and the individual conscience (Pascal). (3) Casuistry gives continuing encouragement to a legalistic view of human existence and divine justice (Luther, Tillich). (4) Casuistry exaggerates the role of the free will in man's life, obscuring man's dependence on God's grace (Luther, Kierkegaard, Tillich). (5) Casuistry encourages man to perform acts out of the fear of law rather than the love of God or the moral universal (Luther, Kant). (6) Casuistry is in the violation of the inner light (George Fox and the Quakers). (7) Casuistry militates against the achievement of a rational ethic based on the greatest good of the greatest number (Jeremy Bentham). (8) Casuistry betrays the divine command of impulse and turns a deaf ear to the call of blood (D. H. Lawrence). (9) Casuistry dishonours the I-thou relationship by treating the moral impulse in an externalized fashion (Buber).

Except for the implicit approval of casuistry found in collections of trial reports and handbooks of cases of conscience, it is not easy to find many positive evaluations of casuistry. Professional interpreters of the law and political leaders, however, have never doubted its necessity. They have always assumed that it is the armature that conscience inevitably generates in its strivings to be effective in the tangled circumstances of the here and now. A powerful expression of the sentiments of judges and scribes, who have always sensed that every community, even the holiest, must plod toward innovation through the seemingly circuitous devices of casuistry, may be found in Justice Benjamin Cardozo's *The Nature of the Judicial Process*. Ordinary men have generally agreed with this view, for it is their experience that "circumstances alter cases."

There is, therefore, a paradox to the problem of casuistry. Intuitionists, mystics and ecstatics abhor organized procedures for applying conscience to its cases; they feel too full of the spirit to accept voices of authority or the clashing claims of the group. Prudent men and judges strive above all to preserve the rule of law. In the absence of evidence that the verdict of conscience rests upon some acceptable common tradition or acknowledged rule, they are likely to resist the appeal to conscience as arbitrary and unconvincing. Judges are only too aware of the vast complications involved in the achievement of a just decision. As too few have realized, the problem of casuistry poses the eternal dilemmas —the dilemmas of the one and the many, permanence and change, tradition and innovation, the letter and the spirit.

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CASUS BELLI, a Latin term describing a situation said to justify a state in initiating war. The United Nations charter provided that warlike measures are permissible only if authorized by the Security council or the general assembly, or if necessary for "individual or collective self-defense" against "armed attack." *See* ARBITRATION, INTERNATIONAL; WAR. (Q. W.)

CAT, properly any member of the family Felidae, of which the domestic cat, *Felis catus*, is the type. The family includes the lion, tiger, leopard, jaguar, lynx, cheetah and numerous species of smaller cats (*see* CARNIVORE). The name "cat" is also applied to other mammals that are more or less catlike in appearance or behaviour. In Australia the dasyures, small weasellike marsupials, are called "native cats"; in the U.S. the spotted skunk, a mustelid, is often called the "civet cat," and the cacomistle, a member of the raccoon family, is commonly called the "ring-tailed cat."

GENERAL

Origin and Evolution.—The history of the cat family can be traced back through the fossil record about 40,000,000 years into Lower Oligocene times. The cat "pattern" seems to have been established very early in the evolution of modern mammals, for the early cats were already typical cats at a time when the ancestors of most other modern mammalian types were scarcely recognizable. Fossil cats from the Oligocene, such as *Dinictis*, are astonishingly similar to modern cats. *Dinictis* was about the size of a lynx, with catlike teeth and retractile claws, but a small brain. The cat pattern must have been very successful, for it remained essentially unchanged throughout the Tertiary while most other mammalian types were undergoing tremendous evolutionary changes.

In *Dinictis* and other early cats the canine teeth in the upper jaw were much larger than in modern cats. From this beginning the cat stock followed two different lines of dental evolution. In one line, the sabre-tooths, the upper canines grew larger and larger, whereas in the second line, the "typical" cats, these teeth became smaller. There were, of course, other differences in other parts of the body.

In the sabre-tooths (Machairdontinae) the upper canines were large sabrelike structures that extended below the chin when the mouth was closed; there was usually a flange on the chin that protected the ends of the sabres when they were not in use. The remaining teeth were not much different from those of other cats except that some of the smaller ones tended to disappear. The sabre-tooths were heavy, slow-moving creatures with heavy forequarters and relatively light hindquarters. About 10 genera are known as fossils. The largest, most advanced and best-known sabre-tooth is *Smilodon*, which was about the size of a modern lion and had canines up to 6 in. long. *Smilodon* became extinct in the Late Pleistocene, only a few thousand years ago. The bones of hundreds of individuals of this sabre-tooth have been found in the Rancho La Brea tar beds in Los Angeles, Calif.

Typical cats (Felinae) first appear in the Lower Pliocene, about 10,000,000 years ago, and have continued almost unchanged into modern times.

Cats are typically solitary animals, hunting their prey by stealth and overwhelming their victims in a short, quick rush or leap. Foot pads help them stalk their prey in silence. They can move very fast in a short dash but are not built for sustained speed. For example, the cheetah is generally credited with being the speediest of mammals since it is capable of speeds of 65–70 m.p.h., but it has little endurance and is soon exhausted. Cats generally are nocturnal in habit; they see best in semidarkness and rely mostly on sight in hunting, although hearing is also keen. The retina of the cat's eye is made extra sensitive to light by a layer of guanine; this substance causes the eye to shine at night in a strong light. The cat's sense of smell is not well developed, but tactile perception is increased by whiskers and by hairs on the inner surface of the ear.

The largest living cat is the tiger, which has been known to reach a weight of more than 500 lb., a height of 5 ft. and a length of 14 ft. Lions seldom exceed 400 lb., a height of $4\frac{1}{2}$ ft. and a length of 9 ft. Full-grown male pumas weigh 160–175 lb., although there are records of more than 200 lb.

One of the most characteristic features of cats is purring, a low continuous humming sound associated with pleasure or contentment. Purring has nothing to do with the true voice of the animal; the vibration frequency is far lower than that of the vocal cords. The mechanism of the purr is not well understood. Some have suggested that purring is produced by the false vocal cords, but this is unlikely. The fact that species of cats in which the hyoid apparatus is incomplete are unable to purr suggests that the whole hyo-laryngeal apparatus vibrates to produce the purr. (See *Classification* below.)

Structure.—The cats are the most highly specialized of all flesh-eating mammals. All cats, from the lion and tiger down to the smallest jungle cat, and including the various breeds of domestic cats, are very much alike in structure. They are powerfully built animals, but very supple. Because their muscle movements are well coordinated and they are adept at using their tails for balance, cats almost always land on their feet when they fall or are dropped. The brain is large and highly developed. In keeping with their carnivorous habits the gut is simple with a short intestine; the small intestine is only about three times the length of the body. The tongue in all cats has a patch of sharp, backward-directed spines near the tip, which has the appearance and feel of a coarse file; these spines help the cat pick up liquids with its tongue.

The most characteristic and specialized features are in the teeth and claws. The teeth (fig. 1) are designed for two functions only: stabbing and cutting. Stabbing is done with the canines, which are long, pointed teeth that project far beyond the other teeth and are capable of making deep puncture wounds. The canines are used in killing prey. Cutting is done with two teeth on each side in the back of the mouth, the fourth premolar in the upper jaw and the first molar in the lower jaw. Each of these has a long cutting blade running along the length of the tooth, and the two blades work against each other exactly like the blades of a pair of shears. They are used for cutting prey into pieces small enough to swallow. The rest of the teeth are more or less degenerate and nonfunctional; most of the cheek teeth do not even meet when the mouth is closed. The dental formula in all cats, for either side of both upper and lower jaws, is: incisors $\frac{3}{3}$, canines $\frac{1}{1}$, premolars $\frac{3}{2}$, molars $\frac{1}{1}$. The total number of teeth is 16 in the upper jaw and

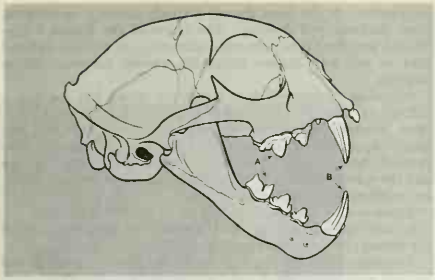


FIG. 1.—SKULL OF CAT: (A) SHEARING TEETH; (B) CANINES

14 in the lower. Primary, or milk, teeth number 24; in the domestic cat these are replaced by the permanent teeth at about five months. Each half of the jaw is hinged to the skull by a transverse roller that fits tightly into a trough on the underside of the skull, an arrangement that makes grinding movements impossible. Another dental characteristic shared by all cats is that they have no flat-crowned crushing teeth and therefore can only cut up their food instead of being able to chew it.

The cats are provided with a second weapon for subduing and holding prey: strong, sharp claws. To prevent the claws from becoming blunted by wearing against the ground there is a remarkable mechanism for retracting them when they are not in use (fig. 2). The claw is retracted or extended by rotating the end bone of the toe (which bears the claw) in an arc around the end of the next bone. Two tendons attached to several of the toe muscles are inserted into the bone that bears the claw, one tendon being inserted above the centre of rotation and the other below. When tension is applied above the centre of rotation (through the common tendon of the extensor digitorum longus, extensor digitorum brevis and interosseus muscles), the bone rolls upward and backward and the claw is retracted. When tension is applied below the centre of rotation (through the tendon of the flexor digitorum longus muscle), the bone rolls downward and forward and the claw is extended or "unsheathed." The action that unsheaths the claws also spreads the toes widely at the same time, making the foot more than twice as broad as it normally is and converting it into a truly formidable weapon. This claw-sheathing mechanism is present in all species of the cat family except the cheetah. It also occurs, though less perfectly developed, in some of the civets. Cats keep their front claws sharp by pulling with them against trees or other tough materials; the back claws are manicured by biting.

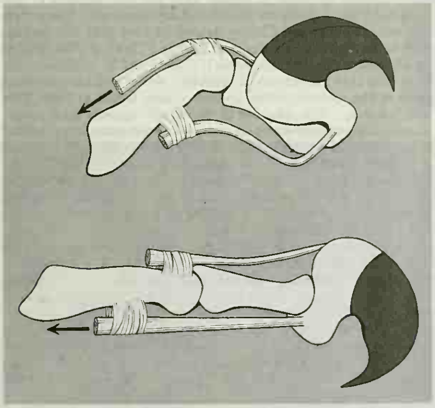


FIG. 2.—MOVEMENT OF RETRACTILE CLAW OF A CAT: (ABOVE) WHEN UPPER TENDON IS PULLED, CLAW IS RETRACTED; (BELOW) WHEN LOWER TENDON IS PULLED, CLAW IS UNSHEATHED

Geographic Distribution.—Cats are found in various species throughout the world except in the Australian region, Madagascar and the oceanic islands. They were absent in South America until the Panama land bridge was re-established in the Pleistocene (about 1,000,000 years ago); then both the sabre-tooths and true cats entered South America. The greatest concentration of species of cats is in southeastern Asia where as many as seven species may occur together in one area.

Seven species of cat are native to the U.S., although all do not occur together in any one place. The puma or cougar (*Felis concolor*) and the bobcat (*L. rufus*) were formerly distributed throughout the U.S. but have been extensively exterminated by man. The lynx (*L. canadensis*) is a Canadian species that enters the northern states of the U.S. Several tropical species barely enter the U.S. along the Mexican borders of Texas, New Mexico and Arizona. These are the jaguar (*Panthera onca*), the ocelot (*F. pardalis*), the margay (*F. wiedii*) and the jaguarundi (*F. yagouaroundi*).

The only species of cat native to Europe is the European wildcat (*Felis sylvestris*). The range of this species formerly included Great Britain, central and southern Europe, and parts of central Asia. It is now much reduced in numbers and probably does not occur anywhere without at least a trace of the domestic cat in its constitution. In Great Britain the wildcat survives only in some Scottish forests. It has not been known in Ireland during historic times.

DOMESTIC CATS

Origin.—The domestic cat is a domesticated form of the African wildcat, *Felis libyca*, which is still widely distributed over Africa and southwestern Asia and interbreeds freely with the modern domestic cat. The colours and markings of the African wildcat are, detail for detail, those of the well-known tabby pattern of the domestic cat. The cat was domesticated by the ancient Egyptians. There are no authentic records of domestication earlier than 1500 B.C., although it may have taken place earlier. The cat was proclaimed a sacred animal in the 5th and 6th dynasties (2500–2300 B.C.), but it had not necessarily been domesticated at that time.

From Egypt the domestic cat spread slowly into the rest of the civilized world. It is not mentioned by any of the ancient writers until the 1st century A.D., except by those who had visited Egypt or had heard of the cat's existence there. Cats are not mentioned in the Salic laws of 8th-century Germany. The earliest record of cats in Great Britain dates back to about A.D. 936 when Howel Dda, prince of south central Wales, enacted laws for their protection.

It has been suggested that the ancestry of the Siamese and Burmese cats is distinct from that of other domestic breeds, representing a domestication of some oriental wild cat. In fact nothing is known of the ancestry of the Siamese-Burmese type, and there is no living species of oriental wild cat that would serve as ancestor.

Characteristics.—The domestic cat is noted for its independence and intractability, traits that endear it to some people but cause others to dislike cats intensely. These characteristics stem directly from the solitary and asocial habits so typical of all species of felids and are as much a part of the cat pattern as are the retractile claws or the typical felid dentition. It is noteworthy that the ancestors of man's other common household pet, the dog (and of most of his other domestic animals), were social animals that lived together in packs in which there was subordination to a leader. The dog readily transfers its allegiance from pack leader to human master. There is no such social background in the ancestry of the cat. Because of its temperament, the cat is able to revert to the wild state more quickly and more successfully than most other domestic animals.

The average weight of the adult American domestic short-hair, as determined by H. B. Latimer on a random sample of 104 individuals, is 6.2 lb. for males and 5.4 lb. for females. These figures are often exceeded, weights of 28 lb. and more having been reported. Average lengths are 28 in. for males and 20 in. for females. Reliable average figures are not available for other breeds of cats.

A breeding female, called a queen, is in heat about three times a year, and the period lasts from three days to three weeks. During this period she usually "calls," a caterwauling that may be almost continuous. Some females do not call. Gestation lasts 55–69 days, and the kittens are born blind and helpless. There are usually four to eight young in a litter; Siamese cats usually have larger litters which may number eight or even nine. The young open their eyes in seven days, stop nursing at about four weeks and mature in five to eight months. Females reach reproductive age at six months; males can produce offspring after the age of about one year. The average life span of a cat is about 14 years, although many individuals live beyond 20 years.

Genetics.—Cats have never been bred for economic purposes; they are relatively slow breeders and their matings are extremely difficult to control unless the animals are completely confined. There has therefore been relatively little scientific breeding of cats, and the facts of inheritance in these animals are not well known.

The commonest basic coat colours in domestic cats are tabby, black, yellow and white. Various combinations and dilutions of these colours occur. Solid white is dominant to all colours, and tabby is dominant to black. The mode of inheritance of black is imperfectly understood; the possibility that it is sex linked is widely accepted, but this has never been proved. The dark seal brown of the Siamese is due to a different genetic factor than black; it is dominant to tabby. Tabby is known to be due to at least two sets of factors, one for banding and one for ticking. Tortoise shell, a piebald pattern of black, yellow and white, results from crossing black and yellow. In such crosses the female progeny is tortoise shell, the male progeny yellow or black. Thus the tortoise-shell pattern appears to be sex linked in some way, but rare male tortoise shells are known and other inconsistencies make an explanation through simple sex linkage untenable.

Maltese is a dilution of tabby, is recessive to intense colour and apparently is due to a single genetic factor. Siamese dilution, the typical coloration of Siamese cats, has been described as a case of imperfect albinism and has been compared to the Himalayan pattern in rabbits (*see* ALBINISM). Its heredity is not well understood. There are also dilutions of the other ordinary colours: blue is dilute black, and cream is dilute yellow. White-spotting also occurs and is dominant to self-colour.

The long-haired coat, called Persian or Angora, appears to be a simple unit character. It is recessive to short-haired. Eye colour is known to be inherited, but its mode of inheritance is not well understood. Blue eye colour seems to be associated with dilution in coat colour; blue-eyed white cats are usually deaf, a fact that was commented on by Charles Darwin. Asymmetry of eye colour is known to be inherited. Polydactylism, the presence of extra toes, is inherited and behaves as a dominant to the normal condition. It appears to be due to a single gene. The extra toes occur on the inner or thumb side of the foot.

Common Diseases.—Cats are subject to a variety of diseases, some of them contagious and with high mortality. The commonest diseases are:

Panleukopenia.—Often miscalled feline distemper, this is the commonest contagious infectious disease in cats. It resembles distemper in dogs by being highly infectious and having a high mortality rate. The disease is seen most often in young cats. A cat affected with the acute form is severely depressed, runs a high fever and shows a pharyngitis and red streaking of the soft palate. The animal refuses to eat or drink, and there may be vomiting and diarrhea. There is very severe dehydration, and this is the most dangerous aspect of the disease. An animal that recovers is usually permanently immune. Immunizing vaccines are effective protective measures.

Feline Pneumonitis.—Sometimes called influenza or distemper, this disease is accompanied by manifestations of rhinitis, conjunctivitis, pharyngitis, low fever, moderate depression and loss of appetite. At the onset there is typically sneezing, lacrimation, nasal discharge and drooling. The course of the disease is protracted, and there is no permanent immunity. A recovered animal may be left with chronic bronchitis, chronic conjunctivitis or sinusitis.

Infectious Anemia.—This is a common disease but one that is difficult to diagnose. At the beginning there is moderate to high fever, weakness, sometimes vomiting, difficulty in breathing and severe depression. Later the animal becomes very weak and depressed, the coat loses its lustre, the inside of the mouth is pale and the spleen is enlarged. The disease usually responds readily to treatment with antibiotics.

Rabies.—Cats are less subject to this disease than are dogs, but it is known to occur in cats. An animal may be immunized against the disease; the immunity presumably lasts 3–4 years.

Parasites.—Cats are attacked by several kinds of external and internal parasites. External parasites are most commonly found on kittens but also occur on adults. The most frequent parasite is the flea, but lice, ticks, mites and fungi (*e.g.*, ringworm) also occur. Internal parasites include roundworms, hookworms and tapeworms.

The Cat in Religion and Witchcraft.—The cat has long played a role in religion and witchcraft. In the Bible it is mentioned only in the apocryphal Epistle of Jeremy (Baruch vi, 22), but it figured prominently in the religions of ancient Egypt, the Norse countries and various parts of the orient. The Egyptians had a cat-headed goddess, named Bast, whose chief seat of worship was the city of Bubastis. Thousands of cat mummies have been discovered in Egypt, and there were even mouse mummies, presumably to provide food for the cats. More often, however, the cat has been associated with sorcery and witchcraft, and the superstitions regarding cats, common in all countries, are innumerable. Superstitions often took extremely vicious forms, and throughout the ages cats have been more cruelly mistreated than any other animal. Black cats in particular have long been regarded as having occult powers.

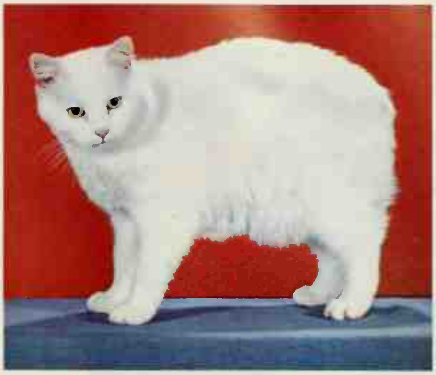
Many people dislike and even fear cats. In extreme cases fear of cats may become morbid and even be accompanied by typical symptoms of hysteria: paleness, profuse sweating, nausea and profound emotional disturbance, sometimes terminating in fainting. This condition, when induced as a reaction to cats, is called aelurophobia.

The Cat in Literature.—The cat is a familiar figure in nursery rhymes and stories. The legend of Dick Whittington and his cat is a particular favourite in Britain while different versions of folk tales like Puss in Boots are known in many countries. The writers Théophile Gautier and Charles Baudelaire have paid him homage and, in the 20th century, Rudyard Kipling ("The Cat Who Walked by Himself," *The Just So Stories*), Colette and T. S. Eliot. Cats have long been the subject of children's stories and have achieved fame in film cartoons in the persons of such heroes as Felix, Tom and Sylvester. The influence of the cat also appears most clearly in everyday language where its many-sided character is crystallized in proverbs and sayings as pithy as they are diverse.

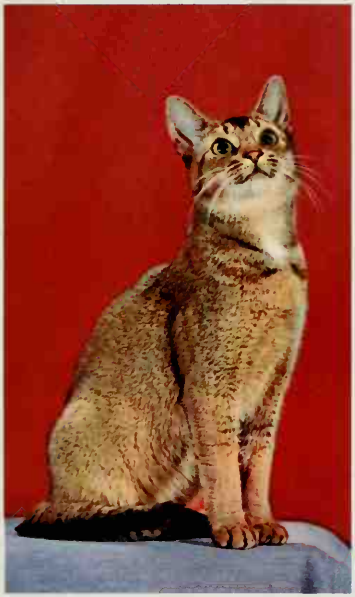
Breeds of Domestic Cats.—Innumerable societies and associations have been formed, particularly in England and the U.S., to foster interest in cats and set standards for the several recognized breeds. The most important such organization in the U.S. is the Cat Fanciers association.

Cats are genetically far less plastic than dogs and therefore have not offered the same opportunities to fanciers. The tremendous size differences between large and small breeds seen in the domestic dog have no parallel in the domestic cat, nor has anything even remotely approaching the wide range of head shapes and body proportions in different breeds of dogs ever appeared among the cats. In cats the differences between one breed and another are largely differences in the colour and texture of the coat. The basic classification is into long-haired (Angora or Persian) and short-haired cats.

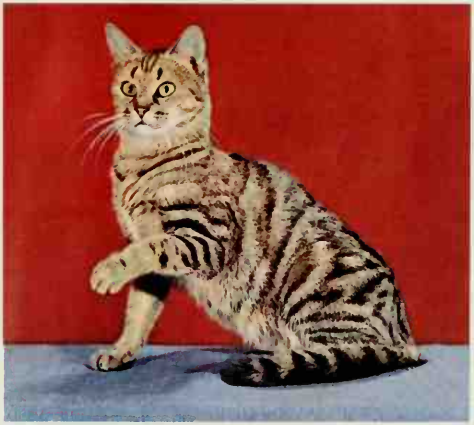
Most of the recognized breeds occur in both short-haired and long-haired varieties and except for hair length are judged by the same standards. Among the long-hairs, Angora was formerly dis-



White Manx (Champion "Creggyn Doo's Muirgheal," owned by Mr. and Mrs. Arthur J. Tomson)

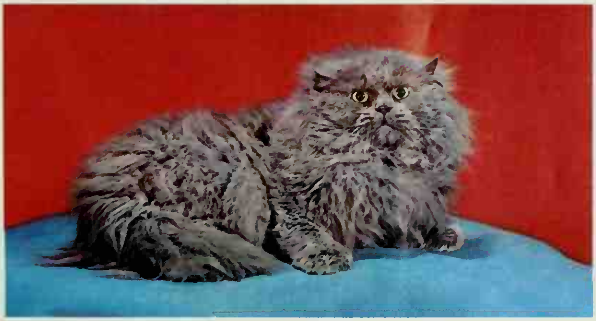


Abyssinian ("Nelaria Titian Peach," owned by Mrs. W. C. Daly)



Striped domestic ("Tabitha," owned by Edith McPhee)

Blue Persian ("Charline's So-Fine Rover," owned by Charline Thayer)



DOMESTIC CATS

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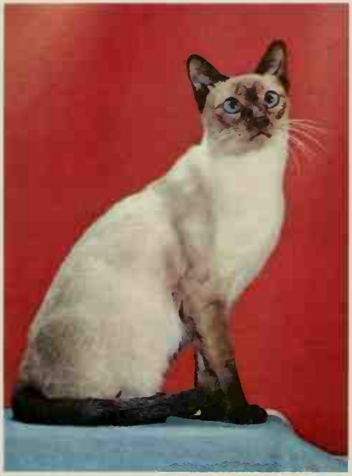
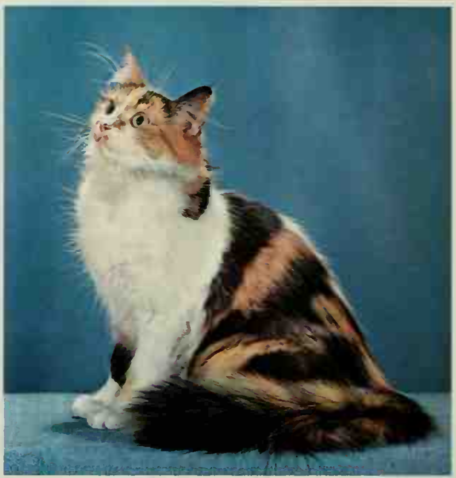


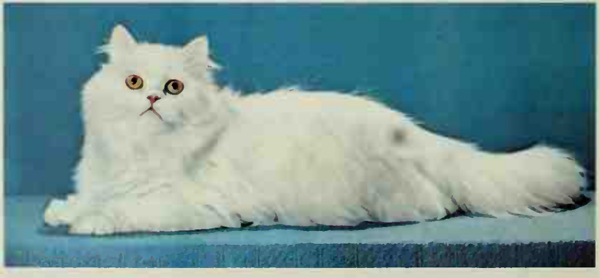
Siamese ("Dalai Jack's Summer Storm," owned by Mrs. W. C. Daly)

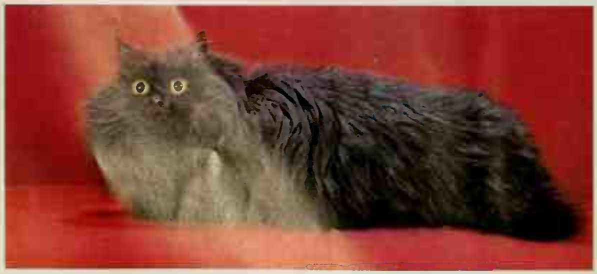


Blotched domestic ("Scooter," owned by Anne-Beth Gajda)

DOMESTIC CATS

White Persian (Quadruple champion "Glengary Sno-Pixie of Joy," owned by Mrs. Arthur Elander)





Black Persian (Double champion "Ayme Tu-Wynn," owned by Mrs. M. E. Thorne)

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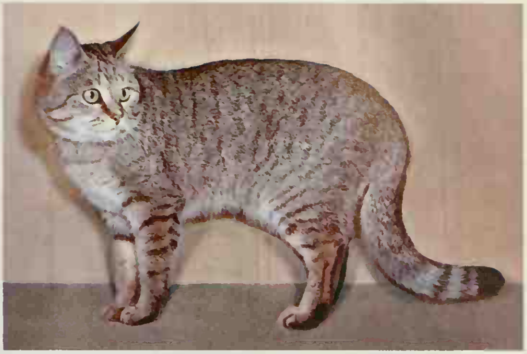
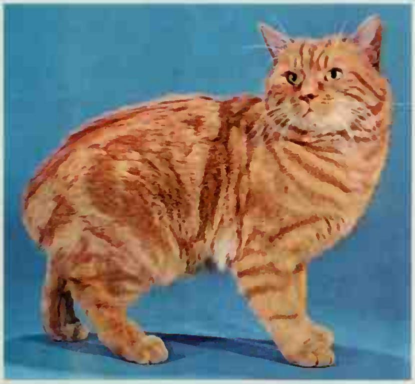
ANCESTRAL AND DOMESTIC CATS

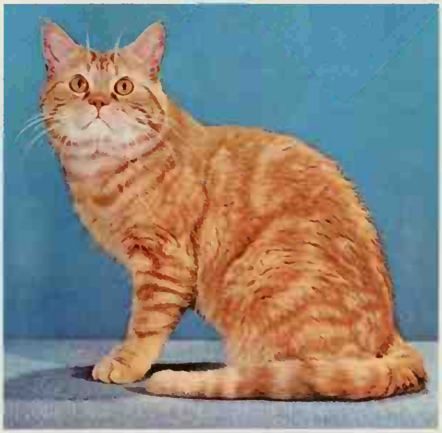


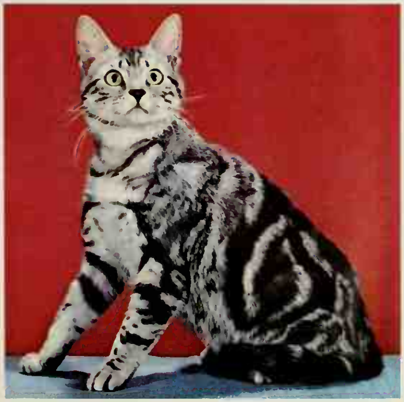
Felis libyca, the direct ancestor of the domestic cat, is an African wildcat

Striped Manx (Grand champion "Glen Orry's Olof of Manx," owned by Ruth and Ellen Carlson)



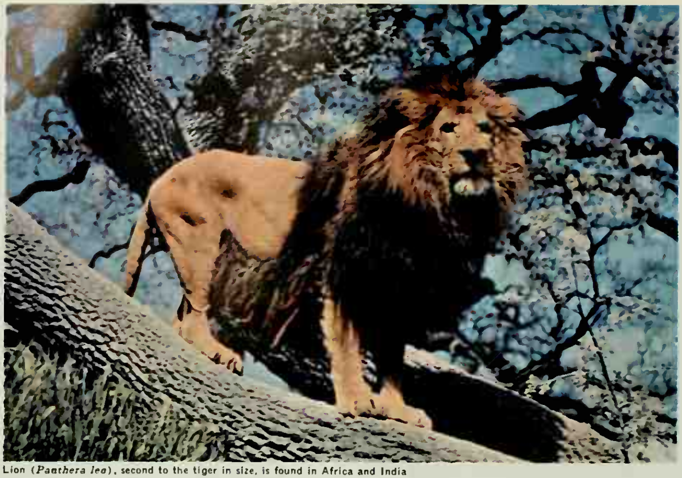
Red tabby (Champion "Caesar of Casanova," owned by Edith McPhee)





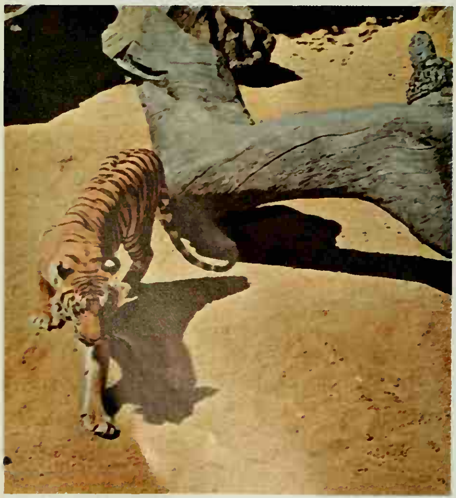
Tabby (Champion "Gem of Du-Ro-Al," owned by Mrs. Alma Cowell)

(CENTRE LEFT, RIGHT AND BOTTOM) PHOTOGRAPHED BY JOHN GAJDA FROM PUBLIX PICTORIAL SERVICE, INC., © ENCYCLOPÆDIA BRITANNICA, INC., (TOP) WOLFGANG LUMMER

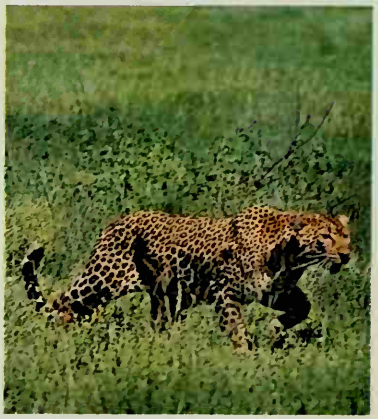


Lion (*Panthera leo*), second to the tiger in size, is found in Africa and India

SOME GREAT CATS

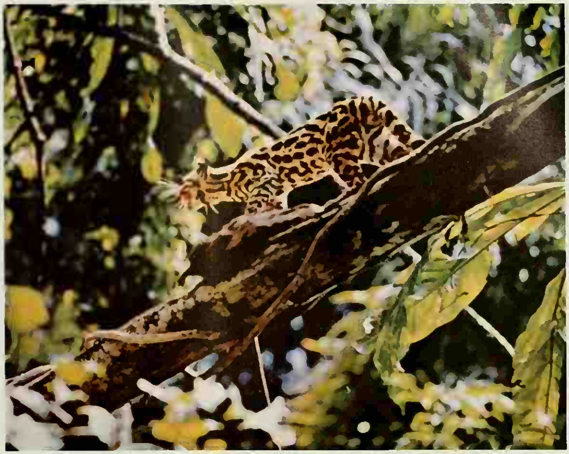


Tiger (*Panthera tigris*), largest of the cat family, sometimes becomes a man-eater, is exclusively Asiatic

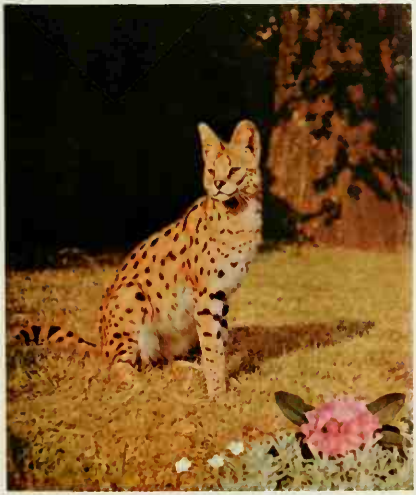


Leopard (*Panthera pardus*), ranging from Africa to Asia, has spots of broken rings

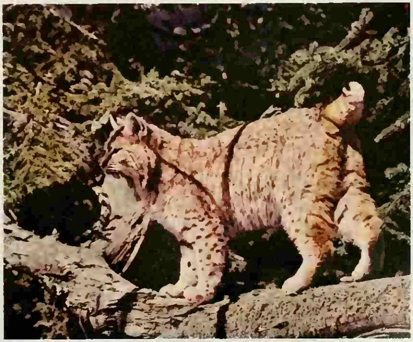
PHOTOGRAPHS (TOP) CY LATOUR—FPG, (BOTTOM LEFT) © 1964 WALT DISNEY PRODUCTIONS, (BOTTOM RIGHT) PROF. B. GRZIMEK, FRANKFURT (M)



Ocelot (*Felis pardalis*), ranges from south central U.S. to Paraguay. The spotted fur varies in colour from pale gray to deep brown



Serval (*Felis serval*), an African wildcat, preys on smaller mammals and water fowl



Bobcat, or bay lynx (*Lynx rufus*), found in North America including Mexico. Its summer coat has fewer spots

SMALLER WILDCATS

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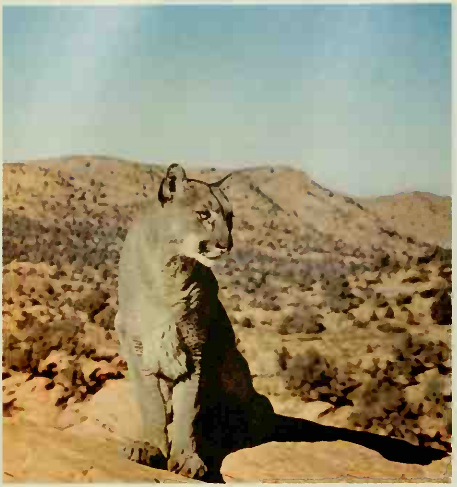
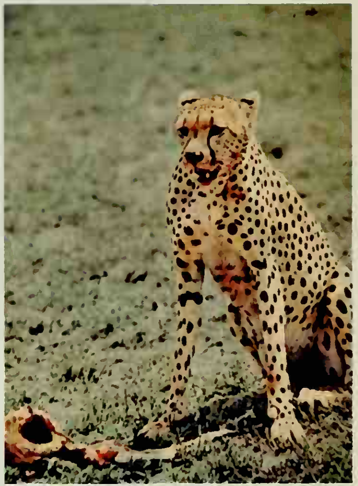
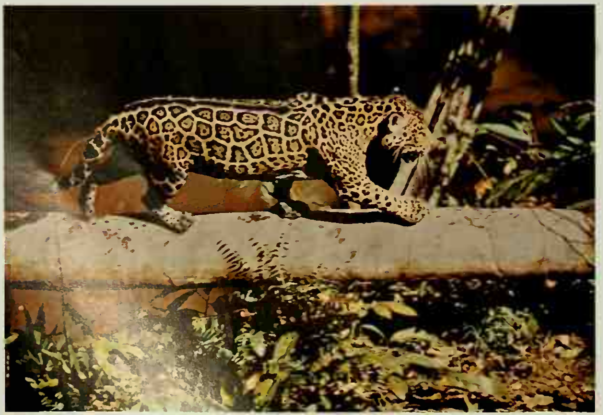


Puma, or mountain lion (*Felis concolor*), found in both North and South America, is the second largest of the American cats



Cheetah (*Acinonyx jubatus*), a swift, long-legged cat of the open plains in Africa and India, has been trained to hunt game

LARGER WILDCATS



Jaguar (*Panthera onca*), ranges from Texas to southern South America. It is the largest of the American cats

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tinguished from Persian but these have now become one as a result of interbreeding.

Recognized show breeds and the characteristics valued most highly by show judges include those listed below. Other varieties occur but are not recognized as show breeds.

Striped Tabby.—The ground colour of the coat is gray. The sides of the body, from shoulder to base of tail, are marked with vertical black stripes. A single black stripe runs down the center of the back from the head to the tip of the tail. On the face and near the root of the tail the stripes tend to break up into spots. There is a M-shaped black marking on the forehead and two horizontal black lines on the cheek. The legs are ringed with black bands called "bracelets." Eyes are of a green or hazel colour.

Brown Tabby.—The ground colour is tawny. The sides are marked with black blotches or broad curved bands. Three black stripes run down the centre of the back. The markings of the face are similar to those of the striped tabby. A butterfly-shaped mark on each shoulder separates the head markings from the stripes on the back. The legs are ringed with black bracelets. Eyes are green, brown or yellow; orange or copper eyes are preferred.

Silver Tabby.—The ground colour is silver, overlaid with black markings similar to those in the brown tabby. Blue-green eyes are preferred.

Black.—The entire coat must be jet black, each hair being black from root to tip. Most black cats have a white spot on the breast, but such individuals cannot be exhibited as perfect black cats. Show specimens must have orange eyes without a trace of green.

Blue.—Often called maltese. The entire coat is uniform blue, ranging in different individuals from slate to lavender. Pale shades are preferred, and the darker colours are seldom seen. The approved eye colour is orange or deep copper.

Orange (Red) and Cream.—Separate classifications are given to these two colours. In both cases the colours must be solid, with no shadings or markings. Eyes must be copper or orange.

White.—The coat is pure white, not a hair of any other colour being allowed in a show cat. Eyes must be either blue or orange.

Tortoise Shell.—The colours are black, red and cream, distributed in distinctly separated patches. No white or tabby markings are allowed. The approved eye colour is copper or orange.

Tortoise Shell and White.—This is similar to tortoise shell except that white is also present. The eyes should be orange.

Abyssinian.—The coat is fawn coloured ticked with dark brown. There is some barring on the legs and tail, though for show purposes the less barring the better. Eyes may be green, yellow or hazel.

Siamese.—The coat is short and close-lying, and its fawn colour shades into cream on the chest and belly. The face mask, ears, feet and tail (called "points") are deep seal brown. The tail may be slightly kinked at or near the tip, but bobbed tails, screwed tails or pompon tails are not allowed. Eyes are blue. There are "blue point" and "chocolate" variants of Siamese.

Burmese.—The coat is very short and close-lying; the colour is sable brown except for slightly paler hues on the chest and belly. There is a clearly defined mask of darker brown on the face. The ears, legs and tail are the same colour as the mask. The tail may be slightly kinked near the tip. Eyes range from golden turquoise to yellow. This breed closely resembles the Siamese.

Manx.—A tailless breed, no vestige of a tail being permitted in show animals. The hind quarters are high. All coat colours are recognized.

CLASSIFICATION

All species of living cats are placed in the family Felidae, one of several families of Carnivora, the order of flesh-eating mammals. The closest living relatives of the cats are the hyenas (family Hyaenidae) and the civets (family Viverridae).

In 1916 R. I. Pocock, of the London zoo, showed that the living cats may be divided into two groups on the basis of the structure of the hyoid apparatus, a group of connected bones at the base of the tongue. In one group of cats one of the hyoid bones (the epihyal) fails to develop and is represented only by a threadlike ligament so that the tongue and larynx are loosely attached to the base of the skull. This group includes the large cats—lion, tiger, leopards, jaguar—which are placed together in the genus *Panthera*. These cats are unable to purr, their voice is a roar and the pupil of the eye is round. In the second group, the genus *Felis*, the hyoid develops normally and all such cats can purr but do not roar. The pupil is usually vertical but is round in a few species. The genus *Felis* includes the mountain lion and all the numerous kinds of smaller cats including the domestic cat. The Canada lynx and bay lynx or bobcat are often placed in a separate genus, *Lynx*. The cheetah or hunting leopard has a normal hyoid but has nonretractile claws and differs from all other cats in other ways. It is placed alone in the genus *Acinonyx*.

See also references under "Cat" in the Index volume.

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CATACOMBS, subterranean cemeteries composed of galleries or passages with side recesses for tombs. The term, of unknown origin, seems to have been applied first to the subterranean cemetery under the basilica of S. Sebastian on the Appian Way near Rome, which became famous as the temporary resting place, it was believed, of the bodies of SS. Peter and Paul in the last half of the 3rd century. By extension, the word eventually came to refer to all the subterranean cemeteries around Rome. By a further extension of meaning, catacomb is used loosely to describe any underground complex of tunnels and chambers, whether originally designed for burials or not; the so-called catacombs of Paris, for example, are really abandoned stone quarries, first used for burials in 1787.

Catacombs were by no means a Christian or an exclusively Roman invention. The custom of burying the dead in underground rock chambers goes far back into antiquity, probably originating as a mimetic reproduction in permanent form of prehistoric house burials. Catacombs are found all over the Mediterranean world: in Malta, near the ancient capital of the island; in Sicily, near Taormina, Syracuse and elsewhere; in Egypt, near Alexandria and Cairo; in Syria, near Saida (the ancient Sidon); in Tunisia, near Susa (the ancient Hadrumetum); and at many places in Italy, especially around Naples and in ancient Etruria. But "the catacombs" still means, in general usage, the early Christian catacombs of Rome. They are the most extensive, the best known and practically speaking the norm of this type of construction, and it is with the Roman catacombs that this article deals.

History.—In Etruscan and republican Roman times inhumation of the dead was generally practised, and extensive catacomblike cemeteries developed around Clusium (Chiusi), Cerveteri and elsewhere. But by the 1st century A.D., cremation had become the normal practice of pagan Rome, and inhumation did not again become customary until the time of Hadrian (A.D. 117–138). So it was more on Jewish than on Roman precedent that early Christian catacombs developed. Accustomed from earliest times to practise inhumation in rock-cut tombs, the Jews found geological conditions around Rome that allowed them to continue to do so. The great plain surrounding the city is composed of three volcanic strata, one of which—granular tufa—is relatively easy to cut, porous so that it drains well and yet strong enough to support galleries and sizable chambers; the other strata—pozzuolana (sand) and lava stone—provided conveniently accessible building material and mortar. The first Jewish catacombs in Rome probably were begun before the Christian era, but in the earliest-known catacomb, near Monteverde in Trastevere, burials probably were begun in the 1st century A.D. Half a dozen other, later Jewish catacombs are known, easily identifiable by the seven-armed candlesticks marking the graves. But these Jewish catacombs were soon far surpassed in number and size by those developed for the rapidly growing Christian community of Rome.

Roman law prohibited cremations or burials within the city walls and further required that cemeteries not be located near residential areas. Thus it is probable that the first Christian catacombs had to be abandoned and destroyed to make room for developing suburban areas as the city expanded beyond its 1st-century limits, especially during its great enlargement in Hadrian's time. The earliest that now remain are located in a rough circle about three miles from the centre of Rome, most of them, like the pagan tombs, near the main roads leading into the city; they are the crypt of S. Lucina and the catacombs of SS. Calixtus, Domitilla and Priscilla, all begun around the middle of the 2nd century A.D. Other well-known, slightly later catacombs are those of SS. Praetextatus (begun *c.* A.D. 185), Sebastian (*c.* 250) and Peter and Marcellinus (*c.* 300).

The major parts of the Christian catacombs—about 40 of which are known—belong to the 3rd century and the early part of the 4th. By A.D. 350 interment in them had become rare; it ceased altogether after the sack of Rome by Alaric in 410. Ruined by the Goths in the 6th century and later by the Lombards, they were abandoned completely after Popes Paul I and Paschal I transferred the holy relics of the martyrs elsewhere; their entrances caved in and their very existence was forgotten until they were rediscovered by chance in 1578. Since that time, notable scholars in every century have contributed to knowledge of them.

Description.—All the catacombs follow roughly the same pattern. Beginning as small private burial areas, they soon became extensive enough to be taken over by the church as communal property and administered by the bishop; with successive generations of use, they finally became vast labyrinths of narrow galleries, usually three to four feet wide, lighted and ventilated by light shafts spaced at wide intervals. Some galleries are hardly tall enough to permit walking upright; others have been cut down so deeply that there may be as many as 12 tiers of burials in long horizontal recesses in the walls; since the galleries were enlarged by deepening, the highest tiers are the oldest (fig. 2).

From the galleries open small rooms called cubicula, which were the original burial places (usually of a single family). Cutting of loculi or loci (grave niches) in the walls and even in the floors of the galleries was a later development, forced by numbers. In Christian cemeteries these niches usually were cut parallel to the gallery (in contrast to pagan areas, where they were at right angles), and sometimes held as many as four bodies, although one was the usual number. They were carefully closed by slabs of marble or huge tiles cemented together; when an epitaph was set up, it was painted or carved on the tiles (fig. 3). Table tombs and arched tombs sometimes are found; sarcophagi rarely. Loculi cut for later burials often damaged or destroyed earlier inscriptions and mural decorations.

Uses.—In the early Christian community catacombs served a variety of functions in addition to burial. Funeral feasts were celebrated in family vaults on the day of burial and on anniversaries. The Eucharist, which always accompanied funerals in the early Christian Church, was celebrated there; in some of the catacombs larger halls and connected suites of chapels functioned in effect as shrines for devotions to saints and martyrs. A famous example is the Triclia in the catacomb of S. Sebastian, to which countless pilgrims came to partake of memorial meals (*refrigeria*) in honour of SS. Peter and Paul and to scratch prayers to them on the walls.

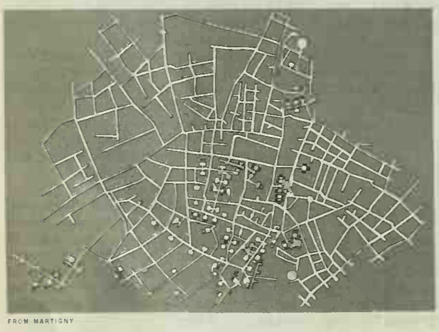
FROM MARTIGNY

FIG. 1.—PLAN OF SECTION OF THE CEMETERY OF S. AGNESE AT ROME: A.D., 3RD CENTURY

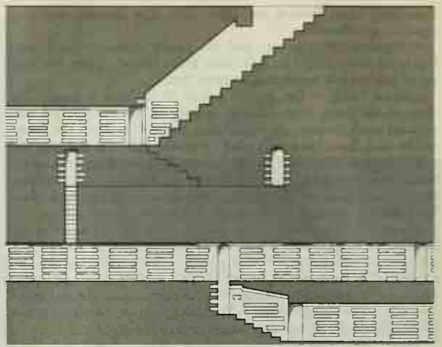
FIG. 2.—SECTION OF GALLERIES AT DIFFERENT LEVELS IN CATACOMBS OF ROME

The catacombs also, because of their intricate layout and access by secret passages to sand quarries and open country, could be used as hiding places during times of persecution and civil commotion. Pope Sixtus II and four deacons, for example, are said to have been captured and killed in the catacomb of S. Sebastian during Valerian's persecution (A.D. 258); later, Christians took refuge there during the barbarian invasions.

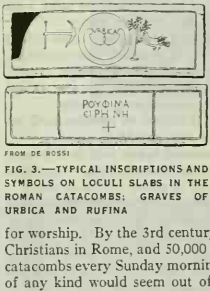

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FIG. 3.—TYPICAL INSCRIPTIONS AND SYMBOLS ON LOCULI SLABS IN THE ROMAN CATACOMBS: GRAVES OF URBICA AND RUFINA

There seems no truth, however, in the widespread belief that early Christians used the catacombs as secret meeting places for worship. By the 3rd century A.D. there were more than 50,000 Christians in Rome, and 50,000 persons could hardly go out to the catacombs every Sunday morning in secret. Furthermore, worship of any kind would seem out of the question in the long, narrow corridors of the catacombs, and even the largest of the tomb chambers, such as the Chapel of the Popes in the catacomb of St. Calixtus, hardly holds 40 persons. Finally, Christians and pagans alike regarded death as unclean, so that while memorial meals or Masses for the dead might be celebrated in the tombs on appropriate occasions, regular public worship in such a place would be unlikely.

Architectural Significance.—Since they were not used as churches, the catacombs as such made little contribution to Christian church architecture. Nevertheless, they had some influence. The use of domical vaults over many cubicula may have some connection with the development of the dome as a Christian symbol of resurrection. More important was the development of memorial chapels above the catacombs, apparently inspired by the Roman tradition of sepulchral monuments. The earliest ones were very small, enclosing only enough space for an altar, officiants and a few worshipers (*e.g.*, the chapel of St. Sixtus, above the catacomb of St. Calixtus). Being entirely devoted to worship, the chapels may have contributed to the increasingly sacred character of church buildings as they developed from the mid-4th century on, in contrast to the half-secular character of earlier types. Later, catacomb chapels become much larger; an example is that dedicated by Sta. Costantia. *c.* 337–350. the outlines of which are still perceptible within the present 7th-century church of S. Agnese. To such buildings the later medieval development of crypts owes much, for its system of galleries beneath a semicircular apse, leading down to catacombs below, seems a clear forerunner of the annular crypt beneath the floor of many medieval churches.

Decoration.—Catacomb paintings provide the chief source of knowledge about primitive Christian art. Although the bulk of early Christian art was produced, of course, in the east, very little of it has survived Muslim iconoclasm, and practically none of what remains antedates the 5th century. In the catacombs, on the other hand, there is a great body of material illustrating the character and principles of Christian art from about 180 (no paintings are surely datable before then) to about 410 (after the sack of Rome in that year, the only important additions were a few commemorative paintings commissioned for the graves of martyrs by later popes). The important frescoes, generally speaking, are confined to cubicula, the earliest being in the catacombs of Domitilla and Priscilla and the crypt of Lucina. The greatest series preserved in any single room of the catacombs is in the Greek chapel in the catacomb of Priscilla.

The themes of the early frescoes are overwhelmingly drawn from the Old Testament. Most popular is the story of Jonah; other favourites are Daniel (represented standing between two lions, his arms upraised), Noah in the ark (in the same position), Abraham on the point of sacrificing Isaac, the three Hebrews in the fiery furnace, Susanna delivered from the Elders and Moses striking the rock to provide water for the Israelites in the wilderness. Even when New Testament subjects begin to appear, representations of Christ are noticeably rare. Thus the Annunciation and the Adoration of the Magi appear often, the Virgin and Child rarely; the Healing of the Paralytic is depicted without the Healer; the Miracle of Loaves and Fishes is suggested only by a "multitude" of seven seated in a semicircle with extra baskets of loaves beside them. Only in later paintings does the figure of Christ commonly appear, and then usually as the miracle worker, as in the Marriage at Cana or the Miracle of Loaves and Fishes.

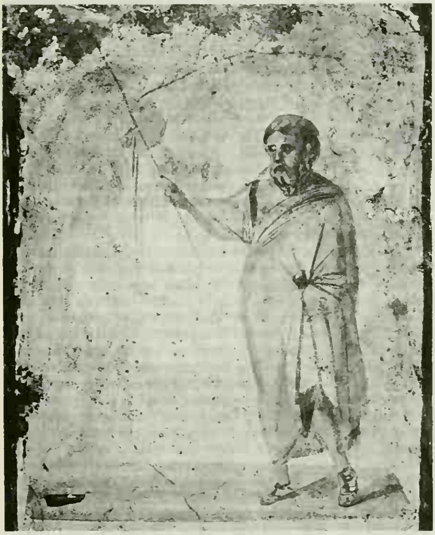
BY COURTESY OF PONTIFICIO ISTITUTO DI ARCHEOLOGIA CRISTIANA

FIG. 4.—"MOSES STRIKING THE ROCK," WALL PAINTING FROM THE CATACOMB OF SS. PETER AND MARCELLINUS, ROME; *c.* A.D. 300

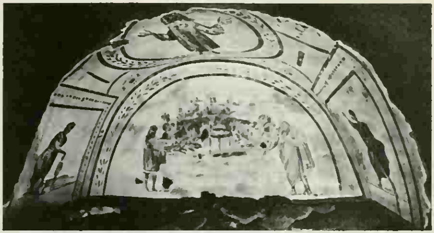
BY COURTESY OF PONTIFICIO ISTITUTO DI ARCHEOLOGIA CRISTIANA

FIG 5.—"THE MARRIAGE AT CANA," WALL PAINTING FROM THE CATACOMB OF SS. PETER AND MARCELLINUS, ROME; *c.* A.D. 300

From this may be deduced the real character and purpose of this art: it is not meant to record historical events but to present the truths of salvation and the hope of deliverance from sin and death. So the Miracle of Loaves and Fishes or the Marriage at Cana prefigure the Lord's Supper (by means of which the faithful partook of the eternal life of Christ); so Moses' delivering the Israelites from death by thirst under the old covenant is a "sweet foretaste" of Christ's providing the Water of Life under the new. Many, if not all, of the themes were suggested by the ritual and liturgy, as, for example, the ancient prayer for the dying (*Commendatio Animae*), which prays God to "deliver the soul of Thy servant, as Thou didst deliver Noah in the flood, Isaac from the sacrificing hand of his father, Daniel from the lions' den, the three youths from the furnace of burning fire . . ." With this in mind, it is easy to understand why the deceased (as well as Noah, Daniel, etc.) are depicted in the *orante* position—standing, with both arms raised; it is the gesture of thanksgiving for deliverance from death and sin.

Further evidence of the nonnaturalistic and nonhistoric nature of this art is the way earlier inscriptions and paintings were so often defaced, destroyed or even painted over in the course of later burials. Paintings in prehistoric caves were treated in the same way. This suggests that in both cases art functioned as the materialization of a wish or prayer, a kind of tangible speech, that, once having served its purpose, lost its value and could be discarded or removed by some later petitioner with perfect propriety. Significant in this connection is the practice of *memoriae damnatio* in the catacombs; that is, a "blotting out" of some unworthy person by destroying his written name, precisely in the same manner (it would seem) as the pharaohs "made" history and "killed" their enemies by altering and destroying references to them in the monumental art and inscriptions of ancient Egypt.

In both style and subject matter the Christian painters of the catacombs borrowed heavily from contemporary Roman practice and precedent. Their generally loose, sketchy technique obviously derives from the kind of impressionistic brushwork that may be seen developing in the frescoes of Pompeii; while for subjects such as the Good Shepherd or the Miracle of Loaves and Fishes (and many more) the painters obviously drew equally on Greco-Roman types, such as Aristaeus the shepherd-hero, or conventional formulas for funeral feasts. But their allegorical and symbolic intent quickly transformed these borrowed elements into a distinctly Christian vehicle of artistic expression—most notably by substituting for the classical humanistic unities of time and space compositions organized in terms of transcendental relationships. (*See* also EARLY CHRISTIAN ART.)

In addition to paintings, the catacombs are rich in early Christian inscriptions. The majority are short, Greek (significantly enough) rather than Latin, simple expressions of confidence in salvation: "Julia, in peace with the saints"; "in thy prayers pray for us, for we know that thou dwellest in Christ." Other inscriptions consist of graffiti scratched by pilgrims and visitors, as; *e.g.*, in the Triclia of the catacomb of S. Sebastian: "Paul and Peter, pray for Victor." Sometimes longer inscriptions honouring the martyrs were placed in the catacombs by later popes; most of these are known only from literary records, the originals having disappeared during the barbarian raids.

In the catacombs, too, many smaller objects left at graves have been found: plates, lamps, several sorts of vessels and, of greatest interest, the "gold glasses"—so called because of the gold leaf medallions sealed in their glass bottoms.

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CATALAN is a Romance language with nearly 6,000,000 speakers; it is spoken over an area of about 22,000 sq.mi., comprising Catalonia (approximately 3,400,000 speakers), an adjacent strip of Aragon with an average width of 15 mi. (100,000), Roussillon (260,000), Valencia (1,800,000) and the Balearic Islands (440,000). It was the official language in this area until 1716, and again in Catalonia from 1931 to 1939; it is still generally spoken in everyday life, in the cities as well as the countryside. More than one-tenth of the books published in Spain in 1927 were in Catalan; six Catalan daily newspapers were published in Barcelona in 1935.

Catalan is akin to Provençal and Spanish, but quite different from both, especially from Spanish. Catalan differs from Spanish in the following of its characteristics: a lack of rising diphthongs (*bé*, *bo* = Sp. *bien*, *bueno*); an abundance of falling diphthongs (*peu*, *pau*, *bou* = Sp. *pie*, *paz*, *buey*); the dropping of final vowels (*llop* = *lobo*; *dolç* = *dulce*); the palatal voiced sounds *j*, *z*, *tj*, *tz* and voiceless *x* (= *sh*); the infinitives and participles stressed on root syllables (*vendre*, *pres* = Sp. *vender*, *prendido*); and the periphrastic past (*vaig cantar* = Sp. *canté*). It is distinguished from Provençal in the following respects: *u* = Prov. *ü*, *o* = Prov. *au*; diphthongization differs (*mig* = Prov. *mieg*, *cull* = *cuelh*, *Déu* = *Dieu*, *creure* = *creire*); proparoxytone accentuation is preserved; and pronouns follow verb forms (*per donar-me* = *per me donà*).

Dialectal and chronological differences within Catalan are very small: a 13th-century text of Raimon Lull is still generally understandable by modern speakers. There are two main dialect groups: occidental, which is subdivided into West Catalan (Ebro and Segre valleys) and Valencian; and oriental, which is subdivided into East Catalan, Balearic and Roussillonnais and which also includes the speech of Alghero, Sardinia, where Catalan was brought in the 14th century. These varieties present only minor differences (some details in pronunciation, conjugation and vocabulary), noticeable solely in the spoken language.

Catalan is the autochthonous continuation of Latin in Roussillon and most of Catalonia. A study of place names indicates that there was no language shift in this area after the fall of the Roman empire. However, the old toponymy of the Ebro valley, the Balearics and Valencia shows a somewhat different phonological type, because Catalan was imported into these areas by reconquest, when the Moors were expelled in the 12th and 13th centuries. *See* also PROVENÇAL LANGUAGE; ROMANCE LANGUAGES.

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CATALANI, ALFREDO (1854–1893), Italian composer whose operas enjoyed a vogue in Italy in the late 19th century, was born June 19, 1854, at Lucca and studied in Paris under François Bazin and in Milan under A. Bazzini. Following the production of his oriental eclogue *La Falce* (1876) he wrote between 1880 and 1886 the operas *Elda*, *Dejanire* and *Edmea*. Often based on poor librettos, his operas are written in a highly romantic style. His most successful was *La Wally* (1892), revived in 1905 by A. Toscanini and filmed in 1932. He died at Milan on Aug. 7, 1893.

See C. Gatti, *Catalani: La vita e le opere* (1953).

CATALAUNIAN PLAINS, BATTLE OF THE, was fought in Gaul in A.D. 451 by Attila (*q.v.*) and the Huns against a mixed Roman and Visigothic force led by the Roman general Aetius and the Visigothic king Theodoric I. The exact site of the battle is disputed. The name Catalauni is first found in Roman authors of the 4th century and denotes the town of Châlons-sur-Marne. The term Campi Catalaunici, which is used by a 5th-century chronicler and by Jordanes (*q.v.*) in connection with the battle, meant, as Jordanes states, a wide area of the plains of Champagne. According to one interpretation, therefore, the great battle was fought in the vicinity of Châlons. But Jordanes adds that this same site was also known as the Mauriac plains, and three other writers of the 6th century state that the battle was fought at Maurica. This place is mentioned in no other connection, but one authority describes it as situated five Roman miles from Augustobona Tricassium (Troyes), and there is no reason for doubting his assertion. On this interpretation the battle was fought not in the vicinity of Châlons but in that of Troyes.

Forcing contingents of his Germanic subjects to follow him, Attila crossed the Rhine early in the campaigning season of 451 and made for Urbs Aurelianensis (Orléans). He had actually entered Orléans before the arrival of Aetius and Theodoric forced him to withdraw, and he fell back to Maurica. The battle, which may have taken place in June, resulted in defeat for Attila, and the ferocity with which it was fought was long remembered. King Theodoric was killed, and according to Jordanes at least 165,000 men fell on each side, but this is an unlikely figure. When Attila began to withdraw from Gaul, Aetius was unable or unwilling to prevent him.

It is unlikely that this was one of the decisive battles of the world as historians have claimed. The empire of the Huns was too predatory and too transient to have held the rich civilization of Gaul in permanent subjection. If Attila had defeated his opponents he would undoubtedly have destroyed many of the Gallic cities and would have plundered widely, but he could hardly have established a realm of pastoral nomads in Gaul nor could he have altered the Latin and urban character of the country.

See E. A. Thompson, *A History of Attila and the Huns* (1948). (E. A. T.)

CATALINA ISLAND: *see* SANTA CATALINA.

CATALOGUE, SALES. A sales catalogue is a systematic presentation of a supplier's merchandise that is distributed as a reference book among prospective purchasers. Its basic functions are to inform prospective buyers as to what products are available from this supplier, describe the qualities of these products and tell how much they cost.

The catalogue is particularly valuable in increasing the productivity of salesmen, for it frees salesmen from the need to devote time to routine aspects of selling and often reduces the frequency with which calls must be made. As labour costs have risen steadily in virtually all English-speaking countries, catalogues have become increasingly important as partial substitutes for the work of salesmen. Although far less expensive than sales man power, catalogues are the most expensive form of advertising used by some companies. Because they are expensive, large catalogues are normally issued only once or twice a year, and their distribution is carefully controlled to avoid sending duplicate copies or giving catalogues to persons who are not prospective purchasers.

The fact that many manufacturers or suppliers offer such a wide assortment of products has given rise to catalogue service firms that perform a kind of wholesaling function. Most industrial purchasers are interested in only one group of products on a manufacturer's list. The catalogue service firms collect data from a number of suppliers, sort these data into product groups for various categories of purchasers and distribute this information through individual specialized catalogues. In this way a manufacturer of widely assorted products need not distribute an expensive catalogue to buyers who may be interested in only one or two pages. Instead, the manufacturer merely submits the specifications of single products or groups of related products for inclusion in one of the specialized catalogues distributed by the catalogue service.

Catalogues are distributed to the general public by mail-order houses, trading-stamp companies, direct-selling firms and retail stores of many types, particularly department stores. These catalogues seek to stimulate sales through carefully chosen illustrations and descriptive text that provide all the important information on sizes, colours, fabrics and prices, and explain how to order the merchandise. Because a catalogue is a representative of the company within the customer's home, each company strives to make its catalogue dignified, precise, attractive and easy to use.

Catalogues issued by mail-order houses, direct-selling firms and trading-stamp companies include a high proportion of the items offered by the firm. Department stores, on the other hand, do not try to include all of the 100,000 to 200,000 items in any one catalogue. These stores often stress special promotions such as a Christmas gift catalogue or a spring fashion catalogue. To differentiate themselves from their numerous competitors, department stores and specialty shops present feature items in their catalogues in much the same way that feature items are displayed within the store. Samples of what can be found in the store are sufficient for this type of catalogue because, in addition to stimulating orders for the merchandise included in the catalogue, the store is primarily interested in persuading customers to come in and shop.

An important problem in catalogue preparation is the inclusion of prices, for it may be desirable to change them before the next catalogue is published. Because it is not feasible to issue a new catalogue to accommodate just a few price changes, some industrial and dealer catalogues omit prices entirely and furnish a separate up-to-date price list that may easily be changed. Other companies issue supplements to the original catalogues when price changes are necessary. Still other companies issue catalogues in loose-leaf binders so that pages may easily be added or replaced.

The choice of catalogue design and format depends largely on the nature of the items to be shown, the audience to be reached and the cost of the catalogue. In general, photographs are more effective than sketches, and photos in colour are preferred over those in black and white. Colour, typography, page layout and size of illustrations serve to emphasize each section of a catalogue while the arrangement of sections and the over-all printing of the catalogue can yield an impression of unity and quality to the catalogue itself and to the merchandise it contains.

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CATALOGUING, LIBRARY. Basic to the organization of any library is a list or catalogue of its items, arranged methodically, usually alphabetically by author, subject and title, providing a description of each item and identifying it from all others, usually by a notation consisting of a combination of numbers and letters. Of the various classification schemes, the Dewey Decimal system and the Library of Congress system are widely used. In the Dewey Decimal system, devised by Melvil Dewey (*q.v.*), books are classified by numbers ranging from 000, the general classification, to 900, history, with decimal subdivisions: 800, literature; 810, American literature; 820, English literature; etc. Many libraries add a code number for the author's name. The Library of Congress classification scheme was planned for highly specialized or very large collections; it is commonly used in such libraries and in those in some universities.

For a bibliography on cataloguing and classification *see* LIBRARY: *Bibliography: Library Organization*.

CATALONIA (Sp. CATALUÑA; Cat. CATALUNYA), a region of Spain comprising the four modern provinces of Barcelona, Gerona, Lérida and Tarragona (*qq.v.*), is the richest and most highly industrialized part of the country. Area 12,328 sq.mi. Pop. (1960) 3,925,779. Formerly a principality of the crown of Aragon, Catalonia has always played an important role in the history of the Iberian peninsula and since the 17th century has been the centre of a separatist movement often dominating Spanish affairs.

It occupies a triangular area in the northeastern corner of Spain, bordered by France and Andorra in the north, by Aragon in the west, by Valencia in the south and by the Mediterranean in the east. A mountainous zone, with more than one-third of its population concentrated in the city of Barcelona (*q.v.*), Catalonia is cut off orographically to the south and west; consequently for much of its history the region has exhibited closer ties with southern France than with the rest of Spain. Catalan (*q.v.*), the native language, is spoken also in Roussillon, north of the Pyrenees, and is quite different from Castilian Spanish.

Catalonia was one of the first Roman possessions in Spain, forming the northeastern portion of Hispania Tarraconensis. Occupied during the 5th century by the Goths, it was taken by the Moors in 712, but Charlemagne began the reconquest later in the 8th century, establishing the March of Gothia as a Frankish outpost. Gerona was taken in 785 and Barcelona, together with land reaching as far as the Llobregat river, in 801. This part of Catalonia was then incorporated into the kingdom of the west Franks, forming part of the Spanish march, and was ruled by successive counts (*see* BARCELONA, COUNTS OF) who continued the reconquest and quickly asserted their independence. Frankish suzerainty over Catalonia was soon only nominal and was completely rejected during the reign of Count Borrell (d. 991). From 1137, when Count Ramón Berenguer IV was betrothed to Petronila, queen of Aragon, Catalonia and Aragon were united under the same ruler (*see* ARAGON). In the 13th and 14th centuries Catalonia monopolized the trade of the western Mediterranean, and Catalan mercenaries, known as the Catalan Grand company, intervened decisively in Italy and Greece (*see* ALMOGÁVARES). Catalan interests, which differed widely from those of Aragon, dominated the union until 1410, when the male line of the counts of Barcelona became extinct. Dissatisfaction in Catalonia with the new Trastámara dynasty steadily increased after 1412 until, during the reign of John II, it developed into a full-scale, but unsuccessful, rebellion (1462–72).

During the 16th century, after the marriage of John II's son Ferdinand with Isabella of Castile had brought about the unification of Spain, Catalonia was relegated to a position of secondary importance in Spanish affairs. This was because, first, the Turks seriously interfered with trade in the western Mediterranean, on which Catalan prosperity depended; and second, because the exploitation of Spanish America was reserved for Castile. By the 17th century the conflict of interests between Catalonia and Castile combined with the decline of the Spanish monarchy's prestige to produce the first of those separatist movements by which the history of Catalonia has since been characterized.

The trouble was caused by an economic crisis during the reign of Philip IV. The king's first minister, the conde de Olivares, wished to resolve his master's financial difficulties by imposing on the whole of Spain a degree of fiscal and administrative unity incompatible with the maintenance of the *fueros* of the lands of the crown of Aragon. The Catalans were not only determined to resist such efforts of centralization, but regarded the shortage of money as due to waste caused by inefficiency at Madrid and rash expenditure on foreign wars. The deadlock reached between Olivares and the Catalan and Aragonese *Cortes* in 1626 was unresolved when, in 1635, war broke out between Spain and France. This aggravated the king's financial position and led to the billeting in Catalonia of "foreign" Castilian troops, whose behaviour initiated a secessionist revolt (June 1640). The rebellious Catalans placed themselves under the protection of the French king Louis XIII, and civil war ensued in which French money and armed support were mainly responsible for keeping the Catalan insurgents in the field, especially after 1641. The fighting did not end until 1659 when, by the treaty of the Pyrenees, Philip IV came to terms with the French; for much of this time Catalonia was more a province of France than of Spain.

In the War of the Grand Alliance, French armies again invaded

Catalonia (1689) at the start of a long but successful campaign terminating in the capture of Barcelona in 1697. The same year, however, the French withdrew under the terms of the peace of Rijswijk.

In 1705, again motivated largely by a desire to ensure preservation of its *fueros*, Catalonia, together with Aragon and Valencia, declared its support for the archduke Charles in the War of the Spanish Succession (*q.v.*). In 1714, however, Catalonia was completely subjugated by Philip V's forces and its constitution and privileges were abrogated. Catalonia subsequently lost nearly all its previous autonomy, but it gained by the encouragement given by the Bourbons to industrial development, while the termination of Castile's monopoly of the trade with Spanish America provided a fresh impulse for Catalan commerce and shipping.

Catalan separatism re-emerged in the 19th century in two forms: in rural areas in the support given to Carlism (*q.v.*) and in the towns in the demands of the manufacturers for high tariffs as protection against British and French competition. The Catalan national resurgence, however, really began with the literary *renaixensa* of the 1850s. This, at first, involved little more than holding competitions between Catalan poets and reviving medieval festivals like the Jocs Florals, but as the movement gathered strength, during the 1860s, more serious efforts were made to revive the use of Catalan (then only spoken in rural areas) as a living language, including the establishment of a Catalan newspaper and a theatre for Catalan plays. Politically, Catalan nationalism, which had been encouraged by the federal movement of 1868–73, became a serious force after 1876, when the defeat of the Carlists led the church to transfer its support to the new, rising movement for regional autonomy. It also then became a predominantly right-wing movement.

The loss of Cuba in 1898, a dramatic revelation of Spain's political and economic decline, served to revive in Catalonia feelings similar to those of 1640. The electoral victory won in 1901 by the new party, the Lliga Regionalista, showed that Catalan nationalism was politically a force of consequence, and the struggle for autonomy commenced in earnest. By 1913 a slight degree of home rule had been obtained under the *ley de mancomunidades*, but this measure was repealed ten years later by Primo de Rivera, who attacked all manifestations of Catalan separatism. Primo de Rivera's policy discredited the right-wing Lliga, attracted support for the nationalist movement from the hitherto uninterested lower middle classes and led to the formation of a left-wing coalition party, the Esquerra Republicana, led by Francesc Macià. The Esquerra won a sweeping victory in the municipal elections of April 1931, and two days later Macià proclaimed a Catalan republic. Thereafter a compromise was worked out with the central republic established at Madrid, and in Sept. 1932 the statute of autonomy for Catalonia was passed by the constituent *Cortes*. Catalonia played a prominent part in the history of the second republic in Spain and in the civil war of 1936–39 (*see* SPAIN: *History*). The nationalist victory in 1939 meant the loss of autonomy, and Gen. Francisco Franco's government adopted a repressive policy toward Catalan nationalism; conversely, Catalonia has been the most notable centre of opposition to Franco. (B. J. R.)

CATALPA, the common and generic name for 12 species of trees of the bignonia family (Bignoniaceae) native to eastern Asia, eastern North America and the West Indies. Catalpas have entire or shallowly lobed, opposite or whorled and usually long-stalked leaves. The showy flowers, borne in clusters terminating the branches, are white, yellow or purplish and more or less marked with yellow, purple or red. The fruit is a long, slender dry capsule containing numerous elongated, hairy or fringed seeds. The North American species are *C. speciosa,* the hardy catalpa, catawba tree or cigar tree, whose natural range is from southern Illinois and Indiana to Arkansas and Texas; and *C. bignonioides,* native from Georgia to Mississippi. Both are naturalized elsewhere in the United States. They and certain Asiatic species are grown as ornamental trees. Wood of the hardy catalpa, durable in contact with the soil, is used for posts and rails. (J. W. TT.)

CATALYSIS. Classically, the word catalysis means dissolution, destruction or ruin. J. J. Berzelius retained this meaning when, in 1836, he used the term to describe the chemical decomposition of a substance hastened by a second substance (a catalyst) that did not enter into the composition of the product formed. With use, the original meaning of catalysis was lost. The term was applied to synthesis (constructive) as well as decomposition (destructive) reactions that were accelerated by a substance (the catalyst) not permanently changed in the process. Since the catalyst is not permanently changed, it may be used over and over again. A small amount of catalyst can thus effect the conversion of a large amount of the substance being changed.

Catalysts may be gases, liquids and solids. They exert their catalytic effects on gases, liquids and solids to produce gases, liquids and solids. Although a few catalysts had been predicted for certain reactions, science in the early 1960s had not progressed to the point where it was possible to make general predictions concerning catalysts for desired reactions. Catalysts for one reaction are often worthless for other reactions. Thus, catalysis bears some of the aspects of an art rather than a science in spite of the many facts known about catalysts and catalytic reactions.

A catalyst can increase the rate of a reaction but it cannot change the position of the final equilibrium reached in a true equilibrium reaction. In a simple reaction such as

$$SO_2 + \frac{1}{2}O_2 \longrightarrow SO_3$$

the catalyst merely hastens the reaction toward equilibrium. Reactions involving organic compounds may be more complicated in that several reactions are possible. Some catalysts are selective in that they hasten only one of two or more possible reactions, leaving the others practically unaffected. For example, two common reactions of ethyl alcohol are:

$$C_2H_5OH \longrightarrow C_2H_4 + H_2O$$
$$C_2H_5OH \longrightarrow CH_3CHO + H_2$$

The first one is catalyzed by gamma alumina (a form of aluminum oxide), the second by copper, each to the practical exclusion of the other. In the absence of catalysts the two reactions occur simultaneously but only at a higher temperature than required for the catalytic reactions. It is the ability of catalysts to accelerate selectively one of several possible reactions that made catalysis so important in industrial organic chemistry.

Some of the most selective catalysts known, namely the enzymes, occur in nature. Each enzyme usually has a single function and will not act as a catalyst in any other way. In digestive processes, for example, a number of enzymes convert food molecules into smaller fragments that can be absorbed through the digestive wall.

It is entirely possible that some if not all of the vitamins and hormones are catalysts. They have the selective action that characterizes catalysts and, in most cases, a very small amount of substance can produce large effects.

PRACTICAL USES

Fixation of Nitrogen.—Catalysis is of great social as well as technical and scientific importance. The average man rarely comes directly in contact with industrial catalysts and, therefore, does not realize what they do for him and how they affect the course of his life or even his death. The part played by catalysts in the production of fixed nitrogen is a good example of such effects.

Fixed nitrogen is one of the essential ingredients of plant food and explosives. It is used in the form of ammonia or its derivatives, or as nitrates. Until about 1915, fixed nitrogen was obtained from Chilean saltpetre (sodium nitrate), from a few saltpetre (potassium nitrate) mines in the United States, Germany and elsewhere, from animal wastes and as a by-product of the coking of coal. At about that time, Fritz Haber and his co-workers produced synthetic ammonia by heating nitrogen and hydrogen under high pressure with a solid catalyst. Many different catalysts have since been used. The early ones were osmium and ruthenium. These were expensive, and so cheaper catalysts were sought and found. Commercial plants employing this process have been installed in every industrial nation in the world.

Another catalytic reaction serves to complement the above reaction. Fixed nitrogen is needed in the form of nitrates as well as in the form of ammonia. Platinum catalysts were developed that catalyze the reaction between ammonia and the oxygen of the air to form nitrogen dioxide, which with water produces nitric acid. The over-all result is a high yield of nitric acid from the catalytic oxidation of ammonia.

These two catalytic reactions have made every nation independent, or potentially independent, of Chilean nitrate or other natural nitrate deposits. The result has been a decline in the price of fixed nitrogen, an increase in consumption and healthier plants for the farmer with better and more economical food for the average man.

These two catalytic reactions also have their sinister aspects, for, until the advent of the atomic bomb, fixed nitrogen was the backbone of both explosives and propellents. Thus, much of the destruction of World War I and World War II can be associated with these catalytic reactions, for the wars would have been quite different if both sides had had to depend on Chilean nitrates for their explosives. (*See* NITRIC ACID AND NITRATES; NITROGEN, FIXATION OF.)

Motor Fuels.—Aside from its application in the fixation of nitrogen, catalysis has other important social implications. A large part, if not most, of the aviation gasoline used by all nations taking part in World War II was made with the aid of catalysts. In the United States, the catalysts were used primarily for the conversion of petroleum into hydrocarbons of good antiknock quality. (1) Petroleum oils were catalytically cracked by means of synthetic silica-alumina or acid-treated clay (montmorillonite) catalysts. This process produced the "base" for the aviation gasoline, and it was responsible for a major part of the aviation gasoline produced. (2) Branched-chain paraffin hydrocarbons were synthesized by the so-called alkylation process using sulfuric or hydrofluoric acid catalysts. Usually, isobutane and mixed butylenes were the raw materials for the process. These were produced by the catalytic as well as the thermal cracking of petroleum. The branched-chain paraffinic product was blended with the "base" from catalytic cracking. (3) Catalytic isomerization of paraffins was used to convert *n*-butane into isobutane and *n*-pentane into isopentane. Anhydrous aluminum chloride provided the essential catalytic material for all the commercial paraffin isomerization processes. (4) Isopropylbenzene was produced from benzene and propylene by means of phosphoric acid catalysts. The isopropylbenzene was added to the gasoline to give extra power under take-off or combat conditions where fuel economy was not a consideration. The British catalytically produced *tert*-butylbenzene from benzene and isobutylene and used it for similar purposes. (5) Propylene and butylene were catalytically polymerized with phosphoric and sulfuric acid catalysts. The product was a mixture of branched-chain octenes. These were catalytically hydrogenated with nickel or molybdenum catalysts to produce branched-chain octanes, which were used in the same way as alkylates, as described in (2) above. (6) Straight-run gasoline was converted to material suitable for use as aviation "base" by the hydroforming process. The major use of this process during World War II, however, was to produce synthetic toluene for manufacture of TNT. During the postwar period vastly superior processes of this general type came into wide use for manufacture of motor gasoline and of synthetic benzene, toluene and xylenes. (*See* also PETROLEUM: *Technology: Refining*.)

The Germans, the Japanese and, to a certain extent, the British used catalytic processes to produce aviation fuels from coal. Two major processes were used: (1) A part of the coal was converted by heat, steam and catalysts into hydrogen. The hydrogen was caused to react catalytically with more of the coal at high pressures to produce liquid hydrocarbons that were used directly or further processed. (2) By means of heat, steam and catalysts, the coal was converted into a mixture of carbon monoxide and hydrogen. These were used in the Fischer-Tropsch process, with catalysts containing nickel or cobalt, to produce synthetic hydrocarbons. Since these hydrocarbons were mostly of the straight-chain variety, they had poor antiknock properties and required further treatment to make good aviation fuel. These Fischer-Tropsch processes also produced diesel fuels of excellent quality as well as waxes and raw materials for synthetic fats and soaps. (*See* also HYDROGENATION; *Fischer-Tropsch Synthesis*.)

Other Commercial Applications.—Catalysts also are essential in the production of synthetic rubber. Most of the synthetic rubber produced in the United States has been made from butadiene and styrene, which are produced with catalysts.

Sulfuric acid, itself a catalyst for many reactions, is produced in huge quantities with the aid of vanadium oxide catalysts that enhance the oxidation of sulfur dioxide to sulfur trioxide.

Vanadium oxides, usually in combination with silver, are also used in the oxidation of naphthalene by air to phthalic anhydride. The consumer sees phthalic anhydride only after it has been transformed by the chemist into synthetic resins or into synthetic dyestuffs.

Methyl alcohol is produced from carbon monoxide and hydrogen. Zinc oxide-chromium oxide combinations are catalysts for this process. By the addition of potassium carbonate to the catalyst, *n*-propyl, isobutyl and higher alcohols are also produced. By means of a copper catalyst, methyl alcohol is converted into formaldehyde. Formaldehyde reaches the public as such or after it has been converted into synthetic resins, such as the phenol-formaldehyde and urea-formaldehyde plastics.

Even human food has felt the influence of catalysts. Many solid fats used for shortening or for making margarine have been produced by the catalytic hydrogenation of oils with nickel as the catalyst. The catalyst is removed completely before the product is marketed.

THEORY OF ACTION

Catalysis may be divided into two broad branches depending on relations between the catalyst and the materials involved in the catalytic reaction. The branches are homogeneous catalysis and heterogeneous catalysis. In homogeneous catalysis there are no phase boundaries between the substances taking part in the reaction and the catalyst. Thus all reactions that involve only gases and are catalyzed by a gaseous catalyst are homogeneous. The same is true for reactions involving mutually soluble liquids or dissolved solids when the catalyst is soluble in the mixture.

In heterogeneous catalysis there is a phase boundary between the catalyst and the substances reacting. The commonest heterogeneous reactions are those involving solid catalysts with liquid or gaseous reactants.

Homogeneous Catalysis.—Suppose that a chemical reaction is occurring in the gaseous state, uninfluenced by the walls of the vessel. Suppose that an observer could follow the movement of all the individual atoms. He would notice persistent groupings of atoms (molecules) that move at velocities of the order of 1,000 m.p.h., colliding frequently with other molecules and emerging from the collision substantially unchanged. He would also notice that there are occasional collisions from which new molecules emerge, and perhaps that molecules occasionally fall apart in the absence of collisions. These events are called elementary reactions. Types of elementary reactions include:

$$\mathrm{A} + \mathrm{B} \longrightarrow \mathrm{C} + \mathrm{D} \qquad \text{(I)}$$
$$\mathrm{A} + \mathrm{B} \longrightarrow \mathrm{A} + \mathrm{C} \qquad \text{(II)}$$
$$\mathrm{A} + \mathrm{B} \longrightarrow \mathrm{C} \qquad \text{(III)}$$
$$\mathrm{A} \longrightarrow \mathrm{B} + \mathrm{C} \qquad \text{(IV)}$$
$$\mathrm{A} + \mathrm{B} + \mathrm{C} \longrightarrow \mathrm{A} + \mathrm{D} \qquad \text{(V)}$$

It seemed reasonably certain in the early 1960s that reactions of all these types actually occurred. Depending upon the reaction under study, the observer might note the occurrence of only a single elementary reaction or of a number of different elementary reactions.

Such direct and detailed observations, of course, cannot be made. The objectives of reaction-rate theory, however, are to determine from the observable data what elementary reactions actually occur and what their rates are, and to interpret these rates in terms of interatomic forces and atomic dynamics.

Of the above elementary reactions, types II and V are inherently catalytic reactions, since A emerges unchanged. Type V corresponds to the combination of free atoms, or simple radicals such as $-OH$. In such cases, momentum and conservation of energy make it impossible for combination to occur without a third body to remove some of the energy. There is little specificity in the effectiveness of various third bodies, and type V is a trivial and uninteresting example of catalysis. Likewise in the case of type II, the examples known in the early 1960s were few and unimportant.

The noncatalytic reactions of types I, III and IV may combine in many ways to produce a total reaction that represents catalysis. A simple illustration utilizing type I reactions is

$$\begin{aligned} A + B &\longrightarrow C + D \\ C + E &\longrightarrow B + F \end{aligned}$$

giving as the ultimate result

$$A + E \longrightarrow D + F$$

catalyzed by B (or C). A specific example is

$$\begin{array}{c} O_3 + ClO_2 \longrightarrow ClO_3 + O_2 \\ \underline{ClO_3 + O_3 \longrightarrow ClO_2 + 2O_2} \\ 2O_3 \longrightarrow 3O_2 \end{array}$$

where the chlorine oxides are catalysts. In any complex mechanism of this character, it is more or less a matter of accident that the catalyst is regenerated. For this reason, there is little basis for distinguishing the theory of homogeneous gas phase catalysis from that of homogeneous gaseous reactions generally.

In solution, acids and bases are powerful catalysts for a wide variety of organic reactions. This special branch of the subject, in fact, has absorbed a predominant part of all modern scientific work on homogeneous catalysis. The original concept of acid and base catalysis was that the effective catalysts were the hydrogen and hydroxyl ions. There are a number of important reactions, such as the hydrolysis of esters and the inversion of sucrose, where the data available in the early 1960s were explicable on this basis. In general, however, it is necessary to invoke the modern definition of an acid as a substance tending to lose a proton and of a base as one tending to gain a proton, and to recognize that all acids and bases may act as catalysts.

The velocities of acid-base catalyzed reactions are strongly affected by the presence of neutral salts. It is customary to distinguish primary and secondary salt effects. The secondary salt effect occurs only in catalysis by weak electrolytes and is caused by increased dissociation of the weak electrolyte due to the presence of the neutral salt. This effect is purely thermodynamic in origin and for sufficiently dilute solutions may be quantitatively predicted by the Debye-Huckel theory. (*See* also QUANTUM MECHANICS: *Specific Heats.*)

The primary salt effect, on the other hand, occurs with all acid-base catalysts regardless of strength. It is specific to the reaction, the catalyst and the added salt. The primary salt effect is usually positive (increase in reaction rate due to salt) but for basic catalysts is sometimes negative. The explanation current in the early 1960s for the primary salt effect was based on J. N. Brönsted's equation

$$k = k_o \frac{f_A f_B}{f_X}$$

for the reaction rate constant k for the reaction

$$A + B \longrightarrow C + D$$

where f_A, f_B and f_X are the activity coefficients for A, B and X, the assumed "critical complex" or intermediate compound, and k_o is a constant. If this equation be granted, the calculation of primary salt effects then becomes a thermodynamic problem. Since definite information as to the critical complex, X, is limited to knowledge of its charge, this thermodynamic problem can be treated only approximately. The results, however, are consistent with experimental data on the primary salt effect.

The general picture of acid-base catalysis, from the standpoint of physical chemistry, is that the catalyst converts the reactant molecule to an ion by proton exchange and that the ion then reacts. The interest of the organic chemist in the same phenomenon is largely that of interpreting the nature of the subsequent reactions. It is impossible to discuss the details here but it may be mentioned that reactions subject to acid-base catalysis include esterification, bromination, isomerization, molecular rearrangements, dehydration, alkylation and polymerization.

Heterogeneous Catalysis.—The best established examples of heterogeneous catalysis involve solid catalysts and liquid or gaseous reactants. It is almost universally true that massive materials have little or no catalytic activity, and that active catalysts are highly porous and have total surface areas of 50–500 sq.m. per gram (5–50 ac. per pound).

Various theories have been proposed to explain the general nature of heterogeneous catalysis. In the early 1960s, however, there were few dissenters from the view that it involves a sequence of reactions in which the catalyst surface participates as an actual chemical reactant. The question of whether the entire surface participates, or only a relatively few "active centres" such as edge or corner atoms in crystals, was in dispute.

Study of the adsorption of gases on catalyst surfaces reveals two types of adsorption. The first type is called physical, or Van der Waals adsorption, since it is believed to be caused by intermolecular forces that do not disturb the existing valence bonds. The second type is called activated adsorption, or chemisorption, since it is believed to represent the creation of new valence bonds. With few exceptions, heterogeneous catalysis depends on activated adsorption.

The rate of every heterogeneous reaction, therefore, depends in principle upon rates of adsorption, reaction and deadsorption. By kinetic treatment of particular reaction mechanisms it is possible to reproduce the major features of experimental rate data, namely that the reaction order is usually low and that retardation not only by the products but by some of the reactants is frequent. The quantitative value of such kinetic treatments is impaired by the practical necessity of using oversimplified models.

Negative Catalysis.—This term has been applied frequently, and rather loosely, to factors that decrease the rate of reaction. On thermodynamic grounds a negative catalyst cannot produce an independently occurring reverse reaction. By definition, a negative catalyst cannot affect the reaction rate constant of any true elementary reaction. The only thing a negative catalyst can do, therefore, is to introduce additional elementary reactions, that may result in a lowered over-all reaction rate. This may be done either by stopping a reaction chain or by destroying a catalyst. The latter effect is usually referred to as poisoning. Poisoning may be either permanent or temporary. From a practical standpoint, poisoning is usually objectionable, although there are a few cases in which selective poisoning is put to practical use. Substances that retard reactions by breaking chains are frequently called inhibitors. They are of major importance in preventing deterioration of gasoline, lubricants, rubber, fats, oils and other important commercial products. *See* also ANTIOXIDANTS.

TECHNIQUE OF CATALYSIS

An outstanding feature of catalysis is that chemical composition alone does not provide an adequate description of a catalyst. It has been seen that a large surface area is generally essential. It is common practice to use an inert material of large surface area as a "support" or "carrier." The active catalyst may be deposited on the support by chemical means. Commonly used supports include activated carbon, diatomaceous earth, pumice, silica gel and alumina. The use of supports is advantageous in some cases because they reduce the cost of using an expensive catalyst material such as platinum or silver and in other cases increase the stability of the catalyst.

Whether supports are used or not, the details of catalyst preparation exert major effects on the properties of the finished catalyst. Some of these effects may be correlated with such properties as crystal structure, crystal size, surface area and residual impurities, but many of them are as yet unexplained.

In many cases a catalyst can be improved by the addition of small amounts of an additional component that is not a catalyst by itself. Such a substance is called a "promoter." Sometimes a second promoter will still further enhance catalytic activity. In other cases a mixture of two catalytic materials will be more active than either alone; this effect is called a "synergism." In still other cases a catalyst may be composed of two materials neither of which is active alone. Thus a catalyst composed of two materials may be a true two-component catalyst or a supported catalyst, or it may involve promotion of synergism.

It is possible to mention only a few of the heterogeneous catalysts that have proved useful. For hydrogenations, catalysts involving metallic nickel, iron, cobalt, platinum, palladium or copper; the oxides of copper, zinc or chromium; and the sulfides of molybdenum are common. For dehydrogenations the catalysts may involve: copper, platinum or palladium as metals; aluminum, magnesium, zinc, chromium and molybdenum as oxygen compounds; and nickel, molybdenum and tungsten as sulfur compounds. For oxidations the catalysts may involve: platinum and silver as metals; and vanadium, silver, copper and chromium as oxygen compounds. For dehydrations gamma alumina is by far the most largely used catalyst. Finally there is a group of apparently dissimilar "acid-acting" catalysts for Friedel-Crafts reactions (*q.v.*) and other reactions that involve carbonium ions. This group includes anhydrous aluminum chloride and bromide, boron fluoride, concentrated sulfuric and phosphoric acids, anhydrous hydrogen fluoride and the silica-alumina type of catalyst used for catalytic cracking.

All known heterogeneous catalysts deteriorate with use. A common and perhaps universal cause of deterioration is loss of surface area by recrystallization. In some cases there is also an actual change in crystal type, such as from gamma alumina to alpha alumina. In addition, most catalysts are subject to "poisoning." Poisons are classed as temporary and permanent. Temporary poisons are adsorbed relatively weakly at reaction conditions, and poisoning effects disappear quite rapidly when the poisons are no longer present in the material flowing to the catalyst. Permanent poisons are more strongly adsorbed, and their effects are not merely transient. Sulfur is a particularly common permanent poison for many metallic catalysts. An important "permanent" poison in some hydrocarbon reactions is a carbonaceous material of high molecular weight and of relatively low hydrogen content that is formed as a minor reaction product. This material is produced in many high-temperature reactions, such as catalytic cracking and dehydrogenation. It is common industrial practice to "regenerate" the catalyst periodically by burning this "coke" under suitably controlled conditions. *See* also Index references under "Catalysis" in the Index volume. (C. L. T.; L. S. Kl.)

CATAMARCA, a northwestern province of Argentina, is separated from Chile by the cordillera of the Andes. Area 38,540 sq.mi. Pop. (1960) 172,407. The province, in general, is mountainous, with many high peaks always covered with snow. Between the mountain ranges are tablelands and valleys, some of which are fertile oases while others are completely arid. The sandy desert on the western side of the Sierra de Aconquija is known as the Argentine Sahara. The climate varies with altitude, but is for the most part warm and dry, with greater rainfall in the east than in the west.

The first settlement in Catamarca was founded by Spaniards in the early colonial period, the region being then under the jurisdiction of the viceroy at Lima. In 1943, when the Argentine government abolished and divided up the northern territory of Los Andes, the department of Antofagasta de la Sierra was incorporated in Catamarca. For many years after the liberation from Spain the *caudillos* of the Catamarca region and their gaucho followers resisted the rule of the distant Buenos Aires government, and the wealthy landowners continued to have an independent spirit. In 1946 Pres. Juan Perón, to suppress local criticism of his regime, used his constitutional prerogative of "intervention" to depose the governor of the province and install a nominee of his own.

Scarcity of water has retarded the development of agriculture and cattle raising, and irrigation provides only a partial remedy. The largest crop is alfalfa for cattle fodder, and there are irrigated vineyards and olive groves. Two of the chief minerals exploited are wolfram and mica. Catamarca is famous for its woolen ponchos and cloth, woven mainly by women. The provincial capital and chief city, Catamarca, is connected by railway with the capital of the republic, Buenos Aires, 895 mi. distant. (Ge. P.)

CATAMARCA (San Fernando de Catamarca), capital of the northwestern Argentine province of the same name. It lies on the Río del Valle de Catamarca, a river situated between the two south-pointing Andean spurs of the sierras of Ambato and Ancasti. The city is 230 mi. N.N.W. of Córdoba and 115 mi. S. of Tucumán. Pop. (1956 est.) 36,916. The sheltered valley, an oasis of fertility in a dry region, is partially wooded and produces fruit in abundance. Other agricultural products are wine, alfalfa, cotton and some cereals. The industries include flour mills, tanneries, woodworking plants, meat-packing and other food-processing factories. A special product is the hand-woven poncho, or woolen cloak, for which the city has long been famous. Mica is mined nearby. Catamarca is a noted tourist centre because its winter climate is genial, the scenery is outstanding and there are hot springs in the nearby sierras. Road communications are more plentiful than rail links and there are air services to Rosario and Tucumán.

Catamarca was founded by Fernando de Mendoza in 1683; and it has many colonial buildings, an art gallery and a museum. The church of the Virgin of the Valley is a centre of pilgrimage. The attractive alameda (public park) has a central lake surrounded by paths and shrubberies. The city's administrative influence over the distinctive valley region has preserved local traditions and a strong community spirit. (G. J. B.)

CATANDUANES, an island province of the Republic of the Philippines, lies across Maqueda channel, off southeastern Luzon. It has an area of 552 sq.mi. and a population (1960) of 156,640. The island was separated from Albay province in 1945. It is a hilly to rolling island on which general farming is carried on, with coconut, rice, abacá (Manila hemp) and yams the chief crops. The first three are also the main exports. The capital and chief port is Virac, on the south coast. Pop. (1960) 34,435. (J. E. Sr.)

CATANIA, a city of Sicily, capital of Catania province, is situated on the Ionian seacoast in the broad plain of Catania, 27 km. (nearly 17 mi.) from Mt. Etna. It is 43 ft. above sea level. Pop. (1957 est.) 344,786 (commune). Catania is the seat of an archbishopric. Standing almost entirely on the lava left by various eruptions, the city slopes slightly downward from north to south. The climate is mild and pleasant.

Almost completely destroyed by an earthquake on Jan. 11, 1693, Catania was reconstructed according to a plan framed by the duke of Camastra. As a result, the centre of the city has a distinctly 18th-century appearance, with broad, straight streets flanked by churches and palaces. Modern Catania is, however, an industrial city and transportation centre. It is the terminus of the railway for Palermo, Messina and Syracuse; and the port, founded by the Bourbon government, is one of the most important in Italy. There are air services from Fontanarossa airport, 3 mi. S. of Catania. Industries include a variety of mechanical and chemical manufactures, food processing and fishing. Half of Sicily's refined sulfur comes from the factories of Catania. In addition, it is the marketing centre for the surrounding agricultural region and exports especially almonds and oranges.

Catania's cultural history might be said to begin with the tradition that the 6th-century Greek lyric poet Stesichorus of Himera was buried there. The University of Catania was founded in 1434 by Alfonso of Aragon, and its library (1755) possesses a number of important manuscripts dating from as early as the 14th and 15th centuries. The university buildings house the Accademia Gioenia (founded 1824) and the Società di Storia Patria per la Sicilia orientale (1904). The municipal library contains a 14th-century illuminated Bible attributed to the school of Pietro Cavallini and a considerable number of autographs, manuscripts and parchments.

Vincenzo Bellini, composer of the opera *Norma,* was born in Catania in 1801. His birthplace, preserved as a museum, contains his death mask, a harpsichord which he used and other memorabilia.

Forty years after his death in 1835, his remains were returned to Catania from Paris and interred in the cathedral. Other famous sons of the city were the poet Mario Rapisardi (1844–1912) and Giovanni Verga (1840–1922), founder of the literary school of *verismo*, who used his native Sicily as the background for many of his novels.

Buildings and Monuments.—The principal thoroughfare, beyond which appears smoking Mt. Etna, is the Via Stesicoro Etnea, named for the poet. Near the Piazza Stesicoro are the imposing ruins of a 2nd-century B.C. Roman amphitheatre. Elliptic in form, it originally measured 410 ft. by 345 ft., exceeded 98 ft. in height and seated 16,000 spectators. During the invasion of Theodoric, part of the material was used to rebuild the city walls. The remains of a Roman basilica are in the Piazza Mazzini. In the nearby Via del Teatro Greco stands the Greek theatre with a Roman superstructure. Attached to it is the Odeon, a smaller, semicircular building where rehearsals and contests were held. There are also remains of Roman baths and aqueducts.

The Castello Ursino with its four angular towers, constructed in the 13th century for Frederick II by Riccardo da Lentini, served as a model of military architecture for several centuries. After being used for some time as a barracks, it was made into a museum. The collection includes numerous classical sculptures, some of great artistic value. There are also a number of medieval and Renaissance sculptures, collections of small Greek, Etruscan and Roman bronzes, Sicilian, Attic and Apulian vases and oriental antiquities and paintings, many by Sicilians.

The centre of modern civic life is the well-proportioned Piazza del Duomo, surrounded by 18th-century palaces and opening onto wide streets. Of the ancient fabric of the cathedral, founded by Roger I in 1090, there remain three apses of dark lava and part of the transept. After the 1693 earthquake the Norman building was reconstructed by the architects Fra Fiolamo Palazzotto and Giovanni Battista Vaccarini (1702–68), the latter of whom was responsible for the façade. In the chapel of Sta. Agata are kept a silver bust of the saint by Giovanni Bartolo of Siena and a reliquary, both 14th century, containing various relics exhibited on the saint's festival. Bellini's tomb is the work of the Florentine G. B. Tassere. Close by the cathedral is the 17th-century baroque church of the monastery of Sta. Agata, circular in form with a cupola supported on a polygonal drum. In the centre of the square stands the elephant fountain, erected in 1736 by Vaccarini. The dark lava elephant, surmounted by an Egyptian obelisk, is ancient, dating perhaps from Roman times. Also in the Piazza del Duomo is the town hall, another work by Vaccarini.

The 17th-century church of S. Nicolò, the largest in Sicily, offers a magnificent view from the drum of the cupola, 210 ft. above ground level. Connected with the church is a Benedictine monastery begun in the 14th century and completed three centuries later. It is said to be one of the largest in the world. Its ornamentation, although executed after the earthquake, retains the exuberance of 17th-century taste. The church of S. Carcere (18th century) has a 13th-century portal that once belonged to the cathedral. The 18th-century Porta Garibaldi achieves a striking effect as a result of the decorative contrast between its dark lava and white limestone.

History.—Catania (Lat. *Catana* or *Catina*) was founded in the second half of the 8th century B.C. when the Chalcidians of Naxos settled a colony at the foot of Mt. Etna. The city acquired importance with Hiero I, tyrant of Syracuse, and his son Deinomenes, who called it Aetna after the volcano. Following the extinction of Deinomenes' people, the ancient inhabitants restored the old name.

Catana was made a Roman colony by Octavian. The Christians there suffered under the persecutions of Decius and Diocletian and the Catanian martyrs included St. Agatha, patron saint of the city. (*See* AGATHA, SAINT.) After the barbarian invasions, Catania fell successively to the Byzantines, the Arabs and the Normans. The city was hostile to the Swabians and was ravaged by Henry VI and by Frederick II. The Aragonese sovereigns resided there. (*See* also SICILY; NAPLES, KINGDOM OF.)

During the 16th and 17th centuries the city was afflicted by civil disorders, incursions of pirates, epidemics, famines and natural disasters, including an eruption of Etna in 1669 and the earthquake of 1693. Later it became subject to the Bourbon kingdom of Naples. Civil disturbances occurring during an outbreak of cholera in 1837 were vigorously suppressed and when, in 1848, Catania joined the other cities of the island in claiming autonomy for Sicily, this movement was also put down by force.

During World War II, after the Anglo-U.S. army had landed in Sicily on July 9, 1943, the Germans defended Catania for several weeks in an attempt to extract themselves from an encircling movement, finally evacuating it on Aug. 5. (M. T. A. N.)

CATANZARO, a town and episcopal see of the Calabria region, Italy, capital of the province of Catanzaro, is located 51.5 km. (32 mi.) S.E. of Cosenza. It stands 1,125 ft. above sea level. Pop. (1957 est.) 69,179 (commune).

In the baroque church of S. Domenico is a Madonna del Rosonio (17th-century Neapolitan school) and the provincial museum contains a Madonna and Child, signed Antonello de Saliba (1508). From a public park, the Villa Margherita, there is a magnificent view as far as the sea. A funicular railway, descending through a tunnel, carries passengers from Catanzaro to the railway station at Catanzaro Sala, on a branch line connecting the two main lines along the east and west coasts of Calabria. Silk weaving gained the town an international reputation during the 17th and 18th centuries.

Founded about the 10th century as Catasonion, a Byzantine town, it was taken in 1059 by Robert Guiscard. Invading peoples from the Saracens to the Swiss, Normans and Angevins recognized its strategic and military importance. In 1528 it resisted a four-month siege by the French and was named *magnifica e fidelissima* by Charles V. It also played an important part during the Napoleonic Wars and the Risorgimento. The town was bombed by the Allies in World War II.

CATAPULT: *see* ENGINES OF WAR.

CATARACT, in medicine, any cloudiness (opacification) of the crystalline lens or the lens capsule of the human eye. *See* EYE, HUMAN: *Diseases of the Crystalline Lens.*

CATARGIU, LASCAR (1823–1899), Rumanian statesman, one of his country's foremost Conservative leaders in the early years of its independence, was born on Nov. 13, 1823 (new style; Nov. 1, old style). He belonged to an ancient Walachian family, one of whose members had been banished in the 17th century and had settled in Moldavia. Under Prince Grigore Ghica (1849–56) Catargiu rose to be prefect of police at Iasi (Jassy). In 1858 he became a member of the *divan ad hoc* of Moldavia, a commission elected in accordance with the treaty of Paris (1856) to vote on the proposed union of Moldavia and Walachia. His strongly conservative views, especially on agrarian reform, induced the Conservatives to support him as a candidate for the throne in 1859. During the reign of Prince Alexandru Cuza (1859–66) Catargiu was one of the opposition leaders plotting to overthrow him and to secure a prince from western Europe instead. After Cuza's deposition he was one of the three regents before Prince Charles of Hohenzollern arrived to become prince of Rumania as Carol I. On Carol's accession (May 1866) Catargiu became president of the council, but he disagreed with his Liberal colleagues I. C. Bratianu and C. A. Rosetti and resigned in July. After eight more ministerial changes, culminating in the antidynastic agitation of 1870–71, Catargiu formed a stable Conservative cabinet, which lasted until 1876. He and his cabinet were subsequently threatened with impeachment for alleged electoral and financial corruption, but the proposal was withdrawn in 1878 and he remained in opposition until 1889, when he formed a short-lived cabinet in which he was also minister of the interior. Minister of the interior again in Ion Florescu's cabinet of March 1891 he again became president of the council in Dec. 1891 and retained this office until 1895. He died at Bucharest on April 11, 1899. (B. BR.)

CATARRHINA, the term used (in contradistinction to Platyrrhina; *q.v.*) to indicate the old world monkeys and apes. It refers to a distinguishing feature of these primates (*q.v.*): the nostrils (the intervening septum being narrow) are closely applied and pointed downward.

CATAWBA, the principal tribe of the eastern division of the

Siouan stock of American Indians. The name is probably derived from the Choctaw *katápa*, meaning "divided" or "separated."

Formerly the dominant people of South Carolina, the Catawba also had divisions extending into North Carolina. In the 17th century the population was about 5,000, but by 1780 it had declined to about 500. In 1950 an estimated 374 Catawba were living on a small reservation in South Carolina.

The Catawba, who were at war with the Iroquois for a long time, furnished a valuable contingent to the South Carolina troops during the American Revolution. They retreated to Virginia upon the advance of British troops in 1780, but they later returned and occupied small towns on the Catawba river. They afterward leased their land and about 1841 sold all of it except one square mile to the state. At that time a number of them went to the territory of the Cherokee in western North Carolina, but they did not remain long with their former enemies and soon returned to South Carolina. A vocabulary of about 300 words, collected by Oscar M. Lieber, the geologist, in 1856, was published in *Collections of the South Carolina Historical Society*, vol. ii (1858).

See James Mooney, "Catawba," in *Handbook of American Indians North of Mexico*, ed. by F. W. Hodge, Bureau of American Ethnology Bulletin 30, part 1 (1912); J. R. Swanton, "Early History of the Eastern Siouan Tribes," in *Essays in Anthropology Presented to A. L. Kroeber* (1936).

CATAWBA, a richly flavoured, large, red grape whose juice varies in colour from amber to pink with different extraction processes. A variety of *Vitis labrusca*, a North American and Asiatic species, it was grown in 1807 in Washington, D.C., and was named after the Catawba river in the nearby Carolinas about 1823. Its cultivation spread rapidly to Ohio, Ontario and the Finger lake section of New York. The vine is disease resistant, prolific and very late ripening, but a heavy yielder. The fruit, medium sweet and highly acid, is readily preserved and resistant to spoilage. Dry Catawba wine is used as a champagne base, and sweetened Catawba still wines are marketed under the varietal name. Much commercially bottled white grape juice is largely Catawba. (R. G. No.)

CATBIRD (*Dumetella carolinensis*), a North American bird of the thrasher family (Mimidae), about nine inches long, breeding from Nova Scotia to southeastern Texas. Its plumage is slate gray, with a black cap and tail and chestnut under tail coverts. It is noted for its distinctive song, which, although having much of the charm of its close relative the mockingbird, is interspersed with petulant mewing protests, hence its common name. The catbird winters in the southern states, in Cuba and from Mexico to Panamá. It is resident in Bermuda. In Australia the name catbird is given to any one of several bowerbirds (*q.v.*) which voice catlike mewings, especially to *Ailuroedus crassirostris*, which builds no bower.

ALLAN D. CRUICKSHANK FROM NATIONAL AUDUBON SOCIETY

CATBIRD (DUMETELLA CAROLINENSIS)

CATBOAT, a small sailing boat having the mast located far forward and carrying only a single fore-and-aft sail, which may be either a Bermuda (three-sided) or a gaff (four-sided) rig. Lateral stability is generally provided by a centreboard, a dagger board or leeboards. Hull construction can be of planked wood, sheet plywood, molded plywood, molded reinforced plastic or aluminum. Many small dinghies used as yacht tenders, racing craft or beginner's boats are catboats. *See* also BOAT. (J. E. CE.)

CATCH, a specifically English name for rounds or perpetual canons designed to be sung by three or more voices. It may possibly derive from the 14th-century Italian *caccia* (*q.v.*), likewise a canonic form, but is in any case appropriate in that each singer has to take up or "catch" the tune in turn. Literary evidence shows that catch-singing was popular in the 16th century, but the first published collection, Thomas Ravenscroft's *Pammelia*, dates from 1609. Its success encouraged him to bring out two further publications, also containing some catches: *Deuteromelia* (1609) and *Melismata* (1611). John Hilton's *Catch That Catch Can* (1652) is probably the most famous of catch collections, but the zenith of the catch came with the Restoration, when the finest composers vied with one another in lavishing ingenuity and indecency on this originally humble form; Purcell ranks supreme on the first account and very high on the second. During the 18th century, when the Noblemen and Gentlemen's Catch club was founded (1761), catches became textually more polite and musically more insipid, although they retained their popularity among convivial musicians. Many of the best examples, however, remain in manuscript for obvious reasons. (J. J. N.)

CATCH CROP, a rapidly growing crop that occupies the soil for short periods to absorb, or "catch," nitrates that might otherwise be carried away in drainage waters. Such crops are usually grown between the times of two principal crops or between the rows of another crop. Rye, oats and vetch are frequently used, but other crops and plants, including weeds, may serve. When the immature plants are plowed under, the nitrogen absorbed is returned to the soil where it can again be used to nourish other plants. Many gardeners and farmers have found that they can improve their production efficiency by giving attention to the use of catch crops in their cropping systems.

In practice, however, the term catch crop is often used with other meanings. It can refer to quickly maturing crops grown between two principal crops for the purpose of keeping the land completely utilized. Defined in this way, catch crops may occupy idle land for longer periods of time and include more species of plants than under the more restricted definition given above. The crops serving as catch crops will be useful not only for conserving nitrates but also for soil protection, soil enrichment and as additional sources of feed for livestock.

Special crops planted between two principal crops for the purpose of protecting the soil against water and wind erosion are frequently called cover crops. They may also function as catch crops and as sources of organic matter for soil enrichment.

Crops planted between two principal crops chiefly for the purpose of soil enrichment are more accurately described as green manure crops. Legumes, because of their ability to obtain nitrogen from the atmosphere, are used more frequently for this purpose than nonlegume crops. In the North American corn belt, for instance, biennial sweet clover, a deep rooted legume, is widely used as a green manure crop. It is seeded in early spring in either fall- or spring-seeded grains and plowed under the following spring for corn. If conditions are favourable, as much as 100 lb. or more of atmospheric nitrogen and several tons of organic matter rich in nutrient minerals may be added to an acre of land. In addition to these benefits, the sweet clover or other green manure crops may also serve as catch and cover crops.

In view of the overlapping functions of catch, cover and green manure crops, it is difficult to use these classifications accurately. Some call all special crops planted between two principal crops catch crops, while others use the designations that best express the major purposes for which the crops are grown. (F. C. BR.)

CATCHMENT AREA, all the area from which precipitation would flow to a stream. *See* WATERSHED.

CATECHISM, a manual of instruction, usually of religious instruction, arranged in the form of questions and answers. Such questions and answers about the rudiments of faith belong to the oral tradition of many religions, but the catechism is a product of Jewish and especially of Christian history. Its primary purpose is indoctrination in faith and morals, but it serves also as a public confession of the faith of the church.

Although the origins of the Christian catechism are medieval, it was in the 16th century that the catechism established itself as a genre of Christian pedagogical literature. Following examples from St. Augustine and other Church Fathers, the medieval catechisms concentrated upon the meaning of faith (the Creed), hope (the Lord's Prayer) and charity (the Ten Commandments). The invention of printing and the religious conflicts of the Reformation combined to make the catechism an essential part of education both in the churches of the Reformation and in Roman Catholicism. It was used to instruct the young, to win converts and to testify to the faith.

Lutheran.—In 1520 Martin Luther had brought out a primer of religion containing brief expositions of the three chief parts contained in the earlier catechisms, and other leaders of the Reformation published similar attempts. All these efforts were superseded in 1529 with the publication of Luther's Small Catechism, perhaps the most influential book produced by any Reformer. Adding discussions of baptism and the Eucharist to the usual three parts, Luther's Small Catechism has been the basic textbook of religious instruction in Lutheranism ever since. Luther's Large Catechism of 1529 was intended for use by the clergy both in preparation of their sermons and in religious instruction. The two catechisms of Luther were incorporated into the *Book of Concord* of 1580 and thus became parts of the public confession of the Lutheran Church (*see* CONCORD, BOOK OF). These works did much to mold the character of the German people and powerfully influenced other compilations in various communions. (*See* also CONFESSIONS OF FAITH, PROTESTANT: *Lutheran Churches.*)

Reformed.—In 1537 John Calvin at Geneva published his catechism for children, the *Instruction and Confession of Faith for the Use of the Church of Geneva,* which explained the Decalogue, the Apostles' Creed, the Lord's Prayer and the sacraments. It was the work of a man who knew little of the child mind, and, though it served as an admirable and lucid epitome of his famous *Institutes,* it was too long and too detailed for use in instructing children. Calvin came to see this, and in 1542 he drafted a new catechism that was much more suitable for teaching purposes. This was used in Geneva and in Scotland. The Reformed churches of the Palatinate, on the other hand, used the Heidelberg Catechism (1563), mainly the work of two of Calvin's disciples, Caspar Olevianus and Zacharias Ursinus. This work, perhaps the most widely accepted symbol of the Calvinist faith, is noteworthy for its emphasis on the less controversial aspects of the Genevan theology. As revised by the synod of Dort in 1619, it became the standard of most of the Reformed churches of central Europe, and in time of the Dutch and German Reformed churches of America. (*See* also HEIDELBERG CATECHISM.)

Presbyterian.—Since 1648 the standard Presbyterian catechisms have been those compiled by the Westminster assembly, presented to parliament in 1647, and then authorized by the general assembly of the Church of Scotland (July 1648) and by the Scottish parliament (Jan. 1649). The Larger Catechism, "for such as have made some proficiency in the knowledge of the Christian religion," is too detailed and minute for memorizing, and has never received anything like the reception accorded to the Shorter Catechism, which is "for such as are of weaker capacity." The work was done by a committee presided over first by Herbert Palmer, master of Queens', Cambridge, and then by Anthony Tuckney, master of Emmanuel. The Shorter Catechism, after a brief introduction on the end, rule and essence of religion, is divided into two parts: (1) the doctrines we are to believe (a) concerning the nature of God, (b) concerning the decrees of God and their execution; (2) the duties we are to perform (a) in regard to the moral law, (b) in regard to the gospel—inward duties (*i.e.,* faith and repentance) and outward duties as to the Word, the sacraments and prayer. It has 107 questions and answers, while the catechism of the Anglican Church has only 24, grouping as it does the Ten Commandments and also the petitions of the Lord's Prayer instead of dealing with them singly.

Roman Catholic.—The Roman Catholic Church had long been using catechisms, and these were multiplied with new emphasis as the church entered the Counter-Reformation. The most famous was that of the Jesuit Peter Canisius, first published in 1555, which went through 400 editions within 150 years. Another catechism that had a large circulation and greatly influenced later works was that of Robert Bellarmine (1597); in France those of Edmond Auger (1563) and J. B. Bossuet (1687) were outstanding. The *Catechism of the Council of Trent,* completed in 1566, was never intended as an ordinary catechism, being written for and addressed to parish priests to serve as model and guide in their instructions and sermons to the people. The Catholic Church, because its unity of doctrine is otherwise so safeguarded, has never adopted any one official catechism for all its members. Each bishop is free to adapt his method of instruction to local conditions. Many bishops, however, have desired a universal catechism; at the Vatican council (1869–70) the project was seriously discussed, with Bellarmine's catechism proposed as model. In more recent times well-known catechisms have been the *Baltimore Catechism* (1885) in the United States, the *Catechism of Christian Doctrine* ("Penny Catechism") in England (1898) and that of Joseph Deharbe (1847) in Germany. In the 20th century, pedagogical-catechetical congresses and periodicals stimulated new methods, which in turn produced new catechisms and aids.

Orthodox.—Peter Mogila composed the *Orthodox Confession of the Catholic and Apostolic Eastern Church,* a counteraction to the activities of the Jesuits and the Reformed Church that was approved at a provincial synod in 1640 and standardized by the synod of Jerusalem in 1672. Because of the conflict that called it forth, the *Confession* of Mogila is not only a manual of instruction but also a declaration of the unique emphases and doctrines of Eastern Orthodoxy against both Roman Catholicism and Protestantism. By order of the tsar Peter the Great a smaller catechism was drawn up in 1723. The catechisms of Levshin Platon (1762) and Philaret (1839), each in his day metropolitan of Moscow, are bulky compilations that cannot be memorized, though there is a short introductory catechism prefaced to Philaret's volume.

Anglican.—The catechism of the Church of England is included in the Book of Common Prayer. It has two parts: (1) the baptismal covenant, the Apostles' Creed, the Decalogue and the Lord's Prayer drawn up probably by Thomas Cranmer and Nicholas Ridley in the time of Edward VI, and variously modified between then (1549) and 1661; (2) the meaning of the two sacraments, written in 1604, on the suggestion of the Puritan faction at the Hampton Court conference, by John Overall, then dean of St. Paul's, and (probably) Alexander Nowell. This supplement to what had become known as the Shorter Catechism established its use as against the longer one, *King Edward VIth's Catechisme,* which had been drawn up in 1553 by John Ponet, bishop of Winchester, and enlarged in 1570 by Nowell, Overall's predecessor as dean of St. Paul's. By the rubric of the Prayer Book and by the 59th canon of 1603, the clergy are enjoined to teach the catechism in church on Sundays and holidays after the second lesson at evening prayer. This custom, long fallen into disuse, was revived during the 20th century, children going to church for a special afternoon service of which catechizing was the chief feature. Compared with the thoroughness of most other catechisms this one seems scanty, but it has a better chance of being memorized and its very simplicity has given it a firm hold on the inner life and conscience of devout members of the Anglican communion throughout the world.

Other.—Almost every Christian denomination has its catechism or catechisms. In 1898 the National Council of the Evangelical Free Churches in England and Wales published an *Evangelical Free Church Catechism,* representing directly or indirectly the beliefs of 60,000,000 or 70,000,000 avowed Christians in all parts of the world, a striking example of interdenominational unity. *The School Catechism* was issued in 1907 by a conference of members of the Reformed churches in Scotland, which met on the invitation of the Church of Scotland. In its compilation representatives of the Episcopal Church in Scotland co-operated, and the book, though "not designed to supersede the distinctive catechisms officially recognized by the several churches for the instruction of their own children," certainly "commends itself as suitable for use in schools where children of various churches are taught together."

The rise of the Sunday school movement in American Protestantism during the 19th century transformed the educational needs of the United States churches. Theoretically, the Sunday schools were to use the Bible as their textbook, but the "helps" compiled for both the teacher and the pupil soon supplanted the catechism as the commonest guide for instruction in Christianity. In the preparation of children for confirmation, however, the catechism remained important even for those denominations that did not employ it in the Sunday school. Objections to education by rote, which were prominent in the educational philosophy of the 20th century, appeared in the educational thought of the churches too and served to relegate the catechism to a secondary position. By the middle of the 20th century the theological changes in American Protestanism associated with the movement sometimes called Neo-Orthodoxy or Dialectical Theology were helping to restore to the catechisms of the Reformation some of their lost prestige.

BIBLIOGRAPHY.—J. M. Reu, *Dr. Martin Luther's Small Catechism: a History of Its Origin, Its Distribution and Its Use* (1929), treats not only Luther's work but many others as well; *Où en est l'enseignement religieux?* (1937) is a detailed discussion of Roman Catholic catechisms from many lands. (A. J. G.; J. J. PN.)

CATECHU (CUTCH or CASHOO), an extract obtained from several plants (the derivation is from the Malay *Kachu*), its chief sources being the wood of two species of acacia, *A. catechu* and *A. suma*, both natives of India. This extract is known as black catechu. A similar extract, known in pharmacy as pale catechu (*catechu pallidum*) and in general commerce as gambir or terra japonica, is produced from the leaves of *Uncaria gambir* and *U. acida*, cinchonaceous plants growing in the Indonesian archipelago. A third product to which the name catechu is applied is obtained from the fruits of the areca or betal palm, *Areca catechu*.

Ordinary black catechu usually is imported in three different forms. The first and best quality, known as Pegu catechu, is obtained in blocks externally covered with large leaves; the second and less pure variety is in masses, which have been molded in sand; and the third consists of large cubes packed in coarse bags.

The wood of the two species of *Acacia* yielding catechu is taken for manufacture when the trees have attained a diameter of about one foot. The bark is stripped off and used for tanning, and the trunk is split up into small fragments that are covered with water and boiled. When the extract begins to thicken, it is decanted into iron pots and boiled down. When it has attained a thick sirupy consistency, it is poured into molds or on mats and allowed to harden by exposure to air and sun.

Catechu so prepared is a dark brown or, in mass, almost black substance, brittle and having generally a shining lustre. It is astringent, with a sweetish taste. In cold water it disintegrates, and in boiling water, alcohol, acetic acid and strong caustic alkali it is completely dissolved. Chemically it consists of a mixture of a peculiar variety of tannin termed catechutannic acid with catechin or catechuic acid, and a brown substance due to the alteration of both these principles.

Gambir, which is similar in chemical composition to ordinary catechu, occurs in commerce in the form of cubes of about an inch in size with a pale brown or yellow colour and an even, earthy fracture. For the preparation of this extract the plants above mentioned are stripped of their leaves and young twigs, and these are boiled down in shallow pans. The juice is strained off, evaporated and, when sufficiently concentrated, cast into shallow boxes, where as it hardens and dries it is cut into small cubes.

Gambir and catechu are extensively employed in dyeing and tanning. For dyeing they have been in use in India from the most remote period, but it was not until the 19th century that they were placed on the list of European dyeing substances. Catechu is fixed by oxidation of the colouring principle, catechin, on the cloth after dyeing or printing; treated thus it yields a variety of durable tints of drabs, browns and olives with different mordants.

The principal consumption of catechu occurs in the preparation of fibrous substances exposed to water, such as fishing lines and nets, and for colouring stout canvas used for covering boxes and suitcases under the name of tanned canvas.

Gambir is used medicinally to a limited extent in the treatment of diarrhea, in the form of an alcoholic extract or in mixtures.

(V. E.)

CATECHUMEN, a person receiving instruction in the Christian religion with a view to baptism. The catechumenate grew naturally out of Judaism, which as a missionary religion had to instruct recruits. These were admitted by circumcision and baptism, women by baptism only. There was a considerable body of potential proselytes on the fringe of Judaism, known as "God-fearers," who, if they shrank from circumcision themselves, generally had the rite performed on their sons.

The apostles are said to have instructed converts after baptism (Acts ii, 41–42); the earliest teaching was presumably an explanation of the messianic prophecies in the Old Testament. On the gentile mission Paul's strongest appeal was made to the "God-fearers," who had been already won for monotheism and Jewish standards of morality. The word *katechein* ("to sound over" or "through," "to instruct") applied to Christian instruction, presumably both before and after baptism, occurs in the New Testament in Luke i, 4; Acts xviii, 25; and Gal. vi, 6. As the gentile element in the church preponderated, instruction became more definite. In the 4th century, with the rise of heresy, detailed doctrinal teaching was given. By this time the postponement of baptism had become general; thus Constantine was not baptized till he was at the point of death. Accordingly a large proportion of Christians belonged to the catechumenate. Most of them were merely "adherents" of the church; others were under definite instruction for baptism. As infant baptism became general, the catechumenate decayed. The baptismal rites now used are clearly adaptations of rites intended for the reception of adult catechumens. In modern times the institution of the catechumenate has been revived in the mission field. *See* also BAPTISM, CHRISTIAN.

(W. K. L. C.)

CATEGORICAL, in common usage, means "unconditional" or "direct and explicit in statement"; also, "pertaining to a category."

In Traditional Logic.—The word is derived, as Petrus Hispanus says (in *Summulae Logicales*, *c.* 1245), from the Aristotelian *kategorumenon* ("predicate") and thus means "predicative." *See* LOGIC for an account of the traditional categorical propositions and categorical syllogism.

In Mathematics.—A set of postulates is said to be categorical if every two models of the postulates are isomorphic. For example, in the case of Peano's postulates for arithmetic (*see* POSTULATE), a model is a system of meanings for the three primitive terms, "0", "number," "successor," which renders all the postulates true. That the postulates are categorical means that any two such models are isomorphic. That is, given two models, it is always possible to find a correspondence between the numbers of one model and the numbers of the other model, such that every number of either one of the models corresponds to a unique number in the other model, such that the 0 of one model corresponds to the 0 of the other model, and such that, if the numbers x, y of one model correspond to the numbers x', y' of the other model respectively, then y' is the successor of x' in the second model if and only if y is the successor of x in the first model. A categorical set of postulates thus determines uniquely the mathematical structure of a model, and in this sense no additional postulates are required (as distinguished from possible additional logical axioms [*see* AXIOM]). (AO. C.)

In Ethics.—Kant introduced the term "categorical imperative" for a moral law that is unconditional or absolute, or whose validity or claim does not depend on any ulterior motive or end. According to Kant there is only one such categorical imperative, which he formulates variously. One formula is: "Act only on such a maxim as you can will that it should become a universal law." This is purely formal and expresses the condition of the rationality of conduct rather than the condition of its morality. Another formula given by Kant is: "So act as to treat humanity, whether in your own person or in another, always as an end, and never as only a means." *See* KANT, IMMANUEL; and ETHICS, HISTORY OF.

CATEGORY. The word "category" has come in unphilosophical contexts to mean much the same as "class," "type" or "kind." Recruits to the armed forces may be put into different categories, according to their physical qualities or according to their technical qualifications.

Originally the word belonged to Greek legal parlance, in which it meant "that of which a person is accused." Aristotle borrowed it for the special purposes of logical theory. In his use the Greek verb from which "category" derives meant "to predicate something of something"; *e.g.*, to assert of Socrates that he is a man, or is mortal, or is married to Xanthippe. Concentrating his attention upon simple assertions of the pattern "Socrates is such and such," Aristotle noticed that there are many important differences between the sorts of predicates that can be asserted of Socrates. To assert that Socrates is a man is to give a piece of information about Socrates of a radically different kind from that given by the assertion that Socrates is pale or that Socrates is older than Alcibiades. The first assertion tells us what Socrates is; the second tells us only what, at a particular moment, he is like in a particular respect; the third tells us only the result of a particular comparison between Socrates and Alcibiades. To put this point in another way, predicates like ". . . is a man" yield answers to the question "What is Socrates?"; predicates like ". . . is pale" yield answers to the question "What like (*qualis*) is Socrates?"; predicates like ". . . in the market place" yield answers to the question "Where is Socrates?"; and so on. No answer to the question "Where is Socrates?" or "How big is Socrates?" is any answer to the question "What is Socrates?"; and no answer to the question "What is Socrates?" is any answer to the question "Where is Socrates?" or "What is Socrates now doing?" Predicates belong to different kinds or types; they yield answers to different questions.

Aristotle came to use the Greek word from which our noun "category" derives to signify not just predicate, but predicate *type*. "Man" and "monkey" are different predicates, but they are predicates of the same type or category. "Socrates is a man" is one answer, "Socrates is a monkey" is another, though false, answer to the question "What is Socrates?" Aristotle listed sometimes ten, sometimes fewer categories or predicate types and coined technical titles for them, some of which came direct from common Greek interrogative words like our "What?" and "How big?" The later latinization of Aristotelian logic originated our category titles like "quality," "quantity," "relation," "substance," "state" (or "condition") and others.

This distinction between kinds of predicate was required by Aristotle in order to resolve a number of logical paradoxes. For example, Socrates could, in the course of a short time, cease to be taller and come to be shorter than Alcibiades; so he is not at the later date what he was at the earlier date. Yet he does not cease to be a human being. How can he not be what he used to be (namely taller than Alcibiades) and still be what he used to be (namely a human being)? The answer is that a change of relation is not a change of sort. Similarly, Socrates who was pale yesterday may be flushed today, without his ceasing to be what he was yesterday, namely older than Alcibiades. A change of (colour) quality (of face) is not a change of (temporal) relation (between dates of birth). Aristotle also noticed the important point that the same word may be employed sometimes in one category and sometimes in another. We may describe a person, a regimen and a place as healthy, yet a place or a course of exercise cannot be well or unwell. To call a place or a regimen "healthy" is to say that it makes or causes people to be in good health. "Healthy" can mean "health causing," or it can mean "health enjoying," and the things that can be asserted or denied to be health causing will or may be entirely different from the things, namely human beings and other living organisms, which can be asserted or denied to be in good health. A few words are category pervasive. The notions of *being, one* and *good* appear, in different modifications, in every category. Such terms came later to be called "transcendentals."

Aristotle himself showed no particular veneration for his lists of sometimes ten, sometimes fewer predicate types. He did not attempt to prove that his lists were exhaustive or that they did not contain some redundancies. Piety induced some of his followers to assume that all conceivable predicates must be lodged in one or other of Aristotle's ten niches; considerations of economy have induced other thinkers to compress the list of irreducible predicate types to two or three. The categories of quality and relation have been held to exhaust the radical predicate types. More harm than good has been done by such economies.

There is however one traditional amplification of Aristotle's basic scheme which, whether or not it was intended by Aristotle himself, has proved important in philosophy and logical theory. The subject term of a proposition of the pattern "Socrates is a man" or "Socrates is elderly" cannot be classified with any of the possible predicates in such propositions. The name of a particular person or thing or event is not the name of a sort or a quality or a relation or a magnitude, etc. Socrates is of a sort, for he is a man; he has qualities, for he is white and wise; he is in relations, for he is married to Xanthippe; and so on. But he is not himself a sort, a quality, a relation or a magnitude, etc. The word "Socrates" could not yield the answer to any question of the form "Of what sort is this?", "Where is it?", "How big is it?" Instead, it has been held that a word like "Socrates" stands for a particular "substance," and "substance" has consequently been used as the title of a type of term which is not a predicate term, but a subject term. Various things can be asserted and denied of Socrates, but "Socrates" cannot be predicated, truly or falsely, of anything. It is not a possible predicate word. The idea that there may be various types of subject terms, as there are various types of predicates, has not been systematically developed—partly because the whole program of breaking all propositions alike down into subjects and predicates has come under effective criticism.

Kant converted the word "category" to a special use of his own, though he clearly believed that his scheme of ideas was closer to Aristotle's than it actually is. Kant was not interested in the different types of predicates predicable of a particular subject or substance, like Socrates. He was interested in the different types of judgment or proposition. In the three propositions "Socrates is mortal," "all men are mortal" and "some men are mortal," the predicates are not merely of the same type. They are the same predicate. But the three propositions differ from one another in another respect, that of what is sometimes called "logical form," in that the first is singular, being about one designated individual, the second is universal, being about every member of the class of men, while the third is particular, in being about some (at least one) undesignated members of the class of men. Socrates might be mortal without all men being mortal; Socrates could not be mortal without at least one member of the class of men being mortal, given that Socrates is a man. But some men might be mortal without Socrates being mortal; and we might know that all men are mortal without knowing that Socrates is mortal; since we might not know that Socrates was a man or even that there was anyone called "Socrates."

These differences of logical form are bound up with the implicational differences between the forces of "all . . . ," "some . . ." and "this . . ." (or "he" or "Socrates"). Other such differences are those hinging on the presence or absence of "not" (or some equivalent), the presence or absence of "if" or "or" (or their equivalents) and the presence or absence of "must" or "may" (or their equivalents). So, while Aristotle's list of categories derived from the study of the different types of predicates in simple, singular, affirmative propositions, Kant's doctrine starts from the consideration of the logically cardinal differences between simple and compound propositions, between affirmative and negative propositions, between universal, particular and singular propositions and between assertoric, apodictic and problematic propositions. Kant was not interested in the differences that had interested Aristotle.

For Aristotle, the notions of quality and quantity (or magnitude) were the types of such predicates as "white" or "sweet" and "six feet tall" or "three hundredweight" respectively. For Kant, differences of "quality" are, in the first instance, the differences between affirmative and negative propositions, and differences of "quantity" are the differences between universal, particular and singular propositions. For Aristotle, "being taller than" signifies a different relation from "being older than." For Kant, "if a metal is heated, it expands" expresses a different relation from that expressed by "this metal is expanding" or that expressed by "either today is Monday or today is Tuesday."

Kant, then, borrowed and transformed the Aristotelian title of "category" and some of the Aristotelian subtitles, like "quality," "quantity" and "relation." But he employed them to mark not just the differences between the logical structures of propositions, but something closely co-ordinated with them. Scientific knowledge, the sort of knowledge to which Isaac Newton had contributed so much, is expressed in systems of propositions or judgments. So too are metaphysical speculations. Propositions of both sorts would have to be of some logical form or other, either negative or affirmative; either universal or particular or singular; either categorical or hypothetical or disjunctive; either assertoric, apodictic or problematic.

The propositions expressing knowledge of things in space and time, however, embody these logical forms only in a specially restricted way, namely so as to be applicable to what human minds can perceive. The purely logical structure of subject-predicate belongs to any simple, singular, assertoric, affirmative proposition; but for a proposition of this structure to express empirical knowledge, it must assert that a spatiotemporal thing has at a given time a certain quality or is for a certain time in a certain state. The subject-predicate structure has to be geared down, so to speak, to the domain of perceivable things and happenings. Similarly, a proposition of natural science may be of the logical structure "if X, then Y"; but it cannot be merely of this structure. For it to apply to the actual world, it must assert a dependence of one temporal state of affairs from another; *i.e.*, a causal connection between events. Kant's categories are the ways in which the propositional structures extracted in logical theory function as the controlling principles of natural knowledge. The world disclosed by a Galileo or a Newton is a world of substances existing in space and time, changing and interacting according to causal laws. The questions put to nature are not whether there are substances existing, changing and interacting, but what substances there are and in what ways they change and interact.

At least a part of Kant's purpose was to explain the insolubility of certain speculative or metaphysical problems by showing that the very posing of these problems presupposed that the categories of, say, substance and causality apply as well to what is not as to what is empirical or phenomenal. He claimed to have proved, on the contrary, that the field of application of these and the other categories was as wide and only as wide as the field of what human beings do or might perceive. There are and must be answers to man's causal questions about empirically ascertainable events; there can be no answers to parallel questions about supposed states of affairs transcending human experiment and observation. Since Kant, the term "category" has tended to disappear from the technical parlance of philosophers and logicians. It has been so heavily loaded, perhaps, with disparate Aristotelian and Kantian connotations that philosophers and logicians have tried to find more noncommittal titles for their basic distinctions. The word "type" and the phrase "logical type," introduced by Bertrand Russell, have tended to displace the word "category," though it must not be supposed that either Aristotle's "category" or Kant's "category" is equivalent to Russell's "logical type."

One point needs further discussion. If it is asked what Aristotle thought that his category titles were titles of, no certain or unambiguous answer can be given. They were indeed titles for types of predicate, or, more broadly, types of "terms" (predicates *or* subjects) of simple, singular propositions. But to say this leaves open the question whether by "predicates" or, more broadly, "terms" reference is made (1) to the grammatical elements into which certain sorts of sentences are analyzed or (2) to things or entities for which such grammatical elements stand. Was Aristotle intending to classify certain classes of parts of speech, or was he intending to classify real things? Was he contributing to a branch of philology, or to the higher reaches of general taxonomy? Neither answer would be satisfactory; nor can either answer be safely fathered on to Aristotle.

Distinctions more or less akin to those which Aristotle drew are nowadays apt to be described not indeed as grammatical but as "semantic" distinctions—distinctions, that is, between kinds or modes of significance. It is possible and for certain purposes necessary to exhibit the general way or ways in which, for example, what is meant by "or" (or "*ou*" or "*oder*") differs from what is meant by "green" (or "*vert*" or "*grün*"). What is meant by the word "or" (or any equivalent expression) is clearly not a thing or a happening. So to specify its semantic function is not to put a thing or a happening into a species or a genus. On the other hand, to specify its semantic function is not just to say that "or" is an English conjunction, since what is being specified is not English as opposed to German or vice versa. On this view a category is a type of semantic function, neither a kind of linguistic expression nor yet a kind of thing or happening.

A child might be puzzled by the fact that while travelers can touch and photograph the North sea, travelers to the north pole can neither touch nor photograph it. It has to be explained to him not that the north pole differs from the North sea as an object, such as glass or air, differs from another object, such as wood or smoke, but rather that the expression "the north pole" and its equivalents do not have the same sort of meaning as the expression "the North sea" and its equivalents. "The North sea" is used to refer to a body of water in a certain place, whereas "the north pole" is used to refer to a certain place—*at* which there may indeed be now one ice hummock and now another. It is not itself an object. In short the expressions have different kinds of semantic function. Their meanings are of different logical types or of different categories. (G. R.)

CATENA, VINCENZO DI BIAGIO (*c.* 1470–1531), Italian painter of religious and portrait subjects who perpetuated the clarity and order of 15th-century painting during a time of great transition and progress in Venetian art, was probably born in Venice. His work reflects the development of the Venetian style from the mature art of Giovanni Bellini (1430–1516) to that of Giorgione, Titian and Palma Vecchio, and reveals its underlying Byzantine tradition.

Catena is known to have been a man of independent wealth who was active in humanist circles. His painting developed under the influence of Giovanni Bellini, from whose compositions he often borrowed liberally, but there is no evidence that he ever worked in the Bellini studio. In 1506 Catena and Giorgione were in partnership, as we learn from the inscription on the back of Giorgione's "Portrait of a Young Woman" in Vienna, and it is therefore surprising to find that Catena's characteristic early signed works from this period are still entirely Bellinesque in character. Catena's development in his ability to organize large compositions may be traced from the "St. Francis" altarpiece in the Venice academy (*c.* 1510) through the Palma Vecchio-influenced "Christ Giving the Keys to St. Peter" in the Prado (before 1520), to the "Martyrdom of St. Christina" in the church of Sta. Maria Materdomini, Venice (*c.* 1520), in which the belated flowering of the Giorgionesque and Titianesque influences upon him are revealed. A group of works showing Raphael's influence, often dated to his last years, may perhaps find a better place in the period 1515–20. This influence first appears in the signed "Portrait of a Man" in Vienna and reaches its climax in the "Holy Family With St. Anne" at Dresden.

The successful fusion of the old and new in Venetian painting is Catena's particular achievement and characterizes the work of the last decade of his activity, culminating in the "Judith" of the Querini-Stampalia gallery, Venice, and the "Warrior Adoring the Infant Christ" in London, in which his sense of formal values and his mature artistic individuality are revealed at their finest.

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CATERHAM AND WARLINGHAM, an urban district of east Surrey, Eng., 18 mi. S. of London and 7 mi. S. of Croydon by road. Pop. (1961) 34.808. Attractively situated in the North Downs, about 75% of the area is within the metropolitan green belt and part within the Surrey hills area of outstanding natural beauty. This widespread area of steep wooded hills and valleys (altitude 400–800 ft.) has six distinct communities: Caterham Valley, Caterham-on-the-Hill, Warlingham, Whyteleafe, Woldingham and Chaldon. It is a dormitory residential district with some light industries, including engineering, chemicals, perfumery and printing. There are frequent rail and bus services to London.

(B. J. S.)

CATESBY, ROBERT (1573–1605), chief instigator of the Gunpowder plot (*q.v.*), was born at Lapworth, Warwickshire. His father, Sir William Catesby, a country gentleman of some means, was, as an earnest Roman Catholic, both fined and imprisoned for refusing to conform to the Church of England. Robert Catesby, also a zealous Catholic, became, because of the sufferings of his father and of other recusants, a staunch opponent of the crown, apparently hoping to supplant the existing regime with a Catholic government. He had all of the qualities of a born conspirator: great determination, the ability to lead and influence others and a personal courage that sometimes bordered on foolhardiness. After his father's death (1598) he was constantly plotting against the crown. In the abortive revolt (1601) of the earl of Essex against Elizabeth I he was wounded and imprisoned, although he was soon released after paying a huge fine. He sent secret agents to Spain (1602) in an attempt to promote a Spanish invasion of England and his activities were so suspect that shortly before Queen Elizabeth's death (March 1603) he was again committed to prison.

Catesby placed little faith in the promises of some toleration for English Catholics made by James I (1603–25), and as early as May 1603 he had conceived the idea of destroying both king and parliament by exploding gunpowder under the parliament building. Temporary concessions granted to the Catholics persuaded him to postpone the plot but in Jan. 1604, after a proclamation banishing priests had been issued, he confided his scheme to his cousin, Thomas Winter. Three other persons were brought into the plot by May 1604: Thomas Percy and John Wright, both intimate friends of Catesby, and Guy Fawkes (*q.v.*), a soldier brought over from the Netherlands. During the ensuing 18 months of preparation, Catesby never wavered in his determination and acted as a source of inspiration to his fellow conspirators. His fatal error was to include among the plotters Francis Tresham, whose note of warning to his brother-in-law, Lord Monteagle, led to the discovery of the plot. After the arrest of Guy Fawkes, Catesby and the remaining conspirators fled from London. Catesby ultimately reached Holbeche house, Staffordshire, where on Nov. 8, 1605, while resisting an attacking force, he was killed. (R. C. Jo.)

CATFISH, the name generally given to fishes of the suborder Siluroidea, order Cypriniformes (Ostariophysi), in which the air bladder is connected with the internal ear by a chain of small bones, probably enabling the fishes to hear well. The name catfish refers to the long barbels or feelers about the mouth (recalling cat whiskers), of which one pair supported by the upper jaw is always present; generally there are two pairs below the chin and frequently another pair developed from the valves between the nostrils. The catfishes comprise a large and varied group containing probably about 2,000 species belonging to 28 different families; most are scavengers feeding on almost any kind of animal or vegetable matter. The larger species have a good taste and are used for food. The spines of the dorsal and pectoral fins are generally present. Venom glands, associated with the spines, can cause painful injuries which may rarely kill humans. Fossils are known dating from the Eocene (about 60,000,000 years ago) or later.

The siluroids are distinguished from the related cyprinoids (characins, minnows and electric eels) by having the body naked or armoured with bony plates, never normally scaled, and by a number of anatomical characters: the air bladder generally extends laterally so that on each side it is in contact with the skin above the pectoral fin.

Fresh-water Catfishes.—*North America.*—The catfishes of North America belong to the family Ictaluridae, which is peculiar to that continent. The Ictaluridae are closely related to the Bagridae of Africa and Asia, and like them and most siluroids have a short dorsal fin, with a spine, followed by a fleshy fin on the tail. The head is rather flat, with the mouth terminal and moderately wide, and the jaws have bands of small teeth; there are eight barbels. About 25 species are known.

Among the larger ictalurids are the blue catfish (*Ictalurus furcatus*) and the flathead catfish (*Pylodictis olivaris*) of the Mississippi valley; they may attain weights of more than 150 lb. These fishes scoop out a nest in the mud into which the female lays eggs. The male parent guards the eggs and later swims with the brood near the shore.

W. T. DAVIDSON FROM NATIONAL AUDUBON SOCIETY

CHANNEL CATFISH (ICTALURUS PUNCTATUS)

The madtoms (*Noturus* species), the smallest of the ictalurids, are the most dangerous; these commonly two- to three-inch roundtailed fish can inflict painful wounds with their pectoral spines.

Certain ictalurids are called bullheads (not to be confused with the marine bullheads or sculpins, family Cottidae); these square-tailed catfishes differ in several technical respects from the other ictalurids (*see* BULLHEAD).

Europe.—The European catfish (*Silurus glanis*), the "wels" of the Germans, is representative of the family Siluridae; it is said to reach a length of 10 ft. and a weight of 500 lb. (*Pangasianodon gigas* of southeastern Asia and *Brachyplatystoma filamentosum* of South America reach comparable sizes.) The wels has a very long tail, beneath which is the long anal fin. Another species (*Parasilurus aristotelis*) occurs in Greece; the remaining Siluridae are Asiatic.

South and Central America.—In South and Central America are no less than 11 families of catfishes, all native. *Diplomyste* species of Chile and Argentina, with toothed upper jaws, are the most primitive living catfishes, but other South American forms are highly specialized. Of the Bunocephalidae *Aspredo batrachus* is remarkable for the way in which the female carries the eggs on the abdomen, each egg being carried in a stalked "skin cup." The Trichomycteridae (Pygidiidae) include *Stegophilus* and *Vandellia,* little, slender, naked fishes that live parasitically on the gill filaments of other fishes, primarily large catfishes (*Brachyplatystoma*). Some of these parasitic fishes, especially the candiru (*Vandellia cirrhosa*), are said to enter the urethra of persons bathing; once in the passage, they distend the short spines with which the gill covers are armed and may thereby cause inflammation or even death to the victim.

The Loricariidae, with about 400 species, are mostly fishes that are covered by an armour of five series of overlapping bony plates on each side of the body; they have their lips expanded into a sucker by means of which they cling to stones. These catfishes feed mainly on mud and algae and have a very long intestine that is coiled like a watch spring. In some species there are pronounced sexual differences, the males having broader and blunter heads, margined with spines or bristles, or bearing branched tentacles on the snout. In the mountain streams of the Andes the Loricariidae are represented by small forms (*Cyclopium* or *Arges*) known as "prenaillas"; in these regions there are no carnivorous fishes to attack them and they are completely naked, having lost the bony armour that protects the lowland forms. A number of these fishes have been observed to climb a precipice from a pothole to the stream above it, obtaining alternate holds with the sucker and the rough surface of the pelvic fins.

The Callichthyidae are another armoured family, but with only two rows of plates on each side of the body. Species of *Callichthys* build nests of grass, sometimes placed in a hole scooped out of the stream bank; both parents guard the nest. In the heavily armoured Doradidae, as in the similar but unrelated Mochocidae of Africa, the air bladder is chiefly a sound-producing organ. Certain *Doras* species travel from one pond to another in the dry season, sometimes journeying all night.

Africa and Asia.—The Clariidae of Africa and Asia are air-breathing fishes provided with air chambers above the gills; in *Clarias* species special vascular treelike organs nearly fill the chamber, but in *Saccobranchus* these are absent and the air bladder extends backwards for half the length of the fish. Clarids are elongated, more or less eel-shaped, catfishes; in the dry season they burrow in the mud, but some species are said to leave their burrows at night and crawl about on land in search of food.

The African Amphiliidae and the Indian Sisoridae have the lower surface of the head and abdomen flat and the paired fins horizontal, an adaptation to life in mountain torrents; in some genera the lips form a sucker similar to that of the Loricariidae.

The electric catfish (*Malapterurus electricus*), family Malapteruridae, is widely distributed in Africa. The skin is soft, and immediately beneath it lies the electric organ, formed of rhomboidal cells of a fine gelatinous substance. Its electric organ differs from that of other fishes in being derived from the integumentary system, not the musculature. The Mochocidae, sometimes called upside-down catfishes because of their habit of flipping over during swimming, are limited to the fresh waters of Africa. Certain species of *Synodontis*, a genus common in the Nile, are white on the back and blackish beneath, a coloration connected with their habit of swimming belly upwards.

Marine Catfishes.—Nearly all the siluroids are fresh-water fishes, but two families are secondarily marine: the Ariidae, found on the coasts and in estuaries of all tropical countries; and the Plotosidae of the Indo-Pacific. The Ariidae are typical siluroids in form and structure of fins, whereas the Plotosidae have a long tail and the anal and caudal fins united. Most Ariidae have eggs as big as marbles, carried in the male's mouth for about one month.

See also FISHES. (C. HU.)

CATGUT, a tough cord made from the intestines of certain animals, particularly sheep, and used for surgical ligatures and sutures, for the strings of violins and related instruments, and for stringing tennis rackets and archery bows. The ancient Egyptians and Babylonians, and the later Greeks and Romans, used the intestines of herbivorous animals for much the same purposes. The origin of the term "catgut" is obscure; it is not known if the intestines of cats were ever put to such uses.

The intestinal tubes of sheep used for catgut, called "runners," are thoroughly washed, cut in ribbons and scraped free of mucous membrane and circular muscle tissue. The ribbons are placed in an alkaline bath for several hours and then stretched on frames. While still moist they are removed, sorted as to size and twisted into cords of varying thicknesses. A smoothing and polishing operation completes the process.

Italian catgut is considered the best for stringing musical instruments. Surgical catgut is sterilized by heat supplied in progressive steps and maintained for several hours; surgical catgut frequently is also treated with an impregnating agent. (E. L. Y.)

CATHA, a shrub (*Catha edulis*, family Celastraceae) native to Arabia and to Africa from Ethiopia to the Cape of Good Hope. It is also cultivated, especially in Arabia, where it is called *khat*, *kat* or *kasta*. The Arabians make a kind of tea from the dried leaves and young shoots. These are also chewed extensively for their stimulant properties, which somewhat resemble those of coca.

CATHARI (CATHARS), a heretical Christian sect that flourished in western Europe in the 12th and 13th centuries. The Cathars can be distinguished from the other heretical sects of the period by their dualistic views and their organized church. Dualism in this sense means the belief that goodness exists only in the spiritual world of the good God; that the material world is evil and was created by an evil god or spirit called Satan; and thus that Good and Evil have two separate creators. Views containing similar implications had been common among the Gnostic sects in the early Christian centuries; these ideas had had their greatest influence on the middle east and on Christian literature in the religion of Mani (*see* MANICHAEISM), and were held in the early middle ages in the Balkans and the near east by the religious sects of the Paulicians and the Bogomils (*qq.v.*). The Cathars were closely connected with the last two, and they were sometimes known in the west as Publicani (a corruption of Pauliciani, but also an echo of the publicans of the New Testament) or Bougres (*i.e.*, Bulgarians, for Bulgaria was the home of the Bogomils); but most commonly as Cathari (Gr. *Catharoi*, "pure") or Albigenses (the men of Albi, after one of their chief centres of influence in the south of France). The word "Albigenses," however, could refer to all the heretics of this region, both Cathars and Waldenses (*q.v.*).

Emergence of the Heresy.—After the fall of the Roman empire dualist heresies were virtually unknown in western Europe until about the year 1000. In the first half of the 11th century isolated groups of heretics appeared of whose doctrine little is known. Some of these groups may have been merely anticlerical and puritanical, like the later Waldenses, but some were certainly dualists. It is clear that these had learned their dualism by contact with the Bogomils, but the nature and extent of the contact is quite uncertain. These groups appeared in western Germany, Flanders, France and northern Italy. In the late 11th century no more was heard of them; then in the 12th century they reappeared in the same areas, revealing the same range of views.

The Gregorian reform of the church in the 11th century was accompanied by widespread popular enthusiasm. But the official church failed in the long run to contain and channel this enthusiasm. The growth of clerical education and the heightened emphasis on the importance of sacraments made of the clergy more a class apart and left the laity with little chance to develop their own initiative in the affairs of the church. It was among the unprivileged lower clergy, poorer knights, merchants and artisans that heresy became popular in the 12th century: among men and women often of considerable intelligence and enterprise but without the means of expressing their zeal (in their own view at least) within the Catholic Church. The heretical movement was one aspect of the religious revival of the day, and in part at least it was a by-product of the immensely rapid cultural, social and economic changes of the 11th and 12th centuries.

The period of most rapid growth came in the 30 years following 1140. At about this time the Bogomil church was reorganizing itself, setting up an episcopate, planning missions; and there is no doubt that Bogomil missionaries, as well as western dualists who had imbibed their doctrines in the Byzantine empire while on the second crusade (1147–49), were at work in the west in the middle of the century. The preaching of St. Bernard against the heresy proved unavailing, and from the 1140s the Cathars were an organized church with a hierarchy, a liturgy and a system of doctrine, though none of these ever became so coherent as their Catholic counterparts. About 1149 the first bishop established himself in the north of France; a few years later he established colleagues at Albi and in Lombardy. The authority of these bishops was not clearly defined; their status was confirmed and the prestige of the Cathar church enhanced by the visit of the Bogomil bishop Nicetas in 1167. He visited both Lombardy and the south of France, which was now becoming the most fruitful area of Cathar activity, held councils and established new bishoprics. In the following years more bishops were set up in Italy, until by the turn of the century there were 11 bishoprics in all, one in the north of France, four in the south (Albi, Toulouse, Carcassonne, Val d'Aran; two more were added later) and six in Italy (Concorezzo near Milan, Desenzano, Bagnolo, Vicenza, Florence and Spoleto). It was in the second half of the 12th century that the Greek word Cathari was first applied to them; its first known use was in Germany in 1163.

Two Parties.—The multiplication of bishoprics in Italy, however, was partly due to a doctrinal rift. Bishop Nicetas had come to the west in 1167 to instill into his colleagues a more thoroughgoing dualism than they had believed in hitherto. The difference corresponded to a divergence within the Bogomil churches themselves: between those who held that Satan, the creator of the world, had once been an angel of God who had fallen from grace, and those who held that he was an independent deity. The former view implied that God was the ultimate creator of the universe, and so involved a modified dualism; the latter—clearly stated in the *Liber de duobus principiis*, which was written by an associate of John de Lugio, the heretic bishop of Bergamo—was more radically dualist. On the whole the Cathars in the south of France accepted the more radical dualism; those in Italy became divided into two parties. The opposition between the two never involved out-and-out schism; they always agreed in their opposition to the Catholic Church. But it was a symptom of the divergences in Cathar doctrine from place to place and time to time which make it exceedingly difficult to define with precision.

Matter, they were all agreed, was evil. Man was an alien and a sojourner in an evil world, and his aim must be to free his spirit, which was in its nature good, and restore it to communion with

God. They believed in the ultimate redemption of spirits—though not always in universal redemption—but thought the process was slow since they believed in the transmigration of souls from man to man or from man to beast (for animals too had souls). There were strict rules for fasting, including the total prohibition of meat; to eat an animal's flesh was tantamount to cannibalism. Sexual intercourse was forbidden: they had a horror of procreation because it involved the imprisonment of more spirit in the world of flesh. Thus they believed passionately in celibacy and in every form of ascetic renunciation of the world; and they looked favourably on suicide, an attitude which made the more fervent of them impervious to persecution.

The extreme asceticism of Cathar doctrine made the Cathar church a church of the elect; and yet in France and northern Italy it became a popular religion. This involved a considerable process of adjustment, which was achieved, as is common in dualist or ascetic religions, by the division of the faithful into two bodies: the "perfect" and the "believers." The perfect were set apart from the mass of believers by an elaborate ceremony of initiation, or spiritual baptism, the *consolamentum.* Within the ranks of the perfect was a hierarchy of bishops and deacons, but they did not have the exclusive right of administering sacraments. The Cathars had two other sacraments apart from *consolamentum* and ordination: penance and breaking of bread. The breaking of bread was a kind of communion; they did not believe in transubstantiation. The perfect devoted themselves to contemplation and were expected to maintain the highest moral standards, and it was the privilege of the believers to provide them with food and drink.

The believers could not be expected to attain the standards of renunciation of the perfect. Many believers underwent the *consolamentum* at the end of their lives, as many early Christians had received baptism on their death beds, so as to avoid the dire consequences of a lapse after being received among the elect. The enemies of the Cathars usually admitted the lofty standards of the perfect, but they accused the believers of all manner of vice. Sexual intercourse was officially forbidden but could not be entirely suppressed. Marriage, however, was regarded as organized vice, and particularly noxious; it seems that casual vice and sodomy were preferred. But the charges of the Catholics were doubtless exaggerated, and in course of time the Cathars came to conform themselves in a variety of ways to normal western standards.

The Cathar doctrines of creation led them to rewrite the biblical story—like all dualists they devised an elaborate mythology to replace it—and to reject the notion that the whole Bible was sacred. They viewed much of the Old Testament with reserve; some of them rejected it altogether; and in the vernacular Bibles they circulated there was much apocryphal matter. The New Testament was accepted but extensively reinterpreted. The orthodox doctrine of incarnation—of God, as it were, imprisoned in human flesh—was impossible to the Cathars. Jesus was an angel merely, who came to indicate the way to salvation not himself to provide it; his human sufferings and death were an illusion.

The Church's Attack.—The Cathar doctrines, therefore, struck at the roots of orthodox Christianity and of the social institutions of Christendom, and the authorities of church and state united to attack them. Some of the heretics of the 11th and early 12th centuries perished, but more often because of the zeal of the lay power or the violence of a mob than at the instruction of the ecclesiastical authorities. But the church's law had always envisaged the possibility that active persecution might be needed; and the catastrophic rapidity with which various heretical sects, and most notably the Cathars, grew in the middle of the 12th century led to a rapid development of the legal machinery. In 1184 Pope Lucius III and the emperor Frederick I Barbarossa joined at Verona in issuing the decree *Ad abolendam,* which laid down a procedure for ecclesiastical trial, after which an obdurate heretic would be handed over to the secular arm for punishment; and punishment meant confiscation of property, exile or even possibly death. Tradition, however, had already established burning as the most suitable punishment for the unrepentant heretic.

Pope Innocent III (1198–1216), like many of the church's leaders, preferred conversion to persecution. But the Cathars were not to be persuaded, and their triumphant progress looked like giving them dominance over the Catholic Church in southern France and northern Italy. By and large the Cathars did not recruit from the nobility; so large a proportion of them were artisans that they were commonly known as the Weavers, and it was under this title that their brief appearance in England in the 1160s was noted by William of Newburgh (*Historia rerum Anglicarum,* ii, 13) and other writers of the late 12th century. But in Provence and to a lesser extent in Italy they won the favour of the nobility, and even recruited some of them. Innocent III's attempts to force Raymond VI, count of Toulouse, to join him in putting down heresy ended in disaster; the papal legate Peter de Castelnau was murdered (Jan. 15, 1208), and the count was generally thought to have been an accessory to the crime. A crusade was proclaimed against the heretics, and a substantial army led by a group of barons from northern France proceeded to ravage Toulouse and massacre the inhabitants, both Cathar and Catholic. The Albigensian crusade was violent and cruel, but it seems that the more orderly persecution sanctioned by Louis IX, in alliance with the nascent Inquisition, was more effective in breaking the power of the Cathars. In 1244 the great fortress of Montségur near the Pyrenees, which had long contained a large nest of the perfect, was captured and destroyed. The Cathars had to go underground, and many of the French Cathars fled to Italy, where persecution was more intermittent.

Final Collapse.—Early in the 13th century the Dominican order was founded to provide learned preachers as able and as poor as the Cathars for the purpose (among others) of combating heresy. It was natural that they should often be employed by the papacy in inquiries into heresy; and it was out of these inquiries that the machinery of the Inquisition (*q.v.*) was gradually developed in the 13th century. In a very different way the other great order of friars founded about the same time, the Friars Minor or Franciscans, were almost equally dangerous to the Cathars. St. Francis also preached to the classes to whom the Cathars had especially appealed; but his message was a message of joy, and he brought home, as it had never been brought home before, that the world was God's world, and good. It is likely that the collapse of the Cathars was as much due to the failure of their appeal as to the fires of the Inquisition, and it is noticeable that they disappeared both in France and in Italy about the same time, although persecution was much more persistent north of the Alps. The hierarchy faded out in the 1270s; the dying embers of Cathar heresy lingered through the 14th century to be finally extinguished early in the 15th.

The Inquisition was their chief legacy to medieval Europe, for the future of the church was to be directly influenced far more by the sects that preached a puritanism and a return to the primitive church innocent of dualism. Of all the sects denounced in the decree *Ad abolendam,* only the Waldenses continue to exist in the 20th century.

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(C. N. L. B.)

CATHARSIS (Gr. "purgation" or "purification"), a term that since the time of Aristotle has been associated with the question of the effects of tragedy on the spectators or on the actors. Aristotle maintained that tragedy and also certain kinds of music tend to purify the spectators and listeners by artistically exciting certain emotions which act as a kind of homeopathic relief from their own selfish passions. Goethe thought that the catharsis affects the actors rather than the spectators or readers. Lessing, however, held that it affects the spectators and readers and also maintained that catharsis takes the form of a sublimation of the emotions or their conversion into virtuous dispositions.

The term catharsis was introduced into psychiatry in 1895 by Sigmund Freud and Josef Breuer (*Studien über Hysterie*) to describe a method of treatment by which hysterical patients, under hypnosis, relived, or at least remembered, the circumstances under which their symptoms originated, expressed the emotion accompanying those circumstances and thus were relieved of the symptoms. Though the term (sometimes used synonymously with abreaction) is no longer in common use among psychiatrists, the idea is in fact a major component of the theory and practice of psychoanalysis. *See* also PSYCHOANALYSIS.

CATHARTIC, an agent used to relieve constipation. The term is used either in a general sense to refer to all agents of this class, or specifically to indicate one of a series differing in severity of action: in increasing order of intensity these are aperients, laxatives, cathartics, purgatives, physics, hydragogues and drastics.

Cathartics, using the term in the general sense, are divided into three groups on the basis of mode of action. The first group includes senna, cascara, aloe, jalap, colocynth, podophyllum, castor oil, croton oil, phenolphthalein and calomel, all of which act by irritating the intestinal tract to produce an increased rate of propulsion of the contents. Most of these are used little or not at all in professional medicine but are common ingredients in proprietary preparations. The second group consists of agents that act by increasing the bulk of the intestinal contents. Salts such as magnesium sulfate and sodium sulfate and hydrophilic (water-attracting) colloids such as agar, psyllium seed and methyl cellulose increase bulk by holding water in the intestinal tract, while bran simply furnishes indigestible fibre. The third group includes mineral oil and olive oil, which act by lubricating the tract and thus facilitating the passage of the intestinal contents.

Cathartics should be taken only upon the advice of a physician. Serious harm can result from an attempt to relieve gastrointestinal symptoms without knowing their cause. Indiscriminate or habitual use, based on the supposed importance of "regularity" fostered by the patent-medicine industry, has in many cases resulted in chronic constipation. (V. E.)

CATHARTIDAE, a family of new world vultures that includes the turkey vulture (turkey buzzard), the South American and California condors, and the black and king vultures. All are carrion eaters.

See VULTURE.

CATHAY, the name by which China became known to medieval Europe. It is derived from the Chinese Khitan, Mongol Kitat, Arabian Ḫitai and Russian Kitai, various names for the pre-Mongol people who swarmed out of southeastern Mongolia in the 10th century A.D. to conquer part of Manchuria and northern China, and held the area for about 200 years. Two Franciscan friars who visited Karakorum (*q.v.*), the ancient Mongol capital, in 1246 and 1254 may have been the first to introduce the names to Europe. In their day and later the Mongols called north China Kitai, south China Mangi, *i.e.*, "land of the Man"—an ancient Chinese name for the people south of the Yangtze river. After contact with China was broken in the 14th century, following the collapse of Mongol power, Europeans were not sure that China and Cathay were one and the same until the Augustinian friar Martin de Rada of Spain in 1575 and the Jesuit Matteo Ricci in 1607 recorded the fact for their respective societies. Both Christopher Columbus and John Cabot, for example, thought they were bound for Cathay, and the former on his final voyage actually believed he had reached Mangi, which he described as contiguous to Cathay. (L. C. G.)

CATHEDRAL, an adjective frequently used as a noun to mean a cathedral church; that is, a church in which a bishop has his official seat or throne (Gr. *cathedra*). Cathedral churches are of different degrees of dignity; there are cathedral churches of simple diocesan bishops, of archbishops or metropolitans, of primates, patriarchs and pope. A cathedral church is not necessarily large and magnificent, although most cathedrals, enriched by successive endowments, have become so. Since the territorial organization of the early church followed that of the Roman empire, cathedrals from the first were established wherever possible in towns, not in villages. In the early middle ages in the west the town in which a cathedral church was situated became known as the cathedral city. This article deals chiefly with cathedral churches in the west.

HISTORY

Early Organization.—The bishop by canon law was pastor of his cathedral church, which was the mother church of his diocese. This in early times was called his parish, a word later used for the smaller units into which the diocese was divided (*see* DIOCESE; PARISH). The cathedral clergy (priests, deacons, subdeacons and clerks in minor orders) originally formed the bishop's familia or household and lived a communal life with him, sharing the common goods of the church and helping to serve its large parish. In early times they were normally clerks, not monks, but their communities in England were often described as *monasteria*, a word which then had a less restricted meaning than it later acquired. Because of this some cathedral churches, such as York and Lincoln, which never had monks attached to them, have inherited the name minster or monastery. In time the common life was abandoned, and the clergy lived in separate houses near the cathedral church, but in the 8th and early 9th centuries the revival of the common life in a stricter form was advocated by ecclesiastical reformers in the Carolingian empire, chiefly as a means of enforcing celibacy among cathedral clergy. The most famous and successful rule for cathedral clergy at that time was composed by Chrodegang, bishop of Metz (742–66); this was based largely on the Benedictine rule, but was less strict in its requirements for individual poverty. At the Council of Aachen (816) it was incorporated in the much longer *Institutio canonicorum*, which became the basis for a widespread adoption of a common life at cathedral and collegiate churches throughout the empire. This movement influenced a number of cathedral churches during the period before the Norman conquest. The clergy who followed a rule of common life were called canons or canonical clerks, because they observed a definite rule (Gr. *canon*).

Secular and Regular Cathedrals.—From the 10th century two increasingly divergent movements can be traced in the history of the organization of communities of canons. On the one hand, attempts to enforce the common life met with more resistance; in times of unrest and relaxation of ecclesiastical discipline many cathedral canons acquired private property, lived in separate houses and divided a large part of the common estates and goods of their church into separate portions called prebends (*i.e.*, "provender") for themselves. Because of these separate possessions they were called "secular" canons. This division of common goods was recognized as permissible on the continent of Europe about the middle of the 11th century. In the religious revival of the same period, however, the "secularizing" movement led to a renewed demand for clergy to live the communal, apostolic life, and, as a result, in the early 12th century, many communities of canons adopted a strict form of common life under the rule of St. Augustine. They were called regular (Lat. *regula*, "rule") or Augustinian canons (*q.v.*), and their life soon became barely distinguishable from that of Benedictine monks. From this time cathedral churches were normally organized on either a regular or a secular basis.

On the greater part of the continent of Europe the regular cathedrals of the middle ages were served by chapters of Augustinian or Premonstratensian canons, although in parts of Germany and in Denmark some were served by Benedictine monks. In England the monastic revival of the 10th century had resulted in the introduction of Benedictine monks to serve three or four cathedrals, and in the ecclesiastical reorganization following the Norman conquest these were increased to nine. In Ireland at Downpatrick and in Sicily at Monreale, Benedictine cathedral chapters were also founded in the late 12th century under Anglo-Norman influence. Carlisle in England, Christ church (Dublin) in Ireland and St. Andrews in Scotland were Augustinian, while Whithorn, the cathedral church of Galloway, was Premonstratensian. All the other medieval cathedrals of Britain gradually became secular in the period following the Norman conquest.

Development in the Middle Ages.—In neither the regular nor the secular cathedrals was the early intimate association of bishop and cathedral clergy maintained. With the end of the missionary period of conversion and with the formation of parishes, the cathedral church lost its parochial character, and the interests of its clergy became centred in its services and government. Their main function was the daily celebration of the canonical hours and Mass on behalf of the whole Christian community, while the bishop was increasingly drawn away from his cathedral church on diocesan duties or affairs of state. The cathedral chapters always kept certain special links with their bishop and diocese. They continued to act as permanent trustees of episcopal property; their consent was necessary to episcopal acts which involved financial arrangements of the church and see; they sometimes exercised episcopal jurisdiction in a vacancy of a see and in 1215 were recognized as having the sole right to elect their bishop. But from the late 11th or 12th century most cathedral chapters controlled their own property, which was separate from that of the bishop. Their endowments steadily increased in the 12th and 13th centuries, and they assumed the position of independent corporations, jealous of their rights and privileges. They reached the peak of their power, wealth, prosperity, independence of their bishop and corporate spirit in the 13th century.

The constitutions of the regular cathedrals showed less variety than those of the secular cathedrals. The convent of regular canons or monks formed the chapter, of which the prior was head, and its government and way of life were ordered by the Benedictine or Augustinian rule. The two main characteristics of the secular constitutions were separate prebendal incomes for the canons and a system of home government at the cathedral based on a varying number of dignitaries who divided the administrative work among them and were supposed to be continuously resident. Within this framework was much local diversity. Generally it seems that the strong, independent chapter, with a dean as sole head under the bishop, developed first in northern France during the 10th and 11th centuries. Elsewhere about this time there was often a division between the spiritual authority in the chapter—exercised usually by a dean in Germany and the Low Countries and by an archpriest in southern France and Italy—and the temporal authority of a provost or archdeacon who administered the estates. In Germany, Scandinavia and parts of eastern and southern France the provost often later emerged as sole head of the chapter, while in Italy about half the cathedrals came to have archdeacons at their heads.

The English secular cathedral constitutions derived from those of Normandy or northern France, where the number, status and precedence of the dignitaries varied. The constitutions of Bayeux and Rouen probably were most influential. In the course of the 12th, 13th and 14th centuries the constitutions of the nine English secular cathedrals became remarkably homogeneous. This seems to have been the result not so much of a common origin or imitation of Norman or French models as of independent development and of the growing practice by the English chapters of borrowing each others' customs, particularly those of Salisbury. Their constitutions are usually described as "four-square," because they were based on four great dignitaries: (1) The dean was president of the chapter and had cure of souls of all the cathedral clergy; he was, however, no more than *primus inter pares* among the canons and shared his power with them and the other dignitaries. (2) The precentor was in charge of the music, liturgy and song school. (3) The chancellor was the chapter's secretary and supervised the cathedral schools of grammar and theology. (4) The treasurer guarded the church's treasures and provided lights and other material necessaries for the services. Under these were various deputies and other officers, such as the subdeacon, succentor, vicechancellor, grammar master, lecturer in theology, subtreasurer, sacrists, masters or wardens of the fabric and common funds, some of whom were canons while others were vicars choral or chantry priests.

Possession of a prebend gave a canon the right to a voice in chapter. These prebends, or separate endowments for canons, normally increased during the 12th century and became fixed in number in the 13th century. Some great continental cathedrals, such as Cologne or Chartres, by the end of the 13th century had more than 70 canons and prebendaries forming the chapter. The prebends were of varying value, but many were sufficient to enable canons to be nonresident and do work at a distance from the cathedral in the rapidly expanding secular and ecclesiastical administrations and in the growing schools and universities of the 13th century. This was useful work for society, but the increasing nonresidence of canons raised a major problem at the cathedrals in the 12th and 13th centuries. In time solutions were found. Nonresidence was soon regarded as lawful for canons, since a canonry was without cure of souls and now that the number of canons had greatly increased it was no longer necessary for all to be present to maintain the daily services. Nonresident canons, however, were forbidden to share in the distributions of money and food from the common fund, which were kept for the residentiaries at the cathedral, and from the 13th century additional endowments were usually appropriated to the common fund rather than to the prebends. By the 14th century in the English secular cathedrals the canons were fairly clearly divided into residentiaries and nonresidents, the residentiaries forming a small inner chapter controlling the services and administration and the lesser clergy within the cathedral close.

The increase in numbers of the lesser clergy at the secular cathedral churches in the later middle ages provided a further reason why it was no longer necessary for all the canons to be resident. The vicars choral and minor canons at the English cathedrals, generally equal in number to the full body of canons, were required to have musical qualifications, and their main function was to sing the services. In French cathedrals there were corresponding bodies of *heuriers*, *matiniers* and demiprebendaries. These clergy soon formed in effect the working staffs of the cathedrals and in England by the mid-13th or 14th century were winning some degree of independence from the resident canons. They formed minor self-governing corporations, managing their own property and living in common halls of residence in the close. About the same time boarding houses and schools were being founded at English cathedrals for boy choristers. The number of chantry priests celebrating private masses and taking part in the main cathedral services was greatest in the 14th century; common halls of residence were founded and minor corporations formed by some of them. Thus the constitution of an English medieval secular cathedral, with its various groups of clergy enjoying some form of self-government under the general direction of the dean and chapter, was much less centralized than that of a cathedral monastery under its prior or than those of the new secular foundations of Henry VIII.

In the late 14th and 15th centuries developments usually regarded as characteristic of the post-Reformation period took place at most English secular cathedrals. The powers of king and bishop over the chapters increased. By the end of the 14th century bishops and deans ordinarily were appointed by papal provision, usually on royal nomination; election by the chapter was becoming no more than a formal ratification of the king's choice. From the second quarter of the 14th century the most usual method of appointment to canonries and prebends was papal provision, the pope providing many royal nominees; the proportion of these royal nominees increased steadily in the late 15th and early 16th centuries. At the same time the number of residentiary canons, vicars, choral and chantry chaplains at the cathedrals was decreasing. Partly this was due to slackness and neglect of duties, partly to economic causes. The endowments of the chapters' common funds had increased and canonical residence had become attractive and profitable in the 13th and 14th centuries, but the agricultural decline of the later 14th and early 15th centuries caused the distributions from the funds to fall in value, and the residentiaries did not encourage other canons to enter residence and share in them. The development was foreshadowed by which after the Reformation the residentiaries were reduced to a fixed number of from five to nine. The vicars choral were also finding that their fixed customary stipends from the individual canons, with the reduced revenues from their own common fund, were no longer sufficient to support the full body of vicars choral. During the same period the endowments of several older chantries were often united in order to support a single priest. (K. Es.)

Effects of the Reformation.—In territories where the churches of the Reformation were in the majority, the existing church buildings continued in use, including the cathedrals. Where bishops were rejected either entirely or as a separate order, cathedrals became simple churches, though usually still called cathedrals. In Sweden the cathedral continued to be the seat of the Lutheran bishop and to be ruled by a dean and chapter. In England, where the order of bishops was retained, the cathedrals remained as the seat of the bishop, and those staffed by secular clergy kept their medieval organization. But at the dissolution of the monasteries under Henry VIII the eight cathedrals till then ruled by Benedictines received new statutes; these, together with the cathedrals of five new bishoprics, became known as "new foundations." In them the power of the dean tended to increase in later centuries. New cathedrals necessitated in the 19th and 20th centuries by the splitting up of dioceses because of increased population were generally ruled over by a provost and had not the funds to employ a staff of residential canons. (X.)

Roman Catholic Church.—The canon law of the Roman Catholic Church makes no architectural conditions for a cathedral, although a spacious sanctuary is desirable for the adequate performance of pontifical rites. It has been emphasized in modern times that size and splendour are in no way necessary attributes, and many cathedrals in later-created dioceses, especially in Africa, are very modest. The only canonical requirement is that they shall be consecrated and adequately endowed. As it lies exclusively with the pope to create a diocese and designate its see, so also does it lie with him to designate its cathedral, although the choice of the bishop or his decision to build one is normally accepted. Although a bishop may by exception simultaneously occupy two or more sees, each with its cathedral, there can never be more than one cathedral in a diocese. The bishop is bound to be present in his cathedral in Advent and Lent and on the feasts of Christmas, Easter, Pentecost and Corpus Christi, and he must normally perform ordinations there in the presence of the canons where chapters exist, as they do not for example in the United States, Canada, Australia or most of Ireland. (M. Dk.)

Orthodox Church.—In the Orthodox Eastern Church the cathedral is the main church in a city where the bishop resides. It becomes the cathedral because it is the church where the bishop celebrates on great festivals, but the ordinary conduct of worship and the parochial duties are the responsibility of the cathedral clergy, who differ little in organization from the staff of any other parish. The system of cathedral chapters has never been developed.

In Russia, where the dioceses have always been few in number and vast in extent, the main church in any large town became known as a cathedral (*sobor*) even though no bishop was in residence there. The principal church of a big monastery also assumed the same name. The Moscow Kremlin since the 15th century has contained several cathedrals, the most famous being those of the Assumption, of the Annunciation and of the Archangels.

(N. M. Z.)

ARCHITECTURE

The architectural history of the west European cathedral begins with the first large Christian basilicas—old St. Peter's and others—built in Rome soon after the Christian church acquired legal status (313). The long colonnaded nave drew the worshiper's attention irresistibly to the eastern apse where stood the main altar and, behind that, the bishop's throne, later moved to a chancel between apse and nave (*see* Apse; Chancel; Nave). In the metropolitan churches, though not usually those of other cities, this eastward drive was checked by the intrusion of a large transverse space called bema (*q.v.*), forerunner of the medieval transept (*q.v.*) and serving both to give room for ceremonial deployment before the altar and to withdraw the mystical focus of the church a little from the congregation. In later centuries the longitudinal and apsidal plan continued in use, with modifications, for many cathedrals and abbey churches (it is impossible to isolate the development of strictly "cathedral" buildings); the cathedral of S. Apollinare in Classe, Ravenna (534–539), was of this type, as was such a Carolingian abbey as Fulda (begun 802).

Hardly any of the typical features of the French High Gothic cathedral would have been possible without preliminary development in the Romanesque period (*c.* 1000–1200). Thus the *chevet* or cluster of apsidal chapels jutting from a passage or ambulatory laid round the main apse—chapels made necessary by increasing worship of saints and the growing custom of each canon saying Mass daily—is traceable at least to St. Martin at Tours of 997–1020; Durham had rib vaults, Nevers (Burgundy) a form of flying buttress and Autun (in the same province) pointed arcades almost half a century before the rebuilding of St. Denis abbey (*c.* 1135–44) as the first of the large true Gothic churches of the Île de France. In the High Gothic cathedral these features developed rapidly: nave vaulting (rediscovered in early Romanesque times to replace the inflammable flat timber roof of the basilicas) was lightened and carried to ever greater heights; translucent glass displaced solid stone wall. The eastward drive of the Early Christian church was replaced by an upward surge: Romanesque Durham was 80 ft. high to the crown of its vaults; Notre Dame, Paris (1163–1208), reached 115 ft.; Beauvais (1247–72) about 157 ft.

By comparison with the French, the English medieval cathedral was of long and low proportions; set within a cloistered precinct proclaiming its monastic or collegiate origin (viz., Canterbury), not jutting up directly from the street; entered through a quiet north porch rather than the spectacular western figure portals of the Île de France. French Gothic cathedrals were primarily centres of urban religious life as their siting indicates. English west fronts often had an impressive program of sculpture, as at Wells, Exeter and elsewhere.

The imagination of the Renaissance humanist-architect was captured anew by the aesthetic possibilities of the "central" plan; of a cathedral centrally domed and symmetrically disposed north, south, east and west, a plan fairly common in earlier times (Hagia Sophia, Constantinople, and S. Vitale, Ravenna, in the 6th century; Aachen cathedral of the 9th; St. Mark's, Venice, in the 11th). Bramante and Michelangelo proposed completely symmetrical plans for the rebuilding of St. Peter's, but the traditional needs of the church compelled Carlo Maderna to add to a long western nave, completed 1614. Sir Christopher Wren was faced with a similar difficulty and forced to a similar modification in the rebuilding of St. Paul's cathedral, London (1675–1711).

Neither the 19th century nor the modern architectural movement beginning in the 1880s produced a special cathedral style. Most architects freely adapted historical styles such as the Byzantine (Westminster cathedral, J. F. Bentley, 1896 *et seq.*) and Gothic (Liverpool, Sir G. G. Scott, 1903 *et seq.*; and the remodeled St. John the Divine, New York city, R. A. Cram and C. F. Ferguson, 1910 *et seq.*). However, in his designs for the new Coventry cathedral (approved 1951, modified 1952–53) B. Spence mainly rejected traditional architectural styles and used tent forms, facet vaulting and other new features. A modern development of the centralized plan is shown in F. Gibberd's scheme (1960) for the Roman Catholic cathedral of Liverpool.

See Basilica; Byzantine Architecture; Gothic Architecture; Religious Architecture; Romanesque Architecture; *see* also references under "Cathedral" in the Index volume.

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CATHELINEAU, JACQUES (1759–1793), a leader of the insurrection of the Vendée during the French Revolution, was born on Jan. 5, 1759, at Pin-en-Mauges in Anjou. In the first years of the Revolution, Cathelineau, a fanatical Catholic himself, listened to the exhortations of Catholic priests and royalist *émigrés* and joined the insurrection provoked by them against the new government. In March 1793, with a band of peasants and smugglers, many of whom were relatives of his, he took the château of Jallais and the town of Chemillé. He then joined forces with other Vendean leaders, J. N. Stofflet and M. L. J. Gigot d' Elbée, and marched with them on Cholet, Vihiers and Chalonnes. With greatly increased troops, the leaders next took Beaupréau, Fontenay, Saumur and Angers in April, May and June 1793. The insurgents' first successes were largely due to surprise, and when they encountered stiffer resistance differences arose among their leaders. To avoid these rivalries, it is thought, Cathelineau was named generalissimo of the rebels, though his authority over the undisciplined troops was not increased by the new office. Finally the combined royalist forces tried to capture Nantes. Cathelineau entered the town in spite of the resistance of Gen. J. B. Canclaux, but he was killed on July 14, 1793, and the Vendean army broke up.

CATHER, WILLA SIBERT (1873–1947), U.S. novelist of the frontier, was born in Winchester, Va., Dec. 7, 1873, and at nine moved with her family to the Nebraska village of Red Cloud. There she grew up among the pioneering immigrants from Europe—Swedes, Bohemians, Russians, Germans—who were breaking the land on the Great Plains. At the University of Nebraska she showed a marked talent for journalism and story writing and on graduating in 1895 obtained a position on a Pittsburgh "family" magazine. Later she worked as copy editor and music and drama editor of the *Pittsburgh Leader*. She turned to teaching in 1901, and in 1903 published her first book of verses, *April Twilights*. In 1905 her first collection of short stories, *The Troll Garden*, led to her appointment as managing editor of *McClure's*, the New York muckraking monthly. After building up its declining circulation, she retired in 1912 to devote herself wholly to novel writing. During these years, frequent visits to the American southwest gave her an intimate acquaintance with a section of the country destined to figure significantly in her work.

Her first novel, *Alexander's Bridge* (1912), was a factitious story of cosmopolitan life. Under the influence of Sarah Orne Jewett's regionalism, however, she turned to her familiar Nebraska material. With *O Pioneers!* (1913) and *My Ántonia* (1918) she found her characteristic themes—the spirit and courage of the frontier she had known in her youth. *One of Ours* (1922), which won the Pulitzer prize, and *A Lost Lady* (1923), which made her famous, mourned the passing of the pioneer spirit in the middle west. In *Song of the Lark* (1915), the tales assembled in *Youth and the Bright Medusa* (1920) and *Lucy Gayheart* (1935) she reflected the other side of her experience—the struggle of a talent to emerge from the constricting life of the prairies and the stifling effects of small town life.

A mature statement of both themes is to be found in three long tales included in *Obscure Destinies* (1932). With success and middle age, however, Miss Cather experienced a strong disillusionment. Her feeling that her world had been swept away by the war is reflected in *The Professor's House* (1925) and her essays *Not Under Forty* (1936). Her solution was to write of the pioneer spirit of another age, that of the French Catholic missionaries in the southwest and the French Canadians at Quebec, in *Death Comes for the Archbishop* (1927) and *Shadows on the Rock* (1931). Her last novel, *Sapphira and the Slave Girl* (1940), marked a return to the Virginia of her ancestors and her childhood. Because of her admiration for French Catholicism, her readers often assume that Miss Cather, who was born a Baptist, underwent conversion to Catholicism. Actually she became an Episcopalian in 1926.

Miss Cather's novels were written with great simplicity and charm. They are nearly all "success" stories; they contain no love themes to speak of, nor do they explore the inner life of the characters. They exalt the American spirit and the conquest of material hardships in the new world. Her art is distinctly minor and elegiac; of its kind it has genuine distinction, and has had wide appeal. She died on April 24, 1947, in New York city.

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The early life of Miss Cather is told in Mildred R. Bennett, *The World of Willa Cather* (1951). (Lx. E.)

CATHERINE (Aikaterine), **SAINT,** of Alexandria, a virgin martyr said to have died at Alexandria at the beginning of the 4th century; but she is nowhere mentioned before the 8th, and her historicity is doubtful. According to the legend, which exists in various versions, she was an extremely learned young girl of noble family who protested against the persecution of Christians under the emperor Maxentius, defeated the most eminent scholars in argument, broke the wheel to which she was tied and was then beheaded. It is said that after her death angels took her body to Mt. Sinai, where it was discovered about A.D. 800. In the middle ages she was one of the most popular saints. Her symbol being a spiked wheel, she is the patron saint of wheelwrights, and also of virgins and scholars. The story of her mystical marriage to Christ dates from the late middle ages. She is one of the 14 auxiliary saints and her feast day is Nov. 25.

See M. J. F. R. I. H. Bremond, *Sainte Catherine d'Alexandrie* (1917); H. Thurston and D. Attwater (eds.), *Butler's Lives of the Saints*, vol. 4, pp. 420–421 (1956). (H. C. G.)

CATHERINE, SAINT, of Bologna (Caterina Vigri) (1413–1463), a Poor Clare whose spiritual writings were very popular in Italy until the end of the 18th century, was born into a noble family at Bologna on Sept. 8, 1413. She was educated at the court of the princess of Este at Ferrara, and entered the order in 1432. In 1456 she founded in Bologna a convent of Poor Clares of which she was the abbess until her death there on March 9, 1463. She was canonized in 1712, and her feast day is March 9. Throughout her life St. Catherine had visions and revelations. Her chief work is *Le arme necessarie alla bataglia spirituale*, composed in 1438 (Eng. trans. by A. G. McDougall, *The Spiritual Armour*, 1926).

See H. Thurston and D. Attwater (eds.) *Butler's Lives of the Saints*, vol. 1, pp. 536–539 (1956); J. Stiénon du Pré, *Ste. Catherine de Bologne* (1949). (H. C. G.)

CATHERINE, SAINT, of Genoa (Caterina Fieschi Adorno) (1447–1510), Italian mystic, was born in Genoa into a distinguished family and received a careful education. Her early aspirations to become a nun were frustrated by her relatives, who married her to Giuliano Adorno, a young man of difficult character. After several years of unhappiness she succumbed to the attractions of a gay life for a time, but was converted by a mystical experience in 1473, which marked the beginning of her life of close union with God. This she combined with the assiduous service of the sick in a hospital at Genoa, in which her husband joined her after he, too, had been converted. She died on Sept. 15, 1510. She was beatified in 1737, and her name was added to the Roman martyrology, with the title of saint, by Benedict XIV; feast day Sept. 15.

St. Catherine's two works, the *Trattato del Purgatorio* and the *Dialogo*, are the outcome of her mystical life. Her authorship of these has been denied, but according to Umile Bonzi da Genova a large part of both works is her own, though they received their final form only after her death. Together with her life, they were first printed in 1551 (Eng. trans. of works by C. Balfour and H. D. Irvine, 1946).

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CATHERINE, SAINT, dei Ricci (Caterina, formerly Alessandra, dei Ricci) (1522–1590), Italian Dominican mystic, was born at Florence on April 23, 1522. At the age of 13 she entered the Dominican convent at Prato, whose prioress she was from 1560 to 1590. She was famous for her visions of the Passion and her stigmatization, and was the author of letters (ed. by Fr. Sisto of Pisa, 1912) and other minor works. She died in Prato on Feb. 1 or 2, 1590. Her admiration for Savonarola delayed her canonization, which took place in 1746. Her feast day is Feb. 13.

See F. M. Capes, *St. Catherine dei Ricci* (1905). (H. C. G.)

CATHERINE, SAINT, of Siena (Caterina Benincasa) (1347–1380), the greatest of the 14th-century Italian mystics, was born at Siena in 1347, the daughter of a dyer. When she was about seven she had her first vision. About 1360 she became a tertiary of the Dominican order, joining the Sisters of Penitence of St. Dominic in Siena and rapidly gaining a wide reputation for her holiness and her severe asceticism.

When Florence was placed under an interdict by Pope Gregory XI in 1376, Catherine determined to take public action to secure a double aim: peace within the church itself and in Italy and a crusade against the Muslims. She went as an unofficial mediator to Avignon with her confessor and biographer Raymond of Capua. Her mission was unsuccessful and she was virtually ignored by the Holy See, but she took advantage of being in Avignon to press her plans for a crusade. It was now clear to her that the return of the pope to Rome, an idea that she did not initiate and previously had not greatly encouraged, was the only way to bring peace to Italy and thus to facilitate a crusade. Catherine left for Tuscany the day after Gregory XI set out for Rome. At his request she went at the beginning of 1378 to Florence, where she was during the Ciompi revolt in June. After a short final stay in Siena, during which she completed her *Dialogo*, begun the previous year, she went to Rome in November, probably at the invitation of Pope Urban VI (*q.v.*), whom she helped in reorganizing the church. Then she tried to restore Joanna I of Naples, a supporter of the antipope Clement VII, to obedience to Urban. But her physical energy was exhausted; she died in Rome on April 29, 1380, attended by a small group of disciples who had remained faithful to her throughout adversity. She was canonized in 1461 and declared patron saint of Italy in 1939. Her feast day is April 30.

Her writings (all of which were dictated) include *Il libro della divina dottrina*, better known as the *Dialogo*, about 380 letters and 26 prayers. They reveal an exceptional political flair as well as deep spirituality. The record which the *Dialogo* contains of her experiences in a state of ecstasy serves to illustrate her doctrine of the "inner cell" of the knowledge of God and of self into which she withdrew.

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CATHERINE, SAINT, of Sweden (Katarina Ulfsdotter) (1331–1381), the constant companion of her mother, St. Bridget of Sweden (*q.v.*), whom she succeeded as superior of the Brigittines (*q.v.*). Her husband, Egard Lydersson of Kyren, died shortly after she joined her mother in Rome in 1349. She did not return to Sweden until 1373 after St. Bridget's death. She took part in the ecclesiastical controversies of her time and supported Urban VI against the antipope. She died on March 24, 1381, as abbess of Vadstena. Her feast day is March 24.

See H. Thurston and D. Attwater (eds.), *Butler's Lives of the Saints*, vol. i, pp. 669–671 (1956). (H. C. G.)

CATHERINE I (1684–1727), empress of Russia, consort and successor of Peter the Great, was the daughter of a Lithuanian peasant who died when she was a child. Marfa Skavronskaya, as she was then called, became a servant in the home of Pastor Glück, the Protestant superintendent of the Marienburg district, and married a Swedish dragoon called Johan. When the Swedes evacuated Marienburg (1702), Marfa became one of the prisoners of war of the Russian marshal B. P. Sheremetev, who sold her to Prince A. D. Menshikov (*q.v.*). At Menshikov's house Peter the Great became her lover. In 1703, after the birth of their first daughter, Marfa was received into the Orthodox Church, when she was rechristened under the name of Catherine (Ekaterina) Alekseevna, the tsarevitch Alexis being her godfather. Peter, who had divorced the tsaritsa Eudoxia, then made Catherine his inseparable companion. She was with him during the campaign of the Pruth (1711), and he always attributed the successful issue of that disastrous war to her courage and *sang-froid*. He married her publicly in Feb. 1712. He was devoted to her, and she was able to act as a buffer between him and his advisers in his frequent accesses of rage.

By the *ukaz* of 1722, Peter reserved the right to designate his successor—to the exclusion of the grand duke Peter, the only son of the tsarevitch Alexis. Though he never availed himself of this right, he had Catherine crowned as empress-consort in the Uspenski cathedral in Moscow on May 18 (new style; 7, old style), 1724. She attended Peter during his last illness and closed his eyes when he died on Feb. 8 (N.S.; Jan. 28, O.S.), 1725. She was at once proclaimed empress regnant by Menshikov and Count P. A. Tolstoi, with support of the guards.

The Academy of Sciences, planned by Peter, was opened under Catherine (1725). The great administrative innovation of her reign, however, was the establishment, in 1726, of the supreme privy council, which considerably reduced the roles of the senate and synod and concentrated executive power in the hands of a few persons. Menshikov, however, continued to dominate affairs and prevailed on Catherine to designate the grand duke Peter as her successor and to agree that he should marry Menshikov's daughter Maria. Foreign policy was principally directed by the astute A. I. Osterman (*q.v.*). Tension grew up between Russia and Great Britain chiefly because George I feared that Russian protection of Charles Frederick of Holstein-Gottorp, who had married Catherine's daughter Anne, might result in Hanover's losing Bremen and Verden, which George had acquired since Charles Frederick had been deprived of Schleswig. A British squadron was sent to the Baltic and anchored at Reval in the spring of 1726. Though the fleet was withdrawn after the empress had protested, she acceded to the Austro-Spanish league against Great Britain in Aug. 1726. Catherine died on May 17 (N.S.; 6, O.S.), 1727. Though quite illiterate, she had proved herself an extremely shrewd and sensible woman. (X.; Lo. L.)

CATHERINE II the Great (1729–1796), empress of Russia from 1762 to 1796, was born at Stettin on May 2 (new style; April 21, old style), 1729, the daughter of the German prince Christian Augustus of Anhalt-Zerbst and his wife Johanna Elizabeth of Holstein-Gottorp. Her baptismal name was Sophia Augusta Frederica. In 1744 she was taken to Russia to be affianced to the grand duke Peter, nephew and heir of the empress Elizabeth. Frederick the Great of Prussia favoured the alliance, his objects being to strengthen the friendship between his kingdom and Russia, to weaken the influence of Austria in Russia and to ruin the chancellor A. P. Bestuzhev-Ryumin (*q.v.*), who was a partisan of the Austrian alliance. The diplomatic intrigue failed, but Sophia won the empress Elizabeth's affection and the marriage was finally decided upon. On July 9 (N.S.; June 28, O.S.), 1744, she was received into the Orthodox Church in Moscow and renamed Catherine (Ekaterina) Alekseevna. On Aug. 21 (N.S.; 10, O.S.), 1745, in St. Petersburg, she was married to the grand duke.

Catherine's married life was unhappy, as her husband was subnormal in physique and in mind and she despised him. Clever and ambitious, however, she accepted the conditions of her marriage because they were a means to power. For 17 years, therefore, she matured her mind and avoided a breach with Elizabeth. The marriage was barren for its first nine years, and the only reason for supposing that the future emperor Paul (born in 1754) was Peter's son was his strong resemblance to Peter in appearance and character. Catherine's scandalous behaviour, meanwhile, was the talk of Europe. Many of her most trusted agents and ministers, both before and after she became empress, were also her lovers.

Accession.—The empress Elizabeth died on Jan. 5, 1762 (N.S.; Dec. 25, 1761, O.S.). The grand duke then succeeded without opposition as Peter III. He committed every possible folly, groveled before Frederick the Great, insulted the church and threatened to divorce Catherine. She refrained from open opposition and acted with the prudence that she had already shown. In June, however, Peter retired to Oranienbaum, 18 mi. from St. Petersburg, leaving Catherine in Peterhof. Then Catherine's lover Grigori Grigorievich Orlov (*q.v.*) and his brother Aleksei persuaded the guards to undertake a *coup d'état*. In the early morning of July 9 (N.S.;

June 28, O.S.) Catherine was secretly escorted to St. Petersburg where she was enthusiastically acclaimed as empress in spite of the earlier scheme, put forward by Nikita Panin, for installing her merely as regent for her son Paul, who was simply proclaimed heir to the throne. The hatred felt for Peter made Catherine's accession to his place easy, and she issued a manifesto representing herself as the defender of the Orthodox faith and of the glory of Russia. Toward the evening, Catherine set forth at the head of her troops to Oranienbaum. Peter did not dare to resist and abdicated the next day. He was sent to a country house at Ropsha, where he died on July 17 (N.S.; 6, O.S.), in the course of a scuffle during dinner. Aleksei Orlov, his custodian, claimed to be unable to remember how this had happened. Catherine, who had not decided what to do about Peter and who was alarmed at the prospect of being suspected of having instigated his murder, issued a second manifesto declaring that she accepted the throne for the good of the country. It was several years, moreover, before she could feel completely secure on the throne. She received a great shock in 1764 when a young officer Vasili Yakovlevich Mirovich attempted to restore the imprisoned emperor Ivan VI (*q.v.*) to the throne.

Internal Affairs.—Catherine the Great ruled Russia for 34 years. Though born a German, she identified herself completely with the Russian people. She was in the truest sense the successor of Peter the Great. Her private life was the object of unceasing curiosity and interest, and a mass of literature has grown up about her lovers and her relations with them. Catherine, however, was never dominated by her lovers, who were the instruments of her policy; it was she who governed Russia, not her favourites. Her main interests were intellectual and political, and her love affairs subsidiary. She was the disciple and friend of the French Encyclopaedists, especially of Voltaire, whose works had first awakened her mind. She corresponded with him, with D'Alembert and, more voluminously, with F. M. Grimm, who spent nearly a year at her court (1777–78) and found her conversation even more brilliant than her letters. Catherine also corresponded at intervals with Frederick the Great and with the Holy Roman emperor Joseph II. Her letters are graceful and witty and show real political and diplomatic insight. She was determined to make Russian society as cultivated as the society of Paris and Berlin. She insisted on a high standard of decorum and of manners at court, encouraged the nobles to travel and fostered the love of French culture. Attaching the greatest importance to education, she formed the first closed educational institutions for girls in Russia (1764). She employed Grimm and others to collect works of art and antiquities for her and practised sculpture and painting herself. She had a passion for reading, made a digest of Blackstone's *Commentaries* and found Buffon's *Histoire naturelle* light reading. Her enthusiasm for Russian history led her to begin writing a history of Russia from the earliest times, and she completed a play, on Shakespearian lines, about the legendary Oleg. She also wrote numerous comedies, proverbs and tales. To find time for all her activities she rose at 5 A.M. and would sometimes work 15 hours a day.

Catherine had great charm and was loved by her servants. She was not revengeful and showed no hostility to her husband's advisers after she had usurped the throne. Nevertheless she possessed a streak of masculine hardness and showed no kindness to her son Paul, whom she deliberately kept at a distance as part of her policy. Her attention and care went to her grandson, the future Alexander I (*q.v.*), whose well-being and education she closely supervised from his very birth (1777). She clearly intended to make him her successor instead of his father Paul, but in the end refrained from doing so.

A disciple of the Encyclopaedists, Catherine naturally began with the definite intention of carrying out domestic reform in Russia, in accordance with the contemporary practice of "enlightened despots." In the event, however, her foreign origins and the fact of her having usurped the throne made her dependent for support on the nobles, whose privileges she vastly increased (particularly by the administrative reform of 1775 and by the "Letter of Grace to the Nobility" of 1785) and to whom she gave new powers over their serfs. She also increased their numbers by grants of crown land. The terrible conditions to which the peasants were reduced led to one revolt after another, culminating in the widespread rising on the Volga in 1773–75 under E. I. Pugachev (*q.v.*). The atrocities committed during the suppression of this rising were in startling contrast with the humanitarian tone of the "Instruction" (1767), which Catherine had drawn up for the grand commission summoned to Moscow in Dec. 1766 to advise on internal reform. This "Instruction," based principally on the works of Montesquieu and C. B. de Beccaria, was so radical that its circulation in France was forbidden, but very little came of the 18 months work of the grand commission until the promulgation, years later, of new ordinances on provincial government (1775) and on municipal government (1785).

Catherine, however, introduced some remarkable measures for the care of the sick and needy. She founded a special medical college, which had to provide all towns with a regular medical service. Also, to set an example, she and her son submitted to the new practice of vaccination.

With the outbreak of the French Revolution, Catherine, like other European sovereigns, fell back on methods of repression. A. N. Radishchev, whose *Journey From St. Petersburg to Moscow* (1790) gave a frank account of the condition of the peasants, was banished to Siberia, although his sentiments were only those of Catherine's own "Instruction" of 1767. Yet she had some able assistants in her domestic administration, notably J. J. Sievars and Count I. I. Betski. On economic problems she followed the teachings of Adam Smith.

Foreign Affairs.—Catherine conducted her own foreign policy. It aimed at the expansion of Russia and was brilliantly successful. Though she could not carry all her projects through, her foreign policy gave Russia unprecedented power and represented a continuation of Peter the Great's achievements. She knew how far she could safely go in the russification of frontier districts and showed a certain liberality to annexed populations.

Up to 1779 Catherine was guided by the idea of a "Northern accord" or "Northern system," which might have secured the political equilibrium of Europe. When this came to nothing, she turned to her famous Greek project, which aimed at expelling the Turks from Europe and restoring the Byzantine empire. In 1780, during the American Revolution, she promoted "armed neutrality at sea."

The many great soldiers and diplomats whom she gathered round her obeyed her instructions implicitly. She had the gift of discovering ability and kept in close touch with all her servants. Among her generals were Aleksandr Mikhailovich Golitsyn, P. A. Rumyantsev, Petr Ivanovich Panin, A. V. Suvorov and G. A. Potemkin. Though Suvorov was one of Russia's greatest generals, Catherine never confided in him quite so much as in Potemkin, whose military abilities were mediocre, but who was first her lover, then her close friend and correspondent. It was at Potemkin's suggestion that she undertook her famous journey (1787) to the south, during which she visited recently acquired territories in the Crimea and also met Joseph II. Her chief advisers and assistants in foreign affairs were Nikita Panin, A. A. Bezborodko, N. V. Repnin, Dmitri Alekseevich Golitsyn and the Vorontsovs.

In 1772 the first partition of Poland took place (*see* POLAND: *History*). The second and third partitions (1793 and 1795) unfortunately gave to Russia not only territories that were ethnically Russian or Ruthenian but also large parts of Poland proper not even coveted by Catherine. In Catherine's two wars against Turkey (1768–74 and 1787–92), Russia won the Crimea and free access to the Black sea (*see* RUSSIA: *History*). It was mainly Catherine's skilful diplomacy that finally secured Russia's territorial gains, both in the west and in the south, though her generals and ministers served her well.

Catherine died of apoplexy on Nov. 17 (N.S.; 6, O.S.), 1796, in St. Petersburg. Already in 1767 the grand commission had offered her the style of "the Great," but she did not use it herself. The Imperial Russian Historical society began the publication of her correspondence in 1867. There is a collection of her writings edited by A. V. Pypin and published by the Russian Academy of Sciences, 12 vol. (1901–07), and editions of her *Mémoires* in French by A. Herzen (1859) and in English, *The Memoirs of Catherine the*

Great, by D. Maroger (1955). There are also English texts of her correspondence with Voltaire, together with the "Instruction" of 1767, ed. by W. F. Reddaway (1931); and of her correspondence with Sir Charles Hanbury-Williams, ed. by the earl of Ilchester and E. Langford-Brooke (1929).

See also references under "Catherine II" in the Index volume.

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CATHERINE (CATHERINE HOWARD) (d. 1542), fifth queen consort of Henry VIII of England, was one of the ten children of Lord Edmund Howard (d. 1539), a poverty-stricken younger son of Thomas Howard, 2nd duke of Norfolk (d. 1524). After her mother's death she lived with Norfolk's widow Agnes. In that lax household she had several lovers: Henry Mannock, her music teacher; Francis Dereham, who called her his wife; and her cousin Thomas Culpepper, to whom she may have been engaged. She was brought to the notice of Henry VIII by Stephen Gardiner, bishop of Winchester and rival of Thomas Cromwell, in 1540, when the king was tiring of Cromwell's policies and of his marriage with Anne of Cleves. Henry married Catherine privately on July 28, publicly acknowledged her as queen on Aug. 8 and for the next 15 months appeared much enamoured of her. But Thomas Cranmer, archbishop of Canterbury, informed him in Nov. 1541 of her misconduct before her marriage and further inquiry revealed more recent meetings with Culpepper and with Dereham, now her secretary. Dereham and Culpepper were executed in December and their accomplices imprisoned. All, like Catherine herself, denied any misconduct since her marriage. Parliament passed a bill of attainder against her, which declared it treason for an unchaste woman to marry the king (Feb. 11, 1542), and Henry, who seems to have been deeply and genuinely distressed, was invited to give it his assent by letters patent without any words or ceremony. Catherine, the least innocent, and in appearance the least unattractive, of Henry's wives, was beheaded in the Tower of London on Feb. 13, 1542.

See L. B. Smith, *A Tudor Tragedy* (1961). (R. B. WM.)

CATHERINE (CATHERINE PARR) (1512–1548), sixth queen consort of Henry VIII of England, was a daughter of Sir Thomas Parr (d. 1517) of Kendal, an official of the royal household. She had two husbands, Edward Borough (d. *c.* 1529) and John Neville, Lord Latimer (d. 1542 or 1543), before she married Henry VIII on July 12, 1543. Small and not beautiful, but tactful and accomplished, she exerted a beneficial influence during the last years of the king's reign. She was on very friendly terms with his three children and took a close interest in their education. She also did what she could to mitigate religious persecution under the Act of Six Articles (1539) and, if John Foxe's *Book of Martyrs* may be believed, herself only escaped arrest on a charge of heresy by tactful flattery of the king. Soon after Henry's death in Jan. 1547 she married a former suitor, Thomas, Lord Seymour of Sudeley, brother of the protector Edward Seymour, duke of Somerset, who at first opposed the match. She died, shortly after giving birth to a daughter, at Sudeley castle, Gloucestershire, on Sept. 7, 1548. A woman of strong piety and considerable learning, Catherine wrote *A Lamentacion or Complaynt of a Sinner* (1548), which was published after her death. (R. B. WM.)

CATHERINE OF ARAGON (1485–1536), first queen consort of Henry VIII of England, youngest daughter of Ferdinand II of Aragon and Isabella of Castile, was born at Alcala de Henares on Dec. 16, 1485, and by the treaty of Medina del Campo (1489) was betrothed to Arthur (b. 1486), eldest son of Henry VII of England. The contract was renewed several times and in the autumn of 1501 Catherine came to England and married Arthur on Nov. 14. She spent the winter with him at Ludlow castle but there, on April 2, 1502, he died. Catherine was betrothed to the king's second son, Henry, in June 1503, and a papal dispensation was obtained for this alliance within the forbidden degrees of consanguinity. But after her mother's death (1504), these plans were interrupted by the struggle between her father Ferdinand and her Habsburg brother-in-law Philip of Burgundy for control of Castile, which, since it caused Ferdinand to ally with France, necessarily drove Henry VII into alliance with the Habsburgs and Burgundy. The negotiations for Catherine's remarriage were thus delayed and she became severely straitened for money. Then, suddenly, the death of Henry VII removed all obstacles. The young Henry VIII, reversing his father's policy, promptly married Catherine on June 11, 1509. For some years he showed himself an affectionate and, by contemporary princely standards, a not unfaithful husband. Catherine shared his interest in learning and letters, in music and dancing, even in sport. She shared also his hostility to France and encouraged him to revive the Spanish alliance and to embark upon the French war of 1511–14. While he was campaigning in France in 1513, she acted as regent and organized England's defenses against the Scottish invasion that was so decisively crushed at the battle of Flodden (Sept. 9).

But Ferdinand failed to play his promised part in the war in 1512 and 1513, and, although the 1514 Paris report that Henry in his anger was contemplating a divorce was probably unfounded, he did make a separate peace, marrying his sister Mary to Louis XII (Oct. 1514). Louis' death (Dec. 31, 1514) and the mounting rivalry between Henry and the new French king, Francis I, soon cooled this entente; but Catherine's failure to produce a male heir to the throne was a more serious threat to her position. She gave birth to six children, including two sons, between Jan. 1510 and Nov. 1518, but all were stillborn or died in very early infancy, except Mary (b. 1516). The Wars of the Roses were still a living memory and it is clear that, as early as 1519–20, Henry's anxiety about the succession boded ill for the continuance of his marriage. The crisis was postponed for a few more years because in 1522, largely through Catherine's influence, her nephew and Ferdinand's grandson, the young emperor Charles V, pledged himself to marry Princess Mary in return for English aid in his war against France. This match with the ruler of the Empire, Spain and the Netherlands might, if the schemes to conquer France succeeded, bring to Charles and Mary "the whole monarchy of christendom" and this glittering prospect temporarily allayed Henry's anxiety about the succession. But when Charles, after beating the French at Pavia (Feb. 1525), not only refused to invade France but also jilted Mary for a Portuguese princess, the problem could no longer be shelved.

Henry's first step was to create Henry Fitzroy, his only illegitimate son, duke of Richmond—Henry VII's title before 1485—and to give him precedence even over Mary. However, an illegitimate male heir was hardly better than a legitimate female heir; and probably by 1526 Henry's infatuation for Anne Boleyn was already encouraging more drastic action. He allowed a secret suit to begin, in May 1527, before archbishops Wolsey and Warham, for the annulment of his marriage to his brother's widow that had been so blighted by the curse of Leviticus (xx, 21). This came to nothing, for Catherine forewarned the pope and emperor and insisted that her cause should be tried at Rome. The case was difficult for Pope Clement VII, since Henry's demand for an annulment entailed the invalidating of a previous pope's dispensation. Moreover imperial troops had just sacked Rome (May 6, 1527) and made Clement practically a prisoner of Catherine's nephew the emperor Charles V. For a time the French invasion of Italy in 1528 made possible papal concessions that culminated in the decretal commission to cardinals Wolsey and Campeggio to try the case in England but when the legates opened their court (May 31, 1529) Catherine denied their jurisdiction and again appealed to Rome. A few weeks later the defeat of the French in Italy at the battle of Landriano (June 21) and Clement's final capitulation to Charles V at Barcelona (June 29) brought the revocation of the cause to Rome (July 1529) and a brief (March 1530) forbidding Henry to marry again until the papal verdict was pronounced.

But Clement was in no hurry to pronounce and Henry took the law into his own hands, finally separating from Catherine in July 1531. His new archbishop of Canterbury Thomas Cranmer annulled their marriage on May 23, 1533, four months after Henry had secretly married Anne Boleyn. Then followed the series of acts repudiating all papal jurisdiction in England and the 1534 Succession act that declared Catherine's marriage null, bastardized Mary and made Anne's child heir to the throne. Only then, on March 23, 1534, did the pope at last declare Catherine's marriage valid. During these unhappy years she showed the same dignified obstinacy as in 1503–09, insisting that, as her marriage to Arthur had never been consummated, she was Henry's lawful wife. She refused to retire to a nunnery, or to exchange her title of queen for that of princess dowager or to accept the 1534 Succession act. Increasingly cut off from her friends, from reliable advisers, even from her daughter, her health eventually gave way and she died at Kimbolton, Huntingdon, on Jan. 7, 1536.

See G. Mattingly, *Catherine of Aragon* (1942). (R. B. Wm.)

CATHERINE of Braganza (1638–1705), queen consort of Charles II of Great Britain, was born at Vila Viçosa, Port., on Nov. 25, 1638, daughter of the future king John IV of Portugal. She was a useful medium for contracting an alliance with England and negotiations for a marriage, begun during the reign of Charles I, were renewed immediately after the Restoration. On June 23, 1661, in spite of Spanish and Dutch opposition, the marriage contract was signed. By it England secured Tangier and Bombay, valuable trading privileges, religious and commercial freedom in Portugal and 2,000,000 Portuguese crowns (about £300,000) in return for military and naval support to be given to Portugal against Spain and liberty of worship for Catherine.

In May 1662 Catherine reached England, and the marriage took place in Portsmouth. Catherine had little personal charm, and Charles's preoccupation with his mistresses soon provoked a scene at court, where Catherine at first refused to receive the reigning favourite, Lady Castlemaine. Eventually, Catherine came to accept the position and showed considerable kindness to the king's mistresses and bastards. Charles, in return, generally treated her fairly kindly, but she always played a very secondary role at court. As the prospect of her bearing children diminished, schemes were set on foot to procure a divorce on various pretexts. As a Roman Catholic, Catherine was attacked by the inventors of the "popish plot," the murder of Sir Edmund Berry Godfrey was ascribed to her servants in 1678 and Titus Oates accused her of a design to poison the king. Oates brought a charge of high treason against her on Nov. 24, the commons passed an address for her removal from Whitehall and it was only the king's protection that saved her from having to stand trial in June 1679. On Nov. 17, in the house of lords, the earl of Shaftesbury moved for a divorce so that Charles might marry a Protestant, but the bill was opposed by the king and found little support among the peers. After the Oxford parliament (1680) Charles's influence revived and the queen's position was no more assailed.

During Charles's last illness in 1685 Catherine did much to assist his reconciliation with the Roman Catholic Church, and she exhibited considerable grief at his death. She interceded with generosity, but ineffectually, for the duke of Monmouth the same year. On June 10, 1688, she was present at the birth of the prince of Wales and later gave evidence before the council that he was in fact Mary of Modena's child. She maintained at first good terms with William and Mary, but the practice of her religion aroused jealousies, while her establishment at Somerset house was said to be the home of cabals against the government. She finally left England for Portugal in March 1692. In 1704 she was appointed regent of Portugal during the illness of her brother Pedro II. She died on Dec. 31, 1705.

See L. C. Davidson, *Catherine of Bragança* (1908); J. Mackay, *Catherine of Braganza* (1937). (H. G. Ro.)

CATHERINE de Médicis (1519–1589), queen consort of Henry II of France and regent during the minority of Charles IX, throughout whose whole reign she controlled royal policy, was born in Florence on April 13, 1519, the daughter of Lorenzo de' Medici, duke of Urbino, and Madeleine de la Tour d'Auvergne. In 1533 she was married to the duc d'Orléans, who in 1547 became king of France as Henry II. The marriage was barren for its first ten years, after which Catherine had five sons and five daughters. Throughout Henry's reign she played little part in politics, as he was completely under the influence of his mistress Diane (*q.v.*) de Poitiers, duchesse de Valentinois. In 1552, however, when Henry II left the kingdom for the campaign of Metz, Catherine was nominated regent, but only with very limited powers.

Catherine still had little authority when her eldest son became king as Francis II on Henry II's death in 1559, since Francis was under the influence of his consort Mary Stuart, whose uncles François, duc de Guise, and Charles, cardinal de Lorraine, were dominant at court. When Francis II died (Dec. 1560), however, Catherine became regent for the new king, his brother Charles IX. Though her regency ended in 1563 she dominated Charles for the rest of his life. (For the state of affairs with which he had to contend *see* France: *History*.) Perpetually anxious about her son's position, which was always threatened on the one hand by Guise ambitions and on the other by the pretensions of the Huguenot princes of the house of Bourbon and their allies, she did not hesitate to set the rival parties against each other when one group seemed to her too powerful. The house of Montmorency, however, on which she might have relied to hold the balance of power, was divided: the constable, Anne, duc de Montmorency, was a Catholic and eventually overcame his hostility to the Guises, whereas his nephews of the house of Châtillon-Coligny were Huguenots. On April 1, 1560, Catherine had appointed Michel de L'Hospital as chancellor, and from 1560 to 1567 she sought to follow his policy of religious conciliation.

There can be no simple definition of Catherine's own religious policy. She had been brought up as a Catholic, but she was by no means a fanatical one; she cared more for power than for any doctrine. Her repeated efforts to reconcile Catholics and Huguenots may be regarded as reflecting a belief, such as was held by many of her contemporaries, in the possibility of peaceful coexistence between the two. On the advice of the chancellor de L'Hospital, she arranged the colloquy of Poissy (1561), which failed, however, to achieve any understanding between the disputing groups. The edict of Jan. 1562 and the peace of Amboise (1563) accorded a reasonable tolerance to the Huguenots.

The renewal of civil war in 1567 frightened Catherine and caused her to give more sympathy to the Catholic party. When she found, however, that the Huguenots could not be crushed by force of arms, she resorted again to a policy of conciliation (peace of St. Germain, 1570), began to negotiate her daughter Margaret's marriage to the Protestant Henry of Navarre (afterward Henry IV of France) and welcomed the admiral Gaspard de Coligny back to court. Coligny, however, then acquired such an influence over Charles that Catherine became alarmed, both at the diminution of her own influence and at the prospect of war against Spain, which Coligny was urging. She therefore fell back on the Guises. On Aug. 22, 1572, four days after Margaret's wedding to Henry of Navarre, an unsuccessful attempt was made on Coligny's life; and on Aug. 24, with Catherine's consent, the massacre of St. Bartholomew's day (*q.v.*) began. For Catherine the ultimate consequence of this was that the crown seemed to be identified with the Guise faction and could no longer count on ready support either from Huguenots or even from moderate Catholics against it.

Henry III, who succeeded his brother Charles in 1574, showed himself more independent of his mother but unable to control the Guises, who soon eclipsed both mother and son. A few days after his attempt to assert himself by the assassination of Henry de Guise (Dec. 23, 1588), Catherine died, at Blois, on Jan. 5, 1589.

Catherine brought from Florence her taste for luxury and beauty. She built and decorated the Tuileries in Paris and gave, as frequently as civil war permitted, sumptuous feasts *à l'italienne* at Fontainebleau, in the Louvre and in the Tuileries. There is an edition of her letters by H. de la Ferrière and G. Baguenault de la Puchesse, ten volumes (1880–1905).

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CATHERINE of Valois (1401–1437), queen consort of

Henry V of England, daughter of Charles VI of France by Isabella of Bavaria, was born in Paris on Oct. 27, 1401, and, with her brothers and sisters, was much neglected in childhood by reason of her father's frequent madness and her mother's selfish indifference. After his accession to the throne (March 1413), Henry V renewed the negotiations for his marriage to Catherine started by his father Henry IV. His demand for a large dowry and the restoration of Normandy and Aquitaine led to war, and the marriage did not take place until June 2, 1420, after the signing of the treaty of Troyes. Catherine was crowned in Westminster abbey in Feb. 1421 and gave birth to a son, afterward Henry VI, in the following December. She joined Henry in France in May 1422 and returned to England after his death in the following August, residing first at Windsor and later at Baynard's castle, London.

From about 1425 gossip associated Catherine's name with that of a Welsh squire, Owen Tudor, and they seem already to have been married when, in 1428, at the instance of Humphrey, duke of Gloucester, an act of parliament was passed forbidding her marriage without the consent of king and council. Tudor was imprisoned in 1436 and Catherine retired to Bermondsey abbey, where she died on Jan. 3, 1437. By Tudor she had three sons and a daughter; the eldest son, Edmund, created earl of Richmond in 1452, was the father of Henry VII.

See A. Strickland, *Lives of the Queens of England*, vol. i (1864); J. H. Wylie and W. T. Waugh, *The Reign of Henry the Fifth*, 3 vol. (1914–29).

CATHODE, a "negative" electrode, the terminal by which electrons from a battery or other energy source enter an electrolyte, electron tube or any direct current load. *See* BATTERY; ELECTROCHEMISTRY; *see* also references under "Cathode" in the Index volume.

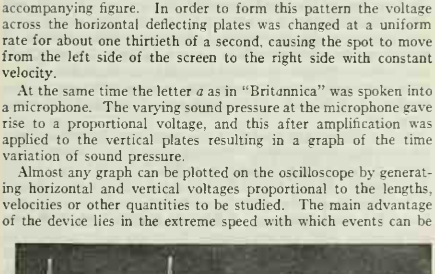
CATHODE-RAY OSCILLOSCOPE. This instrument makes use of a sharply focused electron beam to display scientific data on a luminescent screen similiar to that used in television.

As described in the article RADAR, the vacuum tube ordinarily used focuses the electrons emitted from a hot cathode into a narrow beam which serves as a pointer. The beam passes between two pairs of metal plates and is deflected in a horizontal direction by an amount proportional to the electrical voltage across one pair of plates while it is deflected vertically by the second pair. If desired, the intensity of the beam can be controlled by means of a third voltage placed on a metal mesh or grid near the cathode. After passing between the deflecting plates, the beam is allowed to impinge on a fluorescent screen which glows brightly at the point where the electrons hit it. The combination makes it possible to obtain a luminous graph relating the two applied voltages.

A typical application of the oscilloscope is illustrated by the accompanying figure. In order to form this pattern the voltage across the horizontal deflecting plates was changed at a uniform rate for about one thirtieth of a second, causing the spot to move from the left side of the screen to the right side with constant velocity.

At the same time the letter *a* as in "Britannica" was spoken into a microphone. The varying sound pressure at the microphone gave rise to a proportional voltage, and this after amplification was applied to the vertical plates resulting in a graph of the time variation of sound pressure.

Almost any graph can be plotted on the oscilloscope by generating horizontal and vertical voltages proportional to the lengths, velocities or other quantities to be studied. The main advantage of the device lies in the extreme speed with which events can be recorded: trace speeds of 200 in. in one-millionth of a second have been utilized.



BY COURTESY OF DAVID BOGEN CO.

TIME VARIATION OF SOUND PRESSURE IN A SHORT *a*, AS IN "BRIT*a*NNICA" (FIRST *a*)

Many variations of the oscilloscope tube have been made since the early one of Ferdinand Braun in 1897. Some for ultrafast measurements use patterns of microscopic dimensions; others for lecture purposes project the graphs on a motion-picture screen. It has become perhaps the instrument most generally used by radio laboratories and also by radio repairmen. It finds increasing use in almost all branches of engineering and science.

See also CATHODE RAYS; INSTRUMENTS, ELECTRICAL MEASURING; RADAR; TELEVISION.

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CATHODE RAYS are the streams of negatively charged particles leaving the negative electrode in a discharge tube containing a gas at a low pressure (*see* ELECTRICITY: *Magnetic Fields of Direct Currents: Masses of Electrons and Ions: Cathode Rays*). The cathode rays consist of electrons. Cathode rays have many applications, one of the chief being the excitation of X-rays by the impinging of swift electrons against a hard anticathode. This bombardment, besides exciting X-rays, generates a considerable amount of heat and the anticathode can be used as a cathode-ray furnace for melting small quantities of metal, etc. Forms of apparatus making use of the deflection of a beam of cathode rays by magnetic and electric fields are the cathode-ray oscilloscope (*q.v.*) or cathode-ray tube, which indicates the variation and values of an alternating current or voltage, and the cathode-ray manometer, in which a change of pressure is communicated to tourmaline (*q.v.*) crystals which become electrically charged and produce an electric field which is measured by a cathode-ray oscilloscope. The "picture" tubes of television and radar are other developments of the cathode-ray oscilloscope tube. *See* also ELECTRON TUBE. (H. B. LM.)

CATHOLIC, derived from a Greek word meaning "universal" and used by ecclesiastical writers since the 2nd century to distinguish the church at large from local communities or heretical and schismatic sects. A notable exposition of the meaning of the term as it had developed during the first three centuries was given by St. Cyril of Jerusalem in his *Catecheses* (348): the church is called catholic on the fourfold ground of its worldwide extension, its doctrinal completeness, its adaptation to the needs of men of every kind, and its moral and spiritual perfection. The theory that what has been universally taught or practised is true was first fully developed by St. Augustine in his controversy with the Donatists (393–420), but it received classic expression in a paragraph of St. Vincent of Lérins's *Commonitorium* (434), from which is derived the well-known formula "What all men have at all times and everywhere believed must be regarded as true." St. Vincent maintained that the true faith was that which the church professed throughout the world in agreement with antiquity and the consensus of distinguished theological opinion in former generations. Thus the term tended to acquire the sense of orthodox.

Some confusion in the history of the term has been inevitable as various groups that have been condemned by Rome as heretical or schismatic have not renounced their claim to the note of catholicity, so that in the modern world not only the Roman Catholic Church but also the Eastern Orthodox Church, the Anglican Church and a variety of national churches and minor sects claim to be catholic, if not the only true catholic church. From this point of view the meaning attached to the term catholic and the claim to catholicity will be conditioned by the theory of the nature and constitution of the church accepted, being rigid and exclusive or tolerant and comprehensive as that is rigid or tolerant. The earlier theologians of the Anglican Church were primarily interested in proving the agreement of Anglican theology with the teaching of the ante-Nicene fathers, but with the Oxford movement a school of theologians arose that interpreted the catholicism of the Church of England in a much wider sense (*see* ENGLAND, CHURCH OF). A product of this school was the so-called "branch theory" of the church, which maintained that the Anglican, Roman and Eastern Orthodox churches were all branches of the one true catholic church, and that reunion could be achieved by concessions of these three divisions on controversial questions that divided them without affecting their catholic character. But this theory was repeatedly condemned by Roman theologians. It also failed to recommend itself to the Eastern Orthodox Church.

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CATHOLIC ACTION, in the words of Pope Pius XI, is "the participation of the laity in the hierarchic apostolate, for the defense of religious and moral principles, for the development of a wholesome and beneficent social action, under the guidance of the ecclesiastical hierarchy, outside and above political parties, with intention of restoring Catholic life in the family and in society" (1922). Four characteristics of this work usually are listed: (1) it must be organized; (2) it must be done by the laity; (3) it must be under the direction or "mandate" of the bishop; and (4) it must be the work of the church, in the fields of dogma, morals, liturgy, education and charity.

A distinction normally is drawn between general and specialized Catholic Action. General Catholic Action organizations, such as the Holy Name society or the Legion of Mary, are open to all Roman Catholics, or at least all of a given age. Specialized Catholic Action groups are limited to members of a given profession or interest group: workers, students, doctors, lawyers, married couples, etc. The most famous of the specialized groups is the Jocists (Jeunesse Ouvrière Chretienne; in English-speaking nations called the Young Christian Workers, Y.C.W.), founded by Father Joseph Cardijn in Belgium after World War I, an organized association of factory workers. The specialized movements attempt to bring Christian principles to the particular environments of which its members are part. They normally meet in small groups and discuss passages from the Scriptures and social problems, using the inquiry method of observation, judgment and action. In the United States the best-known specialized movements are the Christian Family Movement, the Young Christian Workers and the Young Christian Students.

Even though Pius XI could say that the Jocists "perfectly interpreted" the principles of Catholic Action, it is clear today that the specialized movements cannot claim a monopoly on the term. In an address to the World Congress of the Lay Apostolate, Pius XII suggested that the term be used in a generic sense to apply to all organized movements of the lay apostolate recognized as such either by the bishops on a national level or by the Holy See.

It is commonly held that besides Catholic Action in the strict sense there is a broader area of the lay apostolate involving activity in the temporal society in, for example, politics, labour unions and co-operatives—institutions that are not strictly ecclesiastical and not under the immediate authority of the hierarchy but that are open to the influence of Christian inspiration. In such work the layman acts as a Christian but not as a representative of the hierarchy.

See C. K. Murphy, *The Spirit of Catholic Action* (1943).
(W. J. Q.)

CATHOLIC APOSTOLIC CHURCH, a religious community that arose in England early in the 19th century. The name was intended by the members to express their unity with all Christians in the one universal church, not to designate any doctrinal separation from those holding the Apostles' Creed. There had been widespread prayer throughout Christendom for the outpouring of the Holy Spirit, especially in preparation for the second advent. The founders of this community believed that God's answer was a restoration of the gifts of the Spirit (I Cor. xii, 7–11), including prophecy, and also of the ministries of apostles, prophets, evangelists and pastors (Eph. iv, 11). The term "Irvingites" sometimes applied to the Catholic Apostolic Church is repudiated by its members; Edward Irving (*q.v.*), best known of the clergy who fostered these prayers, cared for those expelled from other bodies for the exercise of their spiritual gifts, but died in 1834 while the movement was in embryo. The work of reorganization was done by all the "apostles," but largely at the beginning by Henry Drummond whose house at Albury park, Surrey, became a centre of the movement. During 1832–35, 12 men were designated as apostles by others having a prophetic gift. On July 14, 1835, they were "separated" by the angels (bishops) of the local congregations to which they belonged, to engage with the ministers associated with them in a special work of blessing and intercession for the whole church. The apostles spent a year together studying the Scriptures, and then, by contacts with the Anglican, Roman Catholic, Eastern and Reformed churches, assimilated the special truths and forms of worship treasured by each. The result of these contacts was the production, in about the year 1836, of a testimony that warned of the judgments threatening through the existing conditions, ecclesiastical and political, and pointed to God's way of deliverance.

Churches were established throughout Europe, North America and Australia. Each church had an angel, priests and deacons, the duties of the last named including management of its temporal affairs. *The Liturgy and Other Divine Offices* provided services in which vestments, lights and incense were used. The ministers were supported by tithes. Ordinations ceased with the death of the last apostle on Feb. 3, 1901. In the early 1960s there were few ministers remaining, most churches were closed but members still cherished their hope. They explain their position by a comparison with the mission of John the Baptist. As he preceded the Lord's first coming, so this apostolic work witnessed to his second coming.

See E. Miller (a former member but later an opponent), *History and Doctrines of Irvingism* (1878); P. E. Shaw, *The Catholic Apostolic Church* (1946), a thesis by a nonmember.

CATHOLICOS, a title applied in eastern churches to certain ecclesiastical superiors; in earlier times it was sometimes used, like archimandrite and exarch, of a superior abbot. In the Syrian, Assyrian and Georgian churches the chief bishops held this title. In the Armenian church there are two: the supreme catholicos of Etzchmiadzin and the catholicos of Sis. In these churches the catholicos thus has the position of a superior patriarch: the title catholicos-patriarch is sometimes used. (H. M. W.)

CATHOLIC UNIVERSITY OF AMERICA, a national pontifical institution of higher learning at Washington, D.C., was founded at the third plenary council of Baltimore, Md., in 1884, incorporated in 1887 and opened in 1889. *See* WASHINGTON, D.C.

CATHOLIC WORKER MOVEMENT, a Roman Catholic lay movement in the United States and Canada, emphasizing personal reform, radical agrarianism, absolute pacifism and the personal practice of the counsels stated in the Sermon on the Mount. The *Catholic Worker*, a monthly tabloid publication, was founded in 1933 by Dorothy Day at the instigation of Peter Maurin (d. 1949), who described himself as a peasant-philosopher and Christian radical. Maurin's program provided for round-table discussions of Christian social thought, the opening of houses of hospitality for all in need, and establishment of independent farming communes.

A group gathered in New York city under Miss Day's leadership put the program into action. Their example was followed by local groups in the United States and Canada, each of which operated independently. Before World War II there were 35 such groups, maintaining houses of hospitality and farming communes, scattered from Vermont to California. During the war the *Catholic Worker* maintained a strict pacifist position, but many young persons associated with the movement entered the armed services and houses of hospitality that had been in their charge went out of existence. The movement never regained its prewar influence but survived under Miss Day's leadership as a vital force in the Roman Catholic Church. It never sought nor was it granted ecclesiastical recognition. (J. C.)

CATHOLIC YOUTH ORGANIZATION (C.Y.O.), is an agency of the Roman Catholic Church serving youth in its religious, recreational, cultural and social needs; it was founded in Chicago in 1930 by Bishop Bernard Sheil. Membership is by participation, and the range of activities is designed to appeal to all boys and girls, beginning at six years of age, with the objective of character development and delinquency prevention. The various diocesan C.Y.O. programs include, for example, orphans' homes, music departments, scholarships, vacation centres, lecture bureaus, cultural and social programs for high-school students and a variety of athletic activities.

The entirely autonomous diocesan C.Y.O. programs are affiliated with the National Council of Catholic Youth. (W. J. Q.)

CATILINE (LUCIUS SERGIUS CATILINA) (*c.* 108–62 B.C.), a contemptuous and decadent but courageous Roman aristocrat who turned demagogue and in 63 B.C. made an unsuccessful attempt to overthrow the government. He served under Pompey's father in the Social War of 89, acquired an unsavoury reputation under Sulla, was acquitted on a charge of incest with a vestal virgin in 73, became praetor in 68 and governed Africa in 67–66. Under prosecution for extortion, he could not stand for the consulship of 65 or 64, but was eventually acquitted.

Though later there was talk of a conspiracy (the so-called "first Catilinarian conspiracy") to murder the consuls and seize the government early in 65, the fact that M. Licinius Crassus at first supported Catiline as a candidate for the consulship of 63 (and, with Caesar, even bribed on his behalf) shows that he was not then considered the enemy of men of property. Because of the support of the optimates, the "new man" Cicero (*q.v.*) was elected, with Gaius Antonius Hybrida. Catiline was again defeated a year later, in July 63.

After this failure he planned by armed insurrection in Italy and arson in Rome to overthrow the government, cancel debts and seize power. Outside Rome he gained support, chiefly in Etruria (especially at Arretium [Arezzo] and Faesulae [Fiesole], where an impoverished former centurion of Sulla, Gaius Manlius, collected an army) and in Campania, from malcontents who were largely, but not exclusively, veterans of Sulla who had failed to succeed as farmers. In Rome Catiline attracted disappointed politicians, debtors, criminals and many discontented young men of good breeding. Cicero did not trust his colleague, a known associate of Catiline; nevertheless, despite the proclamation of military law (the "last decree") on Oct. 22 and Catiline's withdrawal from Rome on Nov. 8, after Cicero's first speech against him, the senate was not convinced of the danger until early on Dec. 3 when envoys of the Gallic Allobroges were arrested outside Rome with documents which incriminated the conspirators who had been left in Rome, including a praetor P. Cornelius Lentulus Sura, who had been consul in 71 and expelled from the senate in 70. The incriminated men were arrested and executed on Cicero's responsibility on Dec. 5, after a debate in the senate in which Cato (Uticensis), advocating the death penalty, carried the house against Caesar's speech in favour of life imprisonment. Of the various armies which took the field against the revolutionaries at Faesulae, now commanded by Catiline himself, the largest was under Gaius Antonius. When Catiline tried to get over the Apennines into Gaul in Jan. 62, he was engaged at Pistoriae (Pistoia) and was killed with most of his followers, fighting bravely against great odds.

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CATINAT, NICOLAS (1637–1712), marshal of France, whose merit alone won him that dignity, was born on Sept. 1, 1637, son of a prominent Paris lawyer. Having joined the army, he received a captaincy in the French guards when Louis XIV noticed his courage at the siege of Lille (1667). From 1676 he was a staff officer employed by the marquis de Louvois, minister of war, in infantry organization; with his friend Vauban, he represented the thoughtful, hardworking background to the glory of king and army. A mission to Italy and a command at Casale (1682–87) taught him much about localities in Piedmont and about Victor Amadeus of Savoy. Lieutenant general in 1688, he shared with Vauban the real work in capturing Philippsburg on the Rhine. In 1690 the king and Louvois chose him for the small corps in the Alps. In fierce frontal attack (Aug. 18) at Staffarda he routed the duke of Savoy. He captured Susa and then proposed and executed the skilful diversion which took Nice. In March 1693 six great nobles and Catinat were made marshals. After a long defensive period in the Alpine valleys, reinforcements enabled him to save Pignerol (Pinerolo) in a bayonet fight at the battle of Marsaglia (Oct. 4). He was old and ill when the king sent him to Italy in 1701 at the beginning of the War of the Spanish Succession. When, for lack of troops, he retreated before Prince Eugène, Michel Chamillart, minister of war, sent the younger marshal de Villeroi to supplement him. Catinat indignantly watched Villeroi's failures. A wound sent Catinat back to France, and the king gave him the German command for 1702. He soon had to retire. He died at St. Gratien on Feb. 25, 1712. (I. D. E.)

CATION, a positively charged particle or ion which moves toward the negative electrode (cathode) during an electrolysis or an electrical discharge. The cation consists of a single atom or a group of atoms (radical) and bears a specific number of unit positive charges equal to its electrovalence. The silver ion (Ag^+) and the ammonium ion (NH_4^+) are both univalent cations while the mercurous ion (Hg_2^{2+}) and the cupric ion (Cu^{2+}) are bivalent cations. In solution the ion is usually in combination with a number of the solvent molecules. *See* also ELECTRICITY, CONDUCTION OF: *Conduction in Liquids;* ELECTROCHEMISTRY. (J. B. Ps.)

CATLIN, GEORGE (1796–1872), U.S. artist and author who specialized in painting American Indian scenes, was born July 26, 1796, at Wilkes-Barre, Pa. He practised law for a short time, but in 1823 turned to portrait painting, in which he was self-taught. Catlin had been interested in Indian life from his boyhood and in 1829 began a series of visits to various tribes, chiefly in the plains. He made more than 500 paintings and sketches, which he exhibited in a tour of the U.S. and Europe. In 1841 he published the two-volume *Letters and Notes on the Manners, Customs, and Condition of the North American Indians,* illustrated with many engravings.

In later years Catlin traveled through South and Central America, adding sketches to his collection. He died Dec. 23, 1872, in Jersey City, N.J. The bulk of the Catlin collection, which is mainly of ethnographic and historical interest, was acquired by the National museum, Washington, D.C.

His other works included *Catlin's North American Indian Portfolio: Hunting, Rocky Mountains and Prairies of America* (1845); *Catlin's Notes of Eight Years' Travels and Residence in Europe* (1848); *Life Among the Indians* (1867); *Last Rambles Amongst the Indians of the Rocky Mountains and the Andes* (1867).

See Harold McCracken, *George Catlin and the Old Frontier* (1959); Marvin C. Ross (ed.), *Episodes From Life Among the Indians and Last Rambles* (1959), both with illustrations.

CATO, MARCUS PORCIUS (called THE CENSOR) (234–149 B.C.), Roman statesman, orator and the first Latin prose writer of importance, whose reactionary and anti-Hellenic policy was opposed to the ideas exemplified by the Scipio family. Born of yeoman stock at Tusculum, he was bred to agriculture and fought in the Second Punic War, but his oratorical and legal skill and his rigid morality attracted the notice of L. Valerius Flaccus, who helped him to a political career at Rome. Quaestor under Scipio Africanus (204), aedile (199), praetor in Sardinia where he suppressed usury (198), this "new man" was elected consul for 195 with his friend Flaccus. As consul he opposed in vain the repeal of a measure that restricted female extravagance (*lex Oppia*) and then in an extensive and bitter campaign he repressed an insurrection in his province of Spain, for which he was granted a triumph. In 191 he served with distinction under Manius Acilius Glabrio at Thermopylae in the war against the Seleucid king Antiochus III, but later he denounced Glabrio and Q. Minucius Thermus in the law courts; after discrediting these men, who were political supporters of the Scipios, he attacked L. Scipio and Scipio Africanus (*q.v.*) and broke their political influence. This success was followed by his election to the censorship of 184, again with Flaccus as colleague.

His censorial activity reveals his policy, which aimed at preserving the *mos maiorum* ("ancestral custom") and combating the Greek influences encouraged by, *e.g.*, the Scipios and T. Quinctius Flamininus, which Cato believed were undermining older Roman standards of morality. He passed measures against luxury and revised the list of the senate with exceptional severity; he checked the tax gatherers, and promoted much public building including the *Basilica Porcia* (the first basilica in Rome). His censorship impressed later generations, but his policy was too reactionary; his anti-Hellenic attitude was retrograde and lacked wide support. He continued to preach his social doctrine and to fight political battles in the law courts, being himself prosecuted several times. Thus he supported such measures as the *lex Orchia* against luxury (181) and the *lex Voconia* (169) which checked the financial freedom of women: he attacked M. Fulvius Nobilior for his conduct of the censorship of 179 and Sulpicius Galba (consul 144 B.C.) for his cruelty in Lusitania in 151, and spoke against the Athenian philosophers who visited Rome in 155. In later years he may have somewhat moderated the rigidity of his life and become more receptive of Greek influences: he certainly turned to moneymaking and capitalist farming on a considerable, if disguised, scale. Although he wished to protect the well-being of the provincials, his attitude to foreign affairs was narrowly Italian. He rejected the liberal philhellenic policy of the Scipios and wished to have as few contacts with the Greek east as possible. Thus in 167 he supported the granting of independence to Macedonia and opposed the idea of declaring war on Rhodes. But his embassy to Carthage (probably 153) convinced him that the revived prosperity and strength of Rome's old enemy constituted a new threat: constantly repeating the advice "Carthage must be destroyed," he lived long enough to see war declared on Carthage in 149.

A traditionalist who held the family in high regard as an institution, he was a hard husband, a strict father and a cruel master. He made a great contribution to Latin literature, being the author of the first history of Rome in Latin; but his only surviving work is a treatise on agriculture (*De agri cultura*) written about 160 B.C. It dealt with the production of wine, oil and fruit and with grazing, but although it contains details of old customs and superstitions, it was a modern and practical handbook based on Cato's own experience of the capitalist farming that was developing in Latium and Campania. The *Origines*, in seven books of which only a few fragments survive, related the traditions of the foundation of Rome and other Italian cities and treated Rome's history to his own day. In the later books he included some of his own speeches, but at the same time he omitted the names of generals in order to emphasize the corporate achievement of the state. If he proclaimed a simple style(*rem tene, verba sequentur:* "Keep to the subject and the words will follow"), he was not untouched by Greek influences, which can also be detected in his speeches. Of these he published over 150, but only meagre fragments survive. He also compiled an encyclopaedia and *Praecepta* ("maxims") for his son, and works on medicine, jurisprudence and military science. He wrote a *Carmen de moribus* in verse, but the verse proverbs, known as *Catonis disticha*, belong to imperial times. Thus if Cato's contribution to political life was conservative and narrow, failing to recognize or meet the needs of his day, his influence on the growth of Latin literature was immense.

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CATO, MARCUS PORCIUS (called UTICENSIS) (95–46 B.C.), great-grandson of Cato the Censor and a leader of the optimates (the senatorial nobility) who tried to preserve the existence of the republic against powerful individuals, in particular Caesar. On the death of his parents, M. Porcius Cato was brought up in the house of his uncle, M. Livius Drusus (tribune 91). After serving in the ranks against Spartacus (72) and as military tribune in Macedonia (67), he became quaestor (64?), and showed so much zeal in managing the public accounts that he obtained a provincial appointment in Asia. He admired the discipline which L. Licinius Lucullus (*q.v.*) had enforced in his own eastern command, and supported his claims to a triumph, while he opposed the pretensions of Gnaeus Pompeius (*q.v.*). As tribune designate for 62 he supported the prosecution of Murena for bribery, and voted for the execution of the Catilinarian conspirators, thus incurring the resentment of Caesar. As tribune he opposed Metellus Nepos (who proposed the recall of Pompey to restore order) and increased the doles of cheap corn.

Cato's stubborn opposition to the wishes of Pompey, Caesar and Crassus helped to bring about their coalition in the so-called "first triumvirate." Cato's attempt, with Bibulus, to obstruct Caesar's agrarian legislation proved unsuccessful. Yet he was still an obstacle of sufficient importance for Pompey, Caesar and Crassus to desire to get rid of him. At Caesar's instigation he was sent to annex Cyprus (58). On his return two years later he continued to struggle against their combined powers in the city and became involved in scenes of violence and riot. As praetor in 54, he endeavoured to suppress bribery, in which all parties were equally interested. He failed to obtain the consulship of 51, and had decided to retire from public life when the civil war broke out in 49. He realized that the sole chance for the free state lay in supporting Pompey, whom he had formerly opposed. He was entrusted with the defense of Sicily, but finding it impossible to hold the island he joined Pompey at Dyrrachium. He was not present at Pompey's defeat by Caesar at Pharsalus, but after the battle he led a small remnant of their forces to Africa. After a famous march through the desert, he shut himself up in Utica, and even after the decisive defeat of the republican forces at Thapsus (46) he determined to keep the gates closed till he had evacuated his adherents by sea. When the last transports had left, he committed suicide.

During his last moments he had been reading *Phaedo*, Plato's dialogue on the immortality of the soul, but his own philosophy had taught him to act upon a narrow sense of immediate duty without regard to the future. He believed that he was placed in the world to play an active part, and when disabled from carrying out his principles, to retire gravely from it. He had lived for the free state, and it now seemed his duty to perish with it. He was a doctrinaire and obstructionist, an upright leader of the optimates in a corrupt age, and if he lacked constructive ideas he did not fail in courage nor in recognizing Rome's responsibilities to its provinces. His only surviving composition is a letter to Cicero (*Ad Familiares*, xv, 5). Immediately after his death Cato's character became the subject of discussion: Cicero's panegyric *Cato* was answered by Caesar's bitter *Anticato*. M. Junius Brutus (the assassin), dissatisfied with Cicero's work, produced another on the same subject; in Lucan's *Pharsalia*, Cato is represented as a model of virtue and disinterestedness. The Stoic nobles of the early principate regarded him as their saintly patron.

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CATO, PUBLIUS VALERIUS (b. *c.* 100 B.C.), Roman poet and grammarian, was the leader of the "new" school of poetry (*poetae novi*, as Cicero calls them). Its followers rejected the national epic and drama in favour of the short mythological epics (*epyllia*), elegies and lyrics of the Alexandrian school. The great influence of Cato is attested by the anonymous lines quoted by the biographer Suetonius in his *De grammaticis:*

Cato grammaticus, Latina Siren,
Qui solus legit ac facit poetas.
("Cato the grammarian, the Latin Siren,
sole critic and creator of poets . . .")

The compliments paid to his verse by contemporary poets also bear witness to his pre-eminence. According to Suetonius, Cato was a native of Cisalpine Gaul and lost his property during the Sullan disturbances. He lived to a great age and at the end of his life was very poor. Nothing is known of his grammatical treatises.

In the *Indignatio* (probably a prose work) he defended himself against the accusation that he was of servile birth.

Of his poems two titles survive, the *Lydia* and the *Diana* or *Dictynna*. Among the minor poems attributed to Virgil, however, is one called *Dirae* (divided into two parts, *Dirae* and *Lydia*, by F. Jacobs). The *Dirae* consists of imprecations against the estate of which the writer has been deprived, and where he is obliged to leave his beloved Lydia; in the *Lydia*, on the other hand, the estate is envied as the possessor of his charmer.

Joseph Scaliger was the first to attribute the poem to this Cato, on the ground that he had lost an estate and had written a *Lydia*. Neither this attribution nor that to Virgil is acceptable. Probably the two poems were composed by an unknown author about 40 B.C.

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CATS, JAKOB (1577–1660), Dutch poet, a writer of emblem books and didactic verse whose place in the affections of his countrymen is shown by his nickname, "Father Cats," was born in Brouwershaven, Nov. 10, 1577. He took his doctor's degree in law at Orléans, practised at The Hague and, after visits to Oxford and Cambridge, settled in Zeeland, where he accumulated wealth by land reclamation. Becoming a magistrate, he was successively pensionary of Middelburg and Dordrecht and, from 1636 to 1651, grand pensionary of Holland. He took part in diplomatic missions to England, in 1627 to Charles I and in 1651–52, unsuccessfully, to Cromwell. His education, interests and political career gave him an international outlook, and he was in sympathy with such English Puritan writers as Henry Smith, Thomas Gathaker, William Gouge and especially Joseph Hall, whom he had met at Cambridge.

Cats was primarily a writer of poetic emblem books (*q.v.*) a type of literature popular in the 17th century, which consisted of woodcuts or engravings accompanied by verses pointing a moral. He used the emblem book to express the ethical ideas which the early Dutch Calvinists thought important, especially about love and marriage. By being the first to combine emblem literature with love poetry, and by his skill as a storyteller, he achieved enormous popularity. The sources on which he draws are chiefly the Bible and the classics, and occasionally Boccaccio and Cervantes.

His first book, *Sinn'-en minne-beelden* (1618), contained engravings with text in Dutch, Latin and French. Each picture has a threefold interpretation, dealing with what were for Cats the three elements of human life: love, society and religion. Perhaps his most famous emblem book is *Spieghel van den ouden ende nieuwen Tijdt* (1632), from which most of the quotations that have become household sayings are taken. It is written in a more homely style than his earlier works, in popular rather than classical Dutch. Two other works—*Houwelyck* (1625) and *Trou-Ringh* (1637)—are rhymed dissertations on marriage and conjugal fidelity, the first describing the six stages of a woman's life, the second illustrating its theme by a series of well-told popular tales. In one of his last books, *Ouderdom, Buytenleven en Hofgedachten op Zorgh-vliet* (1655), Cats wrote movingly about old age.

Cats died at his country home, Zorgh-vliet, near The Hague, on Sept. 12, 1660. *See* DUTCH LITERATURE.

See P. J. Meertens, *Letterkundig Leven in Zeeland in de XVIe en de eerste helft van de XVIIe eeuw* (1943); G. A. van Es in *Geschiedenis van de Letterkunde der Nederlanden* (1949). A selection of Cats's works was translated into English by R. Pigot (1865). (J. C. B. C.)

CAT'S-EYE, any one of several distinct minerals valued as gem stones, their common characteristic being that when cut with a convex surface they display a luminous band, like that seen by reflection in the eye of a cat (chatoyancy). Precious, oriental or chrysoberyl cat's-eye, the rarest of all, is a chatoyant variety of chrysoberyl (*q.v.*) showing in the finest stones a very sharply defined line of light (*see* GEM). Quartz cat's-eye is the common form of cat's-eye, in which the effect is due to the inclusion of parallel fibres of asbestos. It is obtained chiefly from Ceylon, but, though coming from the east, it is often called occidental cat's-eye—a term intended simply to distinguish it from the finer oriental stone. It is readily distinguished by its inferior density, its specific gravity being only 2.65, while that of oriental cat's-eye is as high as 3.7.

A greenish fibrous quartz, cut as cat's-eye, occurs at Hof and some other localities in Bavaria.

Crocidolite cat's-eye is a beautiful golden-brown mineral, with silky fibres, found in Griqualand West, South Africa, and much used as an ornamental stone, sometimes under the name of South African cat's-eye or tiger's-eye. It consists of fibrous quartz, coloured with oxide of iron, and results from the alteration of crocidolite, a variety of asbestos.

Corundum cat's-eye is star sapphire in which the star is imperfect and reduced to a luminous zone, producing an indistinct cat's-eye effect. (F. W. R.)

CATSKILLS, an area of low mountains and hills made famous by Washington Irving's character Rip Van Winkle. They are located in southeastern New York, which includes most of Greene and Ulster counties, and eastern Delaware and northern Sullivan counties. The name is derived from the Dutch name *Kaaterskill* (Wildcat creek), the name of one of the better-known cloves, or rocky glens, in the area. The eastern border of the Catskills is an escarpment that rises abruptly and with few breaks 1,500 to 2,000 ft. above the Hudson valley. The other borders are less distinct, but are marked by a general decrease in both elevation and relief to the more subdued terrain of the northern Appalachian plateau. The summits of the Catskills rise from 1,200 to 3,000 ft. above the adjacent valley bottoms, and a score or more summits lie between 3,000 and 4,000 ft. above sea level. The highest elevation is Slide mountain (4,185 ft.). Structurally, the Catskills resemble the rest of the northern Appalachian plateau, consisting of gently dipping sedimentary rocks. The much greater elevations in the Catskills are mainly due to the durability of the massive beds of Devonian sandstone and conglomerate that protect the weaker shales underneath from erosion.

New York state owns about 250,000 ac. of land in the Catskills, and the state constitution requires that this area remain in its natural condition. The unusually steep-sided valleys and massive rounded uplands comprise a large natural wilderness within easy reach of the New York metropolitan region. Heavily mantled with mixed broadleaf and needle-leaf forests, the area's beauty is made more spectacular by the deeply scored cloves. Improvements within Catskill state park include campsites, trails and a ski run. The more accessible, privately owned parts of the Catskills are developed intensively for recreation, and include youth camps, summer cottages, exclusive hotel resorts, hunting and fishing lodges and facilities for winter sports. A feature of the southern Catskills is a large Jewish resort colony, concentrated between Livingston Manor and Monticello, N.Y. The artificial lakes in the Catskills include the Ashokan, Downsville, Neversink, Rondout and Schoharie reservoirs, important to the water supply of the New York metropolitan region.

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CATT, CARRIE CHAPMAN (née LANE) (1859–1947), U.S. leader in the woman suffrage and peace movements, was born in Ripon, Wis., Jan. 9, 1859. She graduated from Iowa State college, Ames, in 1880. After studying law for a short time, she served as a high-school principal (Mason City, Ia.) in 1881, and became one of the first women superintendents of schools in 1883. She married Leo Chapman (1884; d. 1886), an editor, then George W. Catt (1890; d. 1905), an engineer. From 1887 to 1890 Mrs. Catt worked to organize the Iowa Woman Suffrage association.

Mrs. Catt reorganized the National American Woman Suffrage association on political district lines, 1905–1915, and from 1915 until her death she was its president. In working for woman suffrage on a national scale, she trained women for direct political action and marshalled seasoned campaigners. After bitter opposition in the senate, congress submitted the 19th amendment to the states in June 1919 and it was ratified in Aug. 1920. (*See*

Women's Suffrage: *The United States*.) In this period Mrs. Catt reorganized her suffrage association, 2,000,000 strong, as the League of Women Voters (*q.v.*).

Meanwhile, in 1902 she had founded the International Woman Suffrage alliance and was its president until 1923. In 1911–12, accompanied by Aletta Jacobs of the Netherlands, she made a feminist voyage around the world.

In 1925 she enlisted the co-operation of 11 national women's organizations in the National Committee on the Cause and Cure of War, to urge U.S. participation in world organization for peace. She was also a strong advocate of world disarmament and prohibition. Following World War II, she was keenly interested in the United Nations and used her influence to have qualified women placed on certain commissions. Mrs. Catt died in New Rochelle, N.Y., on March 9, 1947.

Her works include *Woman Suffrage and Politics: the Inner Story of the Suffrage Movement* (1923), and with others, *Why Wars Must Cease* (1935).

See Mary Gray Peck, *Carrie Chapman Catt: a Biography* (1944). (A. F. Ro.)

CATTANEO, CARLO (1801–1869), an Italian intellectual and publicist of great influence during the *Risorgimento*, was born in Milan on June 15, 1801. After practising as a schoolmaster, he graduated in law from the University of Padua in 1824. His interests were always wide: a pupil of the philosopher G. D. Romagnosi, he early began to publish articles on many subjects and was especially interested in technical, commercial and agricultural improvement. He has been described as the first Italian positivist, but he was always more alive to practical and concrete issues than to speculative ones. Much of his writing appeared between 1839 and 1844 in his periodical *Il Politecnico*. Though often rash and excitable in his private relationships, Cattaneo in *Il Politecnico* usually advocated moderate and cautious practical reforms as the best means of Italian national regeneration. In spite of this, early in 1848, the Austrian censors wanted him to be deported. Only the intervention of the viceroy, the archduke Rainer, saved him. He was therefore still in Milan when the March uprising took place. Being well known, he was made chief of the revolutionary council of war during the famous "Five Days." Soon enraged by the behaviour of Charles Albert (*q.v.*) of Sardinia, he came to believe that the revolution was being sacrificed to Piedmontese ambitions (*see* Italy: *History*). After the Austrian recovery of Milan in August, Cattaneo left the city for Paris and later settled at Lugano. He lived by teaching and journalism until 1859, when he returned to Milan to refound *Il Politecnico*. In 1867 he was elected a deputy to the parliament of the kingdom of Italy but could not bring himself to take the oath of loyalty to the house of Savoy. He died on Feb. 6, 1869, at Castagnola, near Lugano. Among his many publications, the most important are the *Notizie naturali e civili su la Lombardia* (1844), which won him election to the Lombard institute, and *L'Insurrection de Milan en 1848* (1848; new ed. by C. Spellanzon, 1949). There are editions of his letters, *Epistolario,* by R. Caddeo, four volumes (1949–56), and of his historical and geographical works, *Scritti storici e geografici,* by G. Salvemini and E. Sestan (1957).

See A. and J. Mario, *Carlo Cattaneo* (1884); A. Levi, *Il positivismo politico di Carlo Cattaneo* (1928). (J. M. Rs.)

CATTANEO, DANESE DI MICHELE (1509–1573), Italian sculptor, born at Colonnata, near Carrara, was a pupil of Jacopo Sansovino in Rome. It is said he was taken prisoner three times by the imperialists during the sack of Rome in 1527. He fled to Florence, where he carved the marble bust of Alessandro de Medici, and then joined Sansovino in Venice. He was employed by his master on sculptures for the Libreria di San Marco and the Zecca, among his works being the "Apollo" crowning the fountain in the Zecca; the "St. Jerome" in San Salvatore; and the figures on the tombs of Leon Loredano in SS. Giovanni e Paolo and of Andrea Badoer in the Scuola di S. Giovanni Battista. He also worked in Padua for the church of Sant' Antonio. The fine bust of Pietro Cardinal Bembo (1547) on the tomb there is by his hand. At Verona he built the tomb of Gian Fregoso in S. Anastasia with the help of his distinguished pupil Gerolamo Campagna. He returned to Padua in 1572, but death cut short his work on the reliefs for the Capella del Santo, which were completed by Campagna.

Cattaneo was also a poet; his poems *Dell'amor di Marfisa* (1562) were praised by Torquato Tasso. His grandson Niccolo collected his writings.

CATTELL, JAMES McKEEN (1860–1944), U.S. psychologist, whose interests and influence oriented United States psychology toward use of objective methods, study of individual differences, preparation of mental tests and application of psychology to practical affairs, was born at Easton, Pa., May 24, 1860. He studied at Lafayette college in Easton and at the University of Leipzig, and from 1888 to 1891 held the first professorship in psychology at the University of Pennsylvania, Philadelphia. As professor at Columbia university, 1891–1917, he exerted personally and through his students a major influence on the development of U.S. psychology and psychologists.

From 1885 to 1900 Cattell did substantial research on reaction time, reading and perception, association, psychophysics and individual differences. Later he made statistical studies of scientists and published in several editions the directory *American Men of Science* (1906–39). His work on scientists was related to a strong interest in scientific co-operation. Concern for practical utilization of psychology led him to found in 1921 the Psychological corporation, the first of many groups applying psychological techniques to practical affairs; he served for many years as its president. Through much of his life Cattell also edited successfully various scientific journals. He died Jan. 20, 1944. (R. L. Te.)

CATTLE. The word "cattle," which etymologically merely denotes a form of property and is practically synonymous with "chattel," is by common usage a generic term for bovine animals. The animals included under the term are usually divided into the following six groups: (1) buffaloes (India, Africa, etc.); (2) bison (Europe and North America); (3) the yak (Tibet, etc.); (4) the gaur, gayal and banteng (India and southeast Asia); (5) eastern and African domesticated cattle (Brahman or zebu); and (6) western or European domesticated cattle. In addition to the two last-mentioned groups the India buffalo, yak, gayal and banteng have been domesticated. Apart from the buffaloes, which constitute a relatively primitive and rather distinct type, all the species enumerated are rather closely related. The buffaloes do not hybridize with the members of the other groups, but all the rest can be interbred without difficulty and the hybrids, or at least the female hybrids, are quite fertile. (For zoology *see* Bovidae. *See* also Aurochs; Banteng; Bison; Buffalo; Gaur; Gayal; Ox; Yak.)

The ox was one of the earliest of all animals to be domesticated for agricultural purposes. In western Europe there is no evidence of domestication in Paleolithic times but there are plentiful remains in the Swiss lake dwellings and other deposits of Neolithic age. Domesticated cattle existed in Egypt about 3500 B.C., and possibly much earlier, while Babylonian remains have been assigned to still more remote ages.

In all likelihood the wild ancestors of European domesticated cattle belonged to one or more of the subspecies of the aurochs or urus (*Bos primigenius*) which were widely distributed in Europe, western Asia and northern Africa in prehistoric times. However, the earliest known domesticated ox in Europe was a small, slenderly built animal, with short horns, bearing all the marks of a prolonged existence under the care of man and contrasting markedly with the contemporary wild urus. The conclusion has been drawn that the original domestication did not occur in western Europe; probably the little ox (*Bos longifrons* or *Bos brachyceros*), together with corresponding types of sheep and pig, was brought from Asia by Neolithic man in his migrations. Later, in the Bronze Age particularly, a new and larger type of cattle, showing a closer resemblance to the European wild ox, made its appearance. Probably the *Bos longifrons* had been "graded up" by crossing with the wild type. The process was, however, not universal, and even modern breeds like the Jersey and Brown Swiss show a marked resemblance to the Neolithic type.

Whether the Brahman (*Bos indicus*) had a separate origin from the western ox is not known; some authorities seek to relate it with the banteng or gayal. In shape, colour, habits and even in voice it presents many points of difference from western cattle; but the most striking of these, such as the presence of a hump, or the upward inclination of the horns, are not constant. Breeds exist in Africa, Spain, China and elsewhere which are intermediate between Brahman and European cattle, but it is likely that some of these, at least, have arisen from crossing.

The economic value of cattle arose from the docility of the males for draft and the aptitude of the females for supplying milk in excess of the requirements of their offspring. Ultimately they were utilized as food but this was in a sense secondary, and among some peoples their flesh was regarded, for religious or other reasons, as unfit for human consumption. The breeding and rearing of cattle for the primary purpose of supplying meat is a modern development.

Terminology.—In the terminology used to describe the sex and age of cattle, the male is first a bull-calf and if left intact becomes a bull; but if castrated he becomes a steer and in about two or three years grows to be an ox. The female is first a heifer-calf, growing into a heifer and becoming a cow. The age at which a steer becomes an ox and a heifer a cow is not clearly defined and the practice varies. A freemartin is a female bovine born as a twin to a bull and is usually barren. Both in the male and female emasculation is practised because the animals are assumed to fatten more readily; in the case of bulls intended for use as working oxen the object of emasculation, as in the case of stallions, is to make them quieter and more tractable in work.

BREEDS

The exact definition of a breed of cattle is difficult, although the term is commonly used and in practice well understood. It may be said generally to connote a particular type of animal which for a long period has been bred only with those of the same, or closely similar, type, and has hereditary characteristics which are transmissible to its offspring. In every breed, however long established, instances of atavism may and do occur, but these are eliminated and do not affect its general purity. Breeds have been established by generations of cattle breeders aiming at the attainment and preservation of a particular type and working on the principle that "like begets like." It is only within relatively recent times that the laws of heredity founded on the researches of Gregor Mendel have been studied as a science. (*See* also ANIMAL BREEDING.)

There are many old established breeds in Europe, for example, the Charolais and Normande of France, the Holsteins of the Netherlands, the Campagna di Roma of Spain and many others, but the British breeds are of particular interest because of their influence in building up the vast herds which furnish the supplies of beef on which other countries are largely dependent. (*See* BEEF.)

BEEF BREEDS

Shorthorn.—The Shorthorn is an example of improvement of beef cattle by selection within a breed. In the last quarter of the 18th century two brothers, Charles and Robert Colling, farming in Durham county, Eng., began to improve the local cattle of the Teeswater district of that county. Their efforts were supplemented by other constructive breeders, notably Thomas Bates and Thomas Booth in Yorkshire. As many cattle of this breed have been exported to other countries from Durham, they are often called by that name.

Shorthorns may be solid red, red with white markings, white or roan. Roan colour results from a mixture of red and white hairs. The Shorthorn is the only modern breed that has a roan colour, making this colouring an index of Shorthorn breeding. Colour, scale and blocky conformation are characteristics of the breed.

Shorthorns are found in practically every country of the world. They are numerous in North America, in South America (particularly in Argentina), in Europe, being the most popular breed in the British Isles, and are bred to some extent in Europe; in Australia they have long met with favour and have also been bred quite extensively in South Africa. In the United States, Shorthorns are most numerous in the corn belt states but have been used rather extensively in other areas for grading up native or scrub cattle.

The *Shorthorn Herdbook*, the first of its kind for cattle, was begun in 1822 by George Coates. It was published as a private compilation until 1874 when it was taken over by the Shorthorn society. The first U.S. *Shorthorn Herdbook*, which registers all types of Shorthorns except the Milking type in the United States, was published in 1846 and in 1867 the first Canadian *Shorthorn Herdbook* was issued.

Strains of Shorthorns have been selected for milk and butterfat production, as well as beef. In the United States they are called Milking Shorthorns; in Canada, Dual-Purpose Shorthorns; in England and Australia, Dairy Shorthorns. In England many herds of Shorthorn cattle still show the beef and milk combination developed by the early improvers of the breed. In the United States throughout large areas in the middle west as well as in parts of the New England states, Milking Shorthorns are popular.

The Polled Shorthorn, as the name implies, is a strain within the breed possessing all of the Shorthorn characteristics except horns. This strain of polled cattle was developed in the United States in the late 1880s and early 1890s through the use of naturally hornless registered Shorthorns found within the breed. While beef characteristics have been emphasized, many good milkers have been developed among Polled Shorthorns. Cattle of this breed were exported from the United States to Scotland during the late 1950s under a special federal research permit.

Lincolnshire Red Shorthorns are a specialized type of the original Shorthorn stock.

Hereford.—The Hereford is the product of generations of breeding work on the part of landed proprietors and tenant farmers of the fertile valleys in the county of Hereford, Eng. The breed is thought to have descended from the primitive cattle of the country. Herefordshire is noted for its luxuriant grasses, and in that district for many generations the Hereford was bred for beef and draft purposes. The characteristic colour, red with white face and white markings, has been fixed for only a comparatively short time. When the first herdbook was published in 1846, the editor grouped the breed into four classes: mottle faced; light gray; dark gray; and red with white faces. Twenty-five years later all but the last had practically disappeared. The outstanding characteristics of the breed are uniformity of colour, early maturity and ability to thrive under adverse conditions.

Herefords were first introduced into the United States in 1817 by Henry Clay, who imported a young bull, a cow and a heifer to his home in Kentucky. In 1860 Herefords were introduced into Canada by F. W. Stone of Guelph, Ont. In the range areas of North America, it has become the predominating breed from Canada on the north to Mexico on the south. In Great Britain it is chiefly bred in Herefordshire and vicinity although herds of this breed are found in Scotland, Ireland and Wales. The Hereford also has met with much success under range conditions of Australia, New Zealand, Argentina, Uruguay and southern Brazil.

The first *Hereford Herdbook*, published in 1846 as a private enterprise, was taken over by the Hereford Cattle Breeders' Association of England in 1884. The American Hereford Cattle Breeders' association was organized in 1881, and in 1934 the official name was changed to American Hereford association.

In the United States a polled Hereford strain was developed by Warren Gammon of Iowa by selecting naturally hornless registered Herefords. The number of Polled Herefords has increased rapidly and herds are found throughout the United States, including Hawaii. Polled Herefords have been exported to Canada, Mexico, South America, the Philippines and Australia. The American Polled Hereford association is the national organization in the United States.

Angus.—This breed of black, polled beef cattle, for many years known as Aberdeen Angus, originated in the county of Aberdeen, Scot. Its ancestry is obscure. The breed was improved and the present type of the cattle fixed early in the 19th century by a number of constructive breeders among whom Hugh Watson and William McCombie were the most famous.

The characteristic features of the breed are black colour, polled head, compact and low set body, fine quality of flesh and high dressing percentage. The Angus is a beef breed of the highest rank and for years purebred or crossbred Angus steers have held high places of honour at the leading fat stock shows in Great Britain and the United States. This breed was introduced into the United States in 1873 and after that date its influence spread widely in that and other countries.

The first *Polled Herdbook* of Aberdeen Angus cattle was issued in Scotland in 1862. The American Aberdeen Angus Breeders' association was organized in 1883; in 1959 the name was changed to American Angus association.

Devon.—Devons are neat, compact and symmetrical in form with a deep red colour. For centuries they were raised in their native home of north Devon, Eng., primarily for draft purposes, but early in the 19th century were improved for beef production. The *Devon Herdbook* was founded in 1851. In south Devon, where the breed is also known as South Ham, the cattle are larger and are bred primarily for dairy purposes. Because of their adaptability and hardiness, Devons have found favour in New South Wales, South Africa, Brazil, the United States, Uruguay and the West Indies.

Dexter.—This breed, a subvariety of the Kerry, is thought to have arisen from crossing red cattle of the north Devon type with the native Kerry of southern Ireland. The Dexter is small, cows weighing from 500 to 800 lb. and bulls not more than 900 lb. The bodies are compact and round and the legs quite short. The colour is either black or red. The breed attained some popularity in southern Ireland and in England for both beef and milk production.

Galloway.—The beginnings of this breed of polled black cattle originating in Scotland are as obscure as those of the Angus. Although its native home is the ancient province or kingdom of Galloway in southwestern Scotland, it probably had a common origin with the Angus. The two breeds have much in common but the Galloway is distinguished by its coat of curly black hair. The breed has never attained the prominence of other beef breeds but has been used extensively in producing blue-gray crossbred cattle, obtained by breeding white Shorthorn bulls and Galloway cows. There is also a Belted Galloway, with a white belt encircling the body behind the shoulders. Organized effort to promote Galloway cattle began in 1862 with the publication of the *Polled Herdbook*. The first four volumes of this book included both Galloway and Angus. In 1877 an independent Galloway Cattle society was formed. The American Galloway Breeders' association was organized in 1882.

Highland or West Highland.—The native home of this breed, sometimes called Kyloes, is the upland region of western Scotland. Little is known of their early history though it is generally believed they are the aboriginal cattle in that district. A typical West Highland animal with wide spreading horns, long shaggy coat, sturdy frame, thick mane and heavy dewlap makes an impressive picture. The colour is variable, being yellow, red, black, brindle and a mixture of red and black with a tawny red predominating. No other breed of British ancestry equals the West Highland for hardiness and ability to thrive on scanty pasturage. Cattle of this breed are comparatively small and slow in maturing. The breed is not distributed widely outside its native home although some exportations were made.

Longhorn.—The Longhorn breed of Britain is to be distinguished from the longhorn cattle once numerous on the western ranges of the United States. The latter were descended from cattle brought to America by the Spaniards and are practically extinct. But a common characteristic of both is the excessive horn growth from which the name is derived. In England the Longhorn has been improved by selective breeding, but numerically the breed is of little importance. Shorthorns have largely displaced these cattle in most districts.

Sussex.—The Sussex breed, found in Sussex, and to some extent in Kent, Surrey and Hampshire, is descended from the original stock of the country and has probably undergone little change in outward appearance since the middle ages. The Sussex is a heavy muscular animal, dark red in colour and is valued as a good grazer where beef rather than milk is sought. It did not attain wide distribution and even in England was not widely bred outside its own county.

Red Poll.—The Red Poll breed represents a blending of the cattle which were common in Norfolk and Suffolk counties, Eng., for centuries. The horned, red, hardy Norfolk cattle were noted for their fleshing qualities while the larger framed, hornless Suffolks were exceptionally good milkers. The merging of these two bloodlines about 1846 provided the foundation for the present breed. The aim of breeders was to produce medium-sized, hardy, hornless cattle, red in colour, smooth and compact, and equally good as producers of beef and milk. The usefulness of the breed is well established the world over. Exportations were made to the United States, Canada, South Africa, Australia, New Zealand and South and Central America.

Welsh.—The Welsh breed is black with fairly long horns. Until the beginning of the 20th century there were two types known as North and South Welsh, but they were amalgamated in 1904 when the Welsh Black Cattle society was formed and a common herdbook established. The cattle mature rather slowly but grow to a large size and furnish high-quality beef.

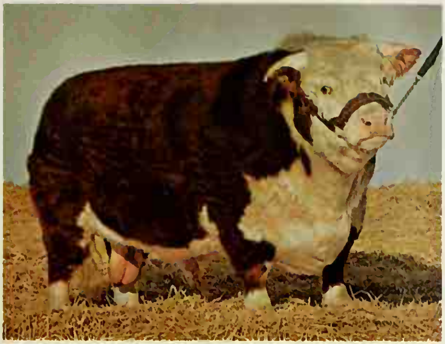
Africander.—The Africander is widely distributed throughout South Africa. Although the origin of the breed is not definitely known, it probably goes back to the Indian (*Bos indicus*) species and not to European (*Bos taurus*) cattle. The breed was produced by the *voortrekkers* who valued their oxen above all other farm possessions. Before and after the Great Trek (1836) a friendly rivalry existed among the farmers of South Africa to possess oxen that were uniform in conformation, shape of horns and colour markings, and that had hard, flinty feet and the straight easy action so desirable for trekking long distances.

The Africander has a hump over and slightly in front of the shoulders. This hump is more rounded, and blends more smoothly into the shoulder than that of Brahman cattle. The colour may vary from dark to light red but dark red is preferred. Later requirements were for an early maturing, uniformly fleshed beef animal that maintains the hardiness of the earlier type. The Africander Cattle Breeders' society was formed in 1912 for the regulation and control of registrations of Africander cattle in the South African *Studbook*.

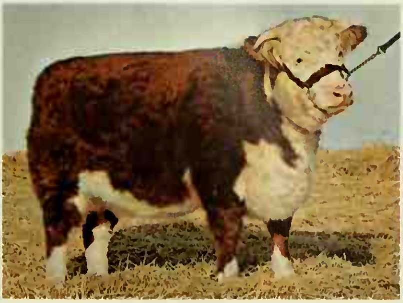
Brahman (Zebu).—The term Brahman was selected by the United States department of agriculture as the name of all breeds of Indian cattle in the United States. In South America and in Europe these cattle are known as zebus. Brahman cattle are characterized by a prominent hump above the shoulders, and an extreme development of loose, pendulous skin under the throat, on the dewlap, navel and the sheath of males. This pendulous skin provides a greater surface area and gives better heat regulation, which is important in hot climates. The rump is drooping. The head is long and narrow, ears are long and carried in a drooping manner, and horns differ widely according to sex and strain. The colour varies from shades of gray to black. Indian cattle, like those of Europe, vary in size, form and symmetry under the influence of local differences in climate, soil and available feed. In their native home, Indian cattle are used primarily for work and milk production. The majority of people of India are averse to killing them for food. Humped cattle of India were imported into the United States as early as 1849, but the importations that had the widest influence were made in 1906 and in 1924. These cattle were used in the Gulf coast area of the United States for crossing with the improved breeds of beef cattle to produce a type adapted to the hot, humid conditions prevailing in that region.

Santa Gertrudis.—This breed of cattle was developed by the King ranch in Texas. It resulted from crossing Brahman bulls of about seven-eighths pure breeding, and purebred Shorthorn cows. Over a period of years, beginning in 1920, selective breeding was practised in which preference was given to red colour without sacrificing type and conformation. Santa Gertrudis cattle are, for the most part, solid red in colour with occasional small white markings, usually on the forehead or in the region of the flanks. They possess a slightly higher percentage of Shorthorn breeding than of Brahman.

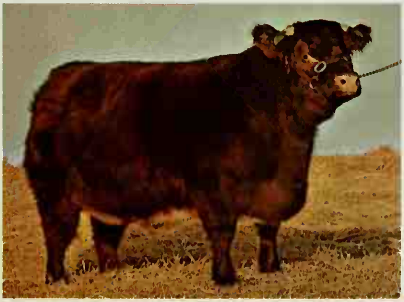
Santa Gertrudis cattle are the heaviest of the beef breeds when



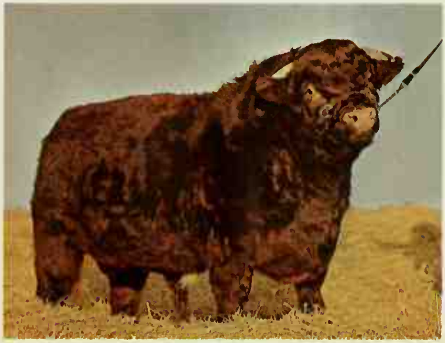
Hereford bull



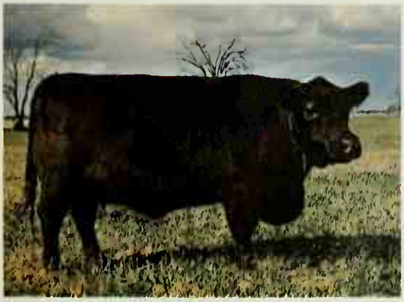
Hereford cow



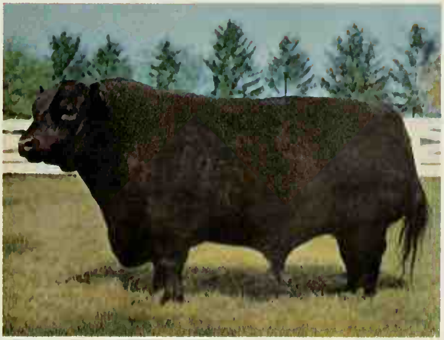
Shorthorn cow



Shorthorn bull



Angus cow

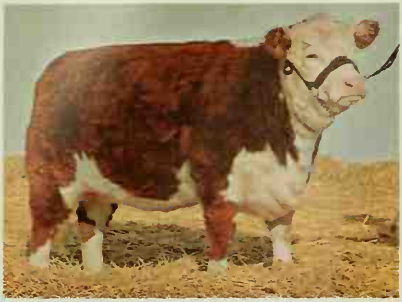


Angus bull

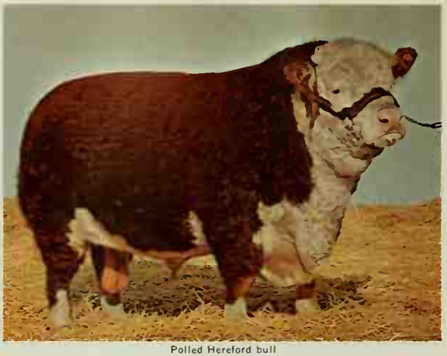
BREEDS OF BEEF CATTLE

PHOTOGRAPHS, (TOP LEFT AND RIGHT, CENTRE LEFT AND RIGHT) ABERNATHY PHOTO CO., (OTHERS) PHOTOGRAPHED ESPECIALLY FOR ENCYCLOPÆDIA BRITANNICA, INC., BY JAMES DE YOUNG

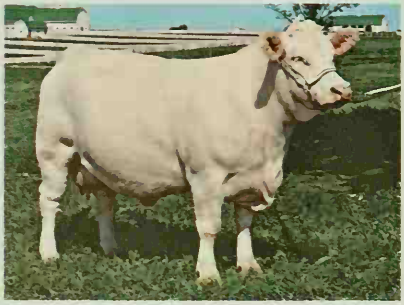
CATTLE



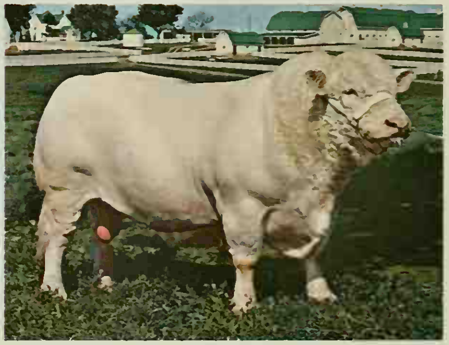
Polled Hereford cow



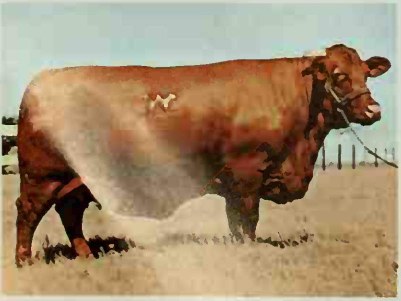
Polled Hereford bull



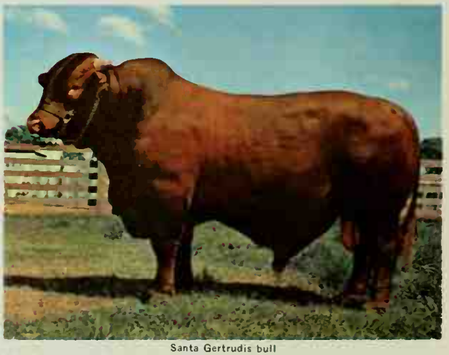
Charolais cow



Charolais bull



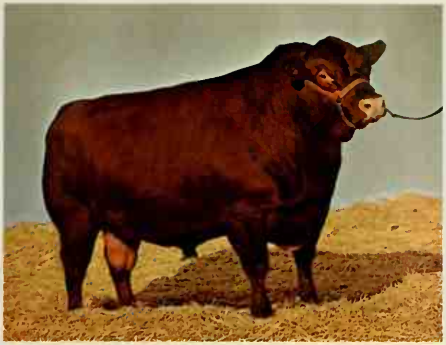
Santa Gertrudis cow



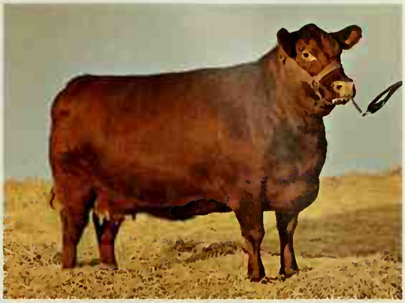
Santa Gertrudis bull

BREEDS OF BEEF CATTLE

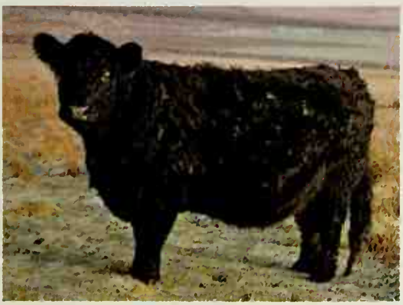
BY COURTESY OF (CENTRE LEFT AND RIGHT) LITTON CHAROLAIS RANCH, (BOTTOM LEFT AND RIGHT) SANTA GERTRUDIS BREEDERS INTERNATIONAL, PHOTOGRAPHS, (OTHERS) ABERNATHY PHOTO CO



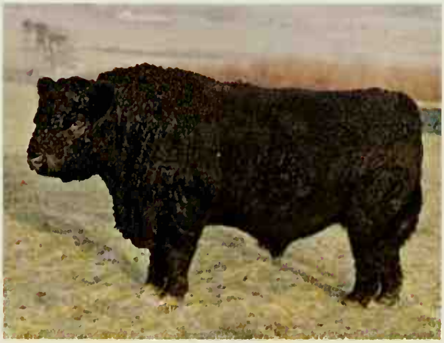
Red Poll bull



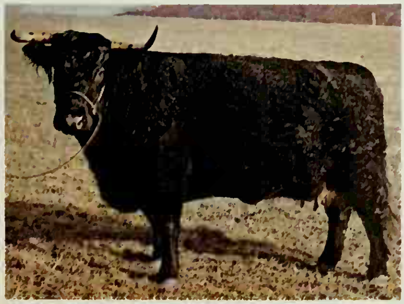
Red Poll cow



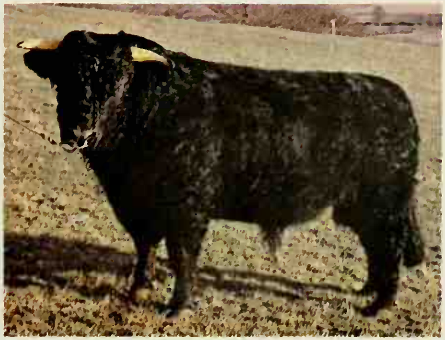
Galloway cow



Galloway bull



Welsh Black cow



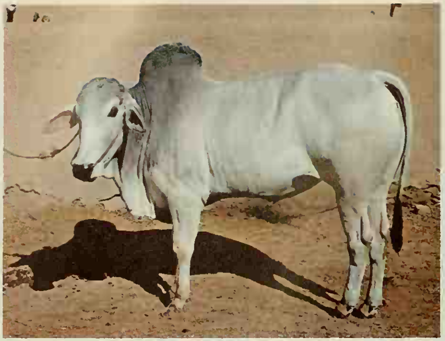
Welsh Black bull

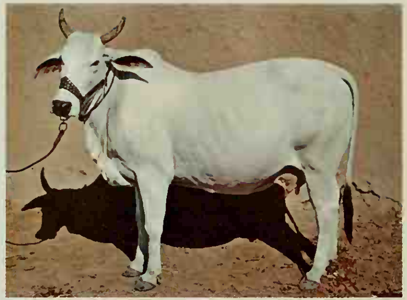
BREEDS OF BEEF CATTLE

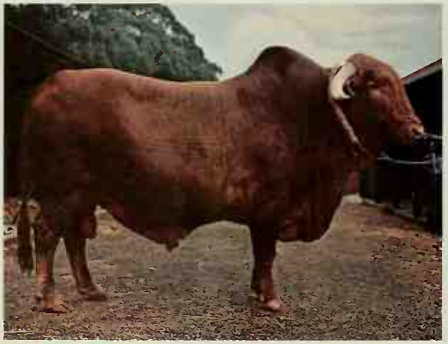
PHOTOGRAPHS, (TOP LEFT AND RIGHT) ABERNATHY PHOTO CO. (CENTRE LEFT AND RIGHT) DAVID PHIN, "THE GALLOWAY NEWS," (OTHERS) PHOTOGRAPHED ESPECIALLY FOR ENCYCLOPÆDIA BRITANNICA INC. BY GEOFFREY CHARLES

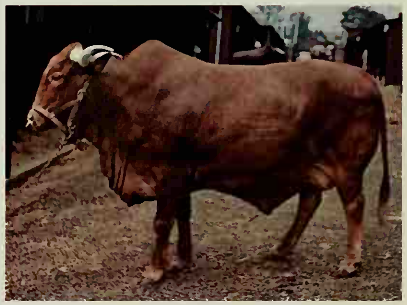
PLATE IV

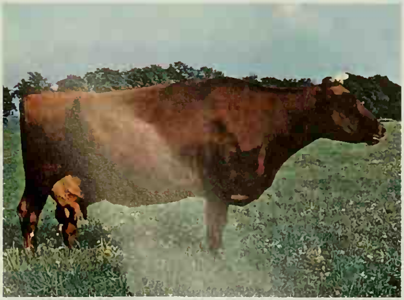
CATTLE

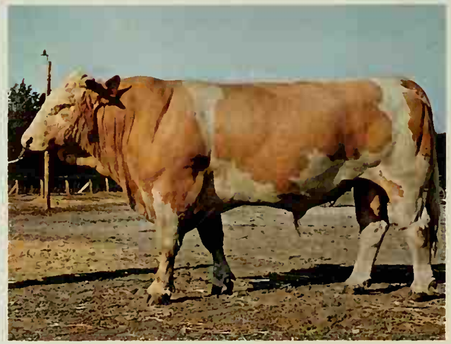

Brahman (zebu) bull


Brahman (zebu) cow


Africander bull

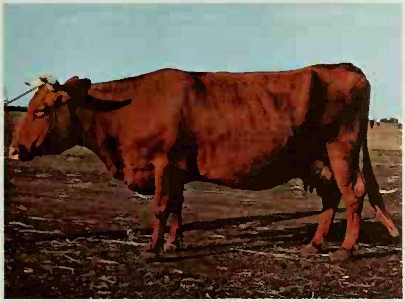

Africander cow

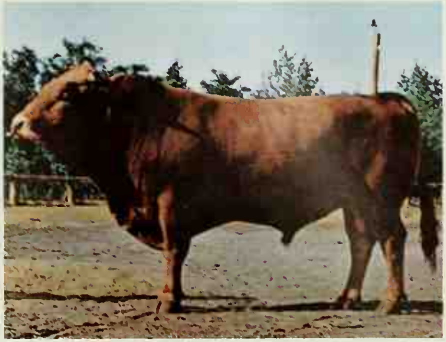

Latvian Brown cow

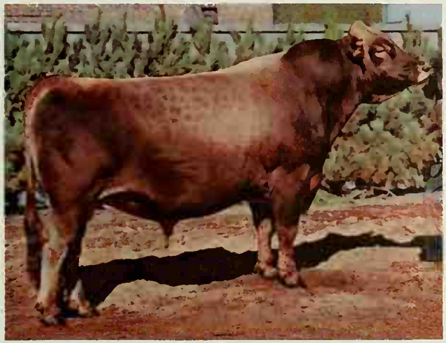

Simmental bull

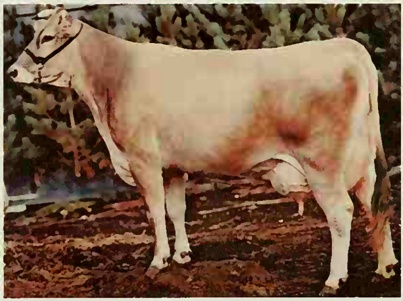
BREEDS OF BEEF CATTLE

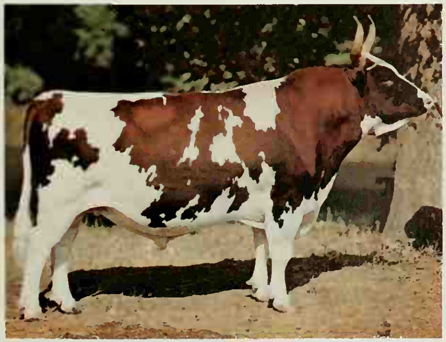
BY COURTESY OF (CENTRE LEFT AND RIGHT) THE MEAT INDUSTRY, REPUBLIC OF SOUTH AFRICA, (BOTTOM LEFT AND RIGHT) R. E. HODGSON, PHOTOGRAPHS, (OTHERS) T. S. NAGARAJAN

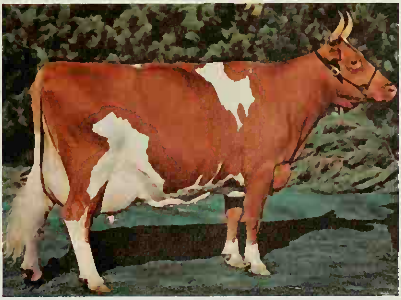

Ukrainian Red Steppe cow


Ukrainian Lebinin bull


Brown Swiss bull


Brown Swiss cow

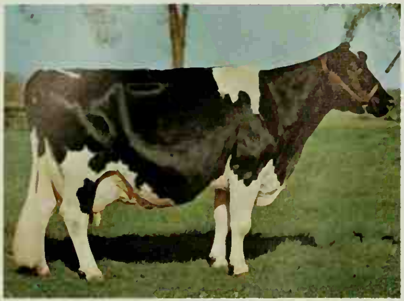

Ayrshire bull


Ayrshire cow

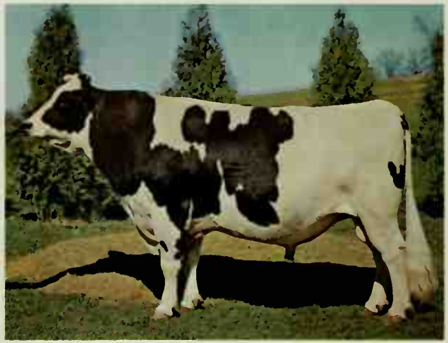
DAIRY AND DUAL-PURPOSE BREEDS

BY COURTESY OF (TOP LEFT AND RIGHT) R. E. HODGSON, PHOTOGRAPHS, (OTHERS) H. A. STROHMEYER, JR.

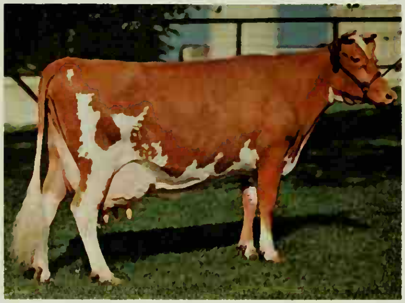
CATTLE



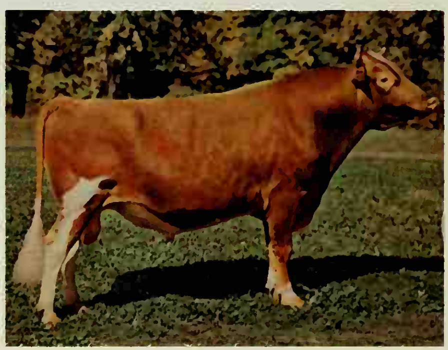
Holstein cow



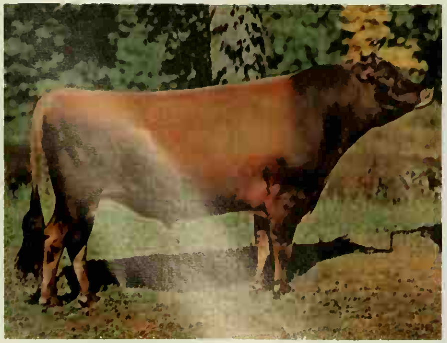
Holstein bull



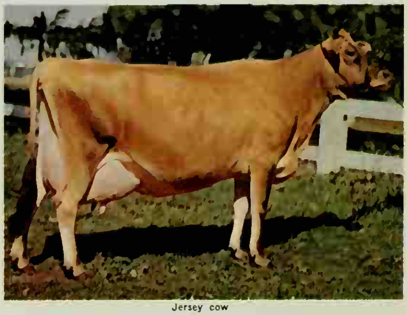
Guernsey cow



Guernsey bull



Jersey bull



Jersey cow

BREEDS OF DAIRY CATTLE

PHOTOGRAPHS: H. A. STROHMEYER, JR

raised under similar conditions. They have great depth and length of body, with more loose skin about the neck, brisket and navel than the breeds of strictly British origin. They proved to be highly adaptable to the semitropical gulf coast.

Brangus.—This name is derived from the parental breeds, Brahman and Angus. The breed had its origin in the 1930s in the southern part of the United States, where a number of breeders employed a breeding program similar to that used by the King ranch in developing the Santa Gertrudis breed. The objective was to obtain animals carrying about three-eighths Brahman and five-eighths Angus blood.

The Brangus is usually black in colour and tends to resemble the Angus in conformation. It has a nearly smooth top line and has less dewlap and less loose skin about the navel than does the Brahman. Although total numbers of Brangus cattle have been relatively small, the breed proved itself useful in crossing with the native cattle of the coastal region. Like the Angus, the breed is polled. The American Brangus Breeders' association was organized in 1949.

DAIRY BREEDS

Holstein-Friesian.—The Holstein-Friesian breed originated in north Holland and Friesland. Its chief characteristics are large size and black and white spotted markings, sharply defined rather than blended. These cattle are believed to have been selected for dairy qualities for about 2,000 years. They have long been widely distributed over the more fertile lowlands of continental Europe where they are valued highly for their milk-producing ability. The milk, however, has a relatively low butterfat content.

When the Dutch colonized New York, they brought their cattle with them, but after the colony was ceded to the British crown and English settlers brought their own cattle, the Dutch cattle disappeared. The first exportation from Holland to the United States was in 1795, but the largest importations were made between the years 1879 and 1887. These cattle were registered in the *Holstein Herdbook* and the *Dutch Friesian Herdbook*. In 1885 the two associations united in the Holstein-Friesian Association of America, the largest dairy breed association in the United States.

The breed is widely distributed but usually is concentrated in areas having good fluid milk markets. Besides being well established in the lowland countries of western Europe, in England and throughout the United States, cattle of this breed are numerous in Canada, Australia, South America and South Africa. With the emphasis on the production of lean beef, the Friesian either as a purebred or crossed with a beef bull is playing an increasingly important part in beef production in Great Britain.

Jersey.—Within sight of the coast of Normandy in the English channel is a group of four small islands, the native home of two distinct breeds of dairy cattle—the Jersey and Guernsey. The island of Jersey, the largest of the group, has an extremely mild climate and cattle can be outdoors most of the year. It is believed that the Jersey is descended from French cattle. Its colour is usually a shade of fawn or cream but darker shades are common. The fawn or cream has been attributed to the cattle of Normandy and the darker colour to those of Brittany. Jersey cattle are relatively small in size. The purity of the breed was recognized in 1763, and in 1789 a law was passed prohibiting the importation of cattle into Jersey except for immediate slaughter. They have been introduced in large numbers into England, one of the earliest herds being formed in 1811. The first exportation of registered Jerseys to the United States was in 1850.

The Jersey is adaptable to a wide range of conditions and its distribution is world-wide. Jersey milk is remarkably rich in butterfat, and for that reason animals of this breed are in demand for crossing with native stock to improve the quality of milk. The Royal Jersey Agricultural society, founded in 1833, assumed supervision of the breed on the island of Jersey, while the English Jersey Cattle society, organized in the 1870s, became the registry association in Great Britain. The American Jersey Cattle club was organized in 1868, and under the supervision of this organization a register-of-merit system was established in 1903.

Guernsey.—The island of Guernsey, another of the Channel Islands, is the home of the Guernsey breed. Like the Jersey, this breed is thought to have descended from the cattle of nearby Normandy and Brittany. All the cattle of the Channel Islands were at one time known as Alderneys. After laws had been enacted prohibiting the importation of cattle to the islands except for slaughter, the Jersey and the Guernsey breeds came to be recognized. Guernsey cattle are fawn coloured, marked with white, and are larger than the Jersey breed. Guernseys are noted for the production of milk of a pronounced yellow colour.

The first Guernseys were exported to the United States in 1830, but it was not until 1880 that the export business became extensive. Numbers of Guernsey cattle are to be found also in England, Australia and Canada. The Royal Guernsey Agricultural and Horticultural society supervises the breed on the island of Guernsey, maintaining two herdbooks, one for general registration and the other for advanced registry. The American Guernsey Cattle club was organized in 1877 and supervises the advanced registry system and pedigree registration of Guernseys in the United States.

Brown Swiss.—The Brown Swiss is native to Switzerland and the breed is probably one of the oldest in existence. While these cattle are classified as a dairy breed in the United States, they are often considered a dual-purpose breed as they are heavier boned and thicker fleshed than the cattle of the Channel Islands breeds. The colour of the Brown Swiss varies from light brown or gray to a dark shade of these colours. Brown Swiss cows are good, persistent milkers, producing milk of average quality as compared with other breeds of dairy cattle.

This breed has found favour in Italy, Austria, Hungary, the United States, Mexico and the South American countries. Brown Swiss were first introduced into the United States in 1869. The Brown Swiss Cattle Breeders' Association of America, organized in 1880, supervises the registration of pedigrees and the register of production of Brown Swiss cattle in the United States.

Ayrshire.—The Ayrshire breed originated in Ayr county, southwestern Scotland, in the latter part of the 18th century and is considered to be the only special dairy breed to have originated in the British Isles. The body colour varies from almost pure white to nearly all cherry red or brown with any combination of these colours. The beef qualities of the breed are of secondary importance. The distribution of the breed is wide, and exportations have been made to many countries. It is strongly represented in Canada, the northeastern part of the United States and also on the continent of Europe, in South Africa, Australia, New Zealand, Puerto Rico, Mexico and Central America. The Ayrshire Breeders' Association of the United States of America fostered herd testing and a system of selective registration for approved sires of the breed.

PEDIGREE CATTLE BREEDING

Many breeds and subbreeds of cattle are distributed throughout the world. On the continent of Europe alone, between 40 and 50 distinct breeds are described. Great Britain is the home of 11 breeds which have been exported to the United States, and in addition as many more minor breeds of local importance. Selective breeding seems to have begun in England about 1770 as the result of the work of Robert Bakewell (*q.v.*), who was not only a pioneer breeder but is reported to have kept records on the progeny of his cattle in order to show their progress. The activities of the Colling brothers in improving the Shorthorn breed rank next to those of Bakewell in livestock improvement. The work begun by these breeders spread over Great Britain and had a lasting influence on livestock improvement throughout the civilized world. As the fame of British cattle spread to other countries, a demand was created for these improved breeds. They were exported to found new herds and to improve native cattle. Practically all modern pure breeds of farm animals became established before the practice of registration, issuing of pedigrees and publication of their respective herdbooks was begun.

The development of breed registry associations in the United States differs somewhat from that of Great Britain, where herdbooks remained open, for a time at least, to all animals that met certain requirements as to breed characteristics. The British practice tended to broaden the base of the breed. Cattle breeders continue to direct their efforts toward further improvement of breeds. Individual excellence and pedigree are accepted as only a part of breed improvement, because the essential test of an animal's breeding ability is in the performance of its progeny. Nonselective testing and the use of progeny-tested animals for breed improvement received increasing attention by constructive breeders. The herd test and advanced register, or record-of-merit testing introduced by breeders of dairy cattle, the get-of-sire class, feedlot performance test for rate of gain and feed efficiency of the progeny, and slaughter test of the progeny of beef breeds are all useful in determining the utility value of registered cattle. Differences of opinion on the use of impartial ratings with pedigrees are usually based on whether the information gained by such measures has enough practical usefulness to be worth the cost.

Cattle breeding is rapidly changing from an art based on observation to a science based on Mendelian laws of inheritance and the application of the theories of population genetics.

The setting up of well-defined types by early breeders, followed by rigid selection of breeding stock, was the basis of present breeds. Most of the subsequent improvement in the common livestock of the world was accomplished by the mating of purebred sires to common females. Even in this procedure best results were obtained when the females were selected with care and a high-quality registered sire was used. The effectiveness of this system of breeding is shown by the type of cattle found in the range area of the United States where most breeders have used registered bulls of the same breed for many generations. The result has been a uniform type of cattle in demand by feeders of the corn belt states.

Because of the long generation interval and the low reproductive rate of cattle, it is necessary for most breeding progress to result from the use of superior sires. Artificial insemination allows the extensive use of sires and thus has made possible an increase in the rate of improvement of cattle. The average dairy sire in an artificial insemination stud is mated to approximately 2,000 cows annually. Sires in natural service are mated to only 30 to 40 cows per year. From this comparison it is evident that sires placed in artificial insemination should be superior sires. In attempting to place superior sires in artificial insemination, various sire testing programs have been developed. For dairy sires some of these tests are the daughter average, the dam-daughter comparison, the contemporary comparison and special test stations. Where the daughters are distributed over many herds and the dams are not selected, the daughter average is a sufficient test. When these conditions are not met, it is necessary to use one of the other methods of testing. The special test stations would be of greatest help in areas where only a small fraction of cows are on test. Most testing of beef sires is done at special test stations. In choosing sires for use in artificial insemination, more emphasis is placed on the utilitarian measures of performance, such as meat and milk production, and less emphasis on breed type.

The mating of closely related animals proved highly successful in some cases and disastrous in others. Bakewell followed this practice, using animals of high merit, whereas Bates was not so successful. Breeders in the 20th century have followed this breeding practice only after using a sire so superior that a successor of equal or superior merit was difficult or impossible to find (*see* Inbreeding). Maintaining this standard of excellence by close breeding may also be possible when both parents are of high individual merit. Instances have occurred in which a new breed has been produced by crossing two or more well-established strains. In theory, the object of crossing two strains is to combine desirable characteristics possessed by each. Limiting factors are time and the expense of keeping the large numbers of animals necessary to fix the type. This system of breeding was followed in developing Polled Herefords, Polled Shorthorns, and the Santa Gertrudis and Brangus breeds. A purebred sire has often been mated to purebred or high-grade females of another breed for the production of market animals and commercial milk cows. Such crosses usually result in increased performance. Generally speaking, crossbreeding produces increased vigour over the mean of the parental breeds.

See also Livestock Judging; Agricultural Education and Research.

NUTRITIVE REQUIREMENTS

The food requirements of cattle vary, depending to some extent on the purpose for which the animal is maintained. The larger part of the feed is required for normal body functions; the remainder is available for growth, fattening, reproduction and lactation. Sources of nutritive energy, protein, fat, minerals and vitamins are essential for the proper nutrition of cattle. Investigations of maintenance and production requirements have been of a highly technical nature and the results have provided feeding standards. As good pasture has a high content of protein, minerals and carotene, and is an economical source of nutritive elements, pasture improvement has received much attention (*see* Grassland). Pasture not only tends to maintain fertility in the herd but also provides the cows with a surplus of various nutritive essentials that can be stored in their bodies and thus ensure them against such deficiencies that might occur from the feeding of low-quality roughage during the winter. Feeders found that a liberal feeding of protein is necessary for high milk production, with a tendency to supply this element in the form of a vegetable protein from green leafy legumes. Vitamin and mineral requirements also received considerable attention. The minerals most likely to be needed to supplement feeds are common salt, calcium, phosphorus, iodine and iron. Other minerals are sometimes required. Calcium and phosphorus requirements are closely associated, since the two elements together in nearly fixed proportions are stored in the bones and secreted in the milk. If either element is deficient in the feed, both bone building and milk secretion are hindered. Phosphorus deficiency is commoner than calcium deficiency, since the soil and hence the forage in some parts of the world is deficient in this element. Where cattle subsist almost entirely on the range it is practical to supply phosphorus (and perhaps other minerals) from sources other than grain and forage (*see* also Fertilizers and Manures: *Influence of Fertilizers on Livestock and Human Food*).

As with minerals, vitamins are perhaps of greater concern in rations for growing and breeding stock than for fattening cattle. Vitamin A appears to be the one most likely to be deficient in feeds for dairy cows, or for steers fattened in areas where green leafy forage and yellow grain are limited. Newborn calves have no reserve of this vitamin but it is supplied by colostrum. Carotene, the yellow plant pigment from which vitamin A is formed in the animal body, occurs in close association with the green colouring matter of pasture plants and other green forage. As a rule, the greener the colour of the hay, the greater the amount of carotene, but hay stored for long periods tends to lose much of its carotene though still retaining most of its colour. Cattle must have an adequate supply of vitamin D to enable them efficiently to assimilate and utilize the calcium and phosphorus in their feed. It is believed that farm animals of all types generally receive an adequate supply of this vitamin by exposure to the sun's rays, depending on the intensity of the sunlight and its concentration of ultraviolet rays. *See* also Feeds, Animal.

MANAGEMENT, CARE AND HANDLING

The management and care of beef and dairy cattle are highly specialized. In the United States, for example, the feeding of beef cattle in the corn belt states, the production of feeder and grass-fat cattle on the ranges of the west, and the production of milk in the dairy sections of the northeast and middle western states all require a high degree of skill with different equipment and in management. The range area is composed of plains and mountainous areas useful for grazing purposes.

Practical ranch operation commonly involves deferred and selective grazing to maintain the supply of forage, selection and culling of the breeding herd, controlled breeding, a well-arranged water supply and the production of winter feed where necessary. All of these practices are conducive to the best condition of the breeding herd and a satisfactory crop of vigorous calves capable of making good gains.

On a well-managed ranch, a relatively high percentage of the investment is in the livestock rather than equipment. The range may be fenced or not, depending on the type of ranch. Corrals are used where large numbers of cattle are handled. In connection with the corral, a chute for holding cattle while being branded or vaccinated is desirable. Range cattle are branded as a means of identification. Brands are recorded by the owner in the state where the ranch is located (*see* BRANDING). Rounding up cattle or working the range is a time of great activity, especially when fat cattle are to be shipped, the breeding herd shifted to winter range, and calves separated from their dams to be sold as feeders or held on the ranch. The winter range is usually a pasture or range that offers some natural protection from storms and provides some grass or browse for grazing. When necessary, maintenance rations of cheap roughages or small amounts of protein supplement are fed during the winter or early spring.

The fattening of beef cattle in the United States is closely related to the production of calves and yearlings in the range area. The most important feeding area is the corn belt states of the middle west where calves or yearlings from the western ranges are fattened in drylots. These cattle are fed corn and hay in feed bunks with some silage, salt and minerals. Most feeders, to make a successful enterprise, combine hogs in the feedlot with the cattle whenever whole grains are being fed. The use of finely ground grains in cattle feeding, a practice commoner than formerly, may make unprofitable the combining of cattle and hogs in the feedlot. In the late 1950s the technique was developed of using hormones or hormonelike substances to increase the rate of daily gain. These were supplied either in the feed or by direct implantation in the animal's body. Inexpensive barns or sheds, feed racks and an adequate water supply are the most important items of equipment and together with feed and labour go to make up the feeding operation. By the early 1960s the use of such mechanical aids as self-unloading wagons, silo unloaders and conveyors for filling feed bunks were being employed on large farms and in large-scale commercial feeding operations to reduce man-hours of labour (*see* CROP-PROCESSING MACHINERY).

In the United States the maintenance of comparatively small breeding herds of registered cattle in many of the other states also requires specialization. Their care, management and breeding differ from those under which commercial range herds are handled. The registered cattle are produced primarily for breeding purposes and receive more attention and are fed more liberally as a rule than cattle produced primarily for slaughter.

Breeding herds are made up of highly selected individuals conforming to the standards of the breed. Cows are bred to calve throughout the year, but most of the calves are born late in winter or early in the spring. During the summer months these calves run with their dams and may be fed grain while on pasture. Cows are usually maintained on pasture and roughage produced on the farm. Young cattle are given every opportunity to develop as considerable income is derived from their sale, especially bulls, either at private sale or auction.

Dairy farming in the United States is usually distinct from the production of beef, but a certain amount of overlapping occurs. Approximately two-thirds of the dairy cows are specialized dairy breeds; the remainder consists of cattle of beef, dual-purpose and mixed breeding. In commercial herds, replacements are commonly bought but some breeders raise their own replacements in order to improve production and lessen the danger of disease. Good cattle and modern methods of care and management are important factors in profitable dairying (*see* DAIRY INDUSTRY).

DISEASES OF CATTLE

The greatest universal hazard in rearing cattle is disease. The most destructive diseases are caused by bacteria, protozoa and filterable viruses, but fungi, parasites, poisons, malnutrition and metabolic disturbances also exact heavy tolls.

Contagious Diseases.—Foot-and-mouth disease (*q.v.*), or aphthous fever, probably is the most widespread and contagious of all infectious maladies of animals. Cattle and other cloven-footed animals, including swine, sheep and goats, are susceptible. The most rigid quarantines and restrictions of movements of animals and animal products frequently fail to control the spread of the malady. In the United States the immediate slaughter of affected and exposed animals completely eradicated the infection on a number of occasions after 1900. This procedure was followed in England and adopted from time to time in some countries on the European continent, but the proximity of areas in which the disease is established is a constant hazard.

The disease is prevalent in most of Europe, Asia, Africa and South America. In countries where the disease is enzootic or where infection recurs from adjoining infected countries, total eradication has been found economically unfeasible and measures to control the infection include prophylactic vaccination, using variations of the product originally developed by S. Schmidt of Denmark and O. Waldmann of Germany in the late 1930s. About 60,000,000 vaccinations of cattle, goats, sheep and swine were applied by the Mexico-United States Commission for Eradication of Foot-and-Mouth Disease in Mexico, where after a five-year campaign, the disease was eradicated in Sept. 1952. Approximately 1,000,000 animals were destroyed in the co-operative program financed by both countries.

Rinderpest (*q.v.*), or cattle plague, a highly fatal, contagious, filterable-virus disease, was widespread in the 19th century practically all over the world but did not occur in North America. Vigorous eradication measures were widely applied, and in the second half of the 20th century it remained only in Asian countries and parts of Africa. The disease is characterized chiefly by severe gastrointestinal involvement. Control in countries where the disease is enzootic involves quarantines and use of preventive vaccines prepared with chemically inactivated tissue or virus attenuated by propagation in other species—goat, rabbit or chicken embryo.

Contagious pleuropneumonia, or lung plague, was prevalent in many countries before the 20th century. By means of quarantines and slaughter of affected animals, the disease was eradicated from Europe and North America. It persisted, however, in Asia, Australia and parts of Africa.

Tuberculosis (*q.v.*) in cattle is a widespread, chronic, bacterial disease caused by an organism closely related to that of human tuberculosis. Almost all mammals, including man, are susceptible to bovine tuberculosis. Cattle are relatively insusceptible, however, to the human and avian types of the infection. The bovine infection may be readily transmitted by infected milk and milk products. Pasteurization is an effective safeguard. The disease may be successfully controlled by quarantines and repeated application of the tuberculin test. The test is accurate to a high degree even in mildly affected animals. The infected animals may be placed in quarantine, thus reducing spread of the disease, or they may be slaughtered at once. The latter procedure, with quarantines and disinfection of infected premises, was followed in the United States. The extent of bovine tuberculosis, formerly averaging about 5% and much higher in some areas, was reduced to less than 0.2% in all parts of the U.S. Repeated testing is necessary, however, as long as any infection remains.

Brucellosis (*q.v.*), or Bang's disease, which is characterized by abortion and sterility, is a problem wherever breeding operations are conducted. The infection, caused by *Brucella abortus*, is prevalent to a greater or lesser extent throughout the world. Diseased animals are detected by tests of the blood or milk. Control may be effected by segregation or destruction of affected animals, with appropriate quarantine measures, with or without the aid of preventive vaccine. The most widely used vaccine is prepared with the so-called strain 19 of *Brucella abortus* which is especially useful in immature cattle. Man frequently contracts the infection, referred to as undulant fever, from infected cattle, swine or goats.

Mastitis, or inflammation of the udder, rivals all bacterial infections of dairy cattle in the aggregate loss it causes. It occurs in acute and chronic forms. Death rarely results but the infection, which may be due to streptococci, staphylococci or other organisms, causes alteration and material reduction of the milk secretion. Since the development of the sulfonamides and other antibiotic agents such as penicillin and streptomycin, considerable success has been achieved in treatment. The disease may be controlled by segregation of infected animals, sanitation and careful milking practices.

Johne's disease, or paratuberculosis, is a chronic disease of cattle, which causes considerable loss in Great Britain, North America and other parts of the world. The causative organism, *Bacillus* (*Mycobacterium*) *paratuberculosis*, produces a chronic dysentery which results in progressive emaciation and death in many cases.

Two acute, fatal, bacterial diseases of cattle are anthrax (*q.v.*) and black quarter (blackleg). These occur in quite definitely defined districts in widely separated parts of the world. In these enzootic areas, vaccination with biological products prepared from the respective causative bacteria is generally effective in control. Anthrax may be acquired by other animals, including man.

Others.—Bovines, like other ruminants, possess a complex stomach having four divisions, the largest of which, the rumen, or paunch, has a capacity of as much as 50 gal. (*see* RUMINANT). This anatomical peculiarity is responsible for frequent digestive disturbances. Bloat and impaction are common. Cattle also frequently suffer from perforations of the stomach by foreign metallic objects which are commonly ingested with the feed and cause death if they penetrate the heart sac.

Calves, especially those of the dairy breeds, commonly develop fatal intestinal disorders and pneumonia unless special care is taken in feeding, sanitation and housing.

Dairy cows are prone to develop metabolic diseases. Milk fever, or parturient paresis, is the commonest of these. It occurs usually just after parturition and invariably results in death if treatment is not given. Another such disease is acetonemia, or ketosis, in which there are acidosis, subnormal quantities of sugar in the blood and faulty fat metabolism, with excess formation of ketones in the body.

Cattle may be afflicted with other diseases, infectious and otherwise, which cause considerable losses. These include actinobacillosis and actinomycosis (wooden tongue and lumpy jaw); cowpox, which is closely related to smallpox; epithelioma (cancer eye); infectious keratitis (pinkeye); leptospirosis; leukemia; pasteurellosis (hemorrhagic septicemia); rabies; rickets; trypanosomiasis; mucosal diseases; vibriosis; rhinotracheitis (red nose); and external and internal parasites. (M. S. SN.; W. B. N.)

Parasites of Cattle.—Parasites of cattle, belonging to such zoological groups as protozoa, worms and arthropods, cause extensive economic loss. Successful control measures generally consist in attacking the various parasites at vulnerable points in their life cycles by following recommended management procedures including treatment.

The diseases caused by protozoa, or one-celled animals, are especially important in tropical and subtropical countries. Among the most destructive are piroplasmosis or tick fever, anaplasmosis, surra and nagana, or sleeping sickness (*q.v.*), transmitted by the tsetse fly (*q.v.*). All these diseases are caused by minute parasites that live in the red blood cells or in the blood stream, and are usually transmitted by bloodsucking arthropods such as ticks and flies; they are generally characterized by fever and destruction of the red cells. The monetary loss from these diseases is great. However, by the second half of the 20th century practically all of these losses had been eliminated in the United States through eradication of cattle ticks by systematic dipping of ticky cattle in standardized arsenical dips. Control of other protozoan blood diseases, especially those transmitted by flies, proved less satisfactory.

Other protozoan diseases of cattle are coccidiosis and venereal trichomoniasis. Coccidiosis is an intestinal disease characterized by bloody diarrhea and emaciation. It is caused by sporozoan parasites that infect the inner lining of the intestine. The infection is largely in calves and is controlled by strict sanitation. Venereal trichomoniasis is caused by a small flagellate organism that is transmitted through coitus. Infection results in early abortion, sterility and other breeding difficulties.

The worm parasites are flukes, tapeworms and roundworms. The common liver fluke (*Fasciola hepatica*) lives in the bile ducts; it causes extensive damage to the liver and general unthriftiness of the infected animal. The complicated life history and control measures are the same as those discussed under diseases and parasites of sheep. (*See* SHEEP: *Parasitic Infestations.*)

Several species of tapeworms infest the digestive tract but these worms do not appear to cause extensive injury. The larval or bladderworm stage of the common tapeworm (*Taenia saginata*) of man occurs in the muscles and causes a condition known as "measly beef." Cattle acquire the infestation by swallowing the eggs while grazing on pastures that have been contaminated by excrement from tapeworm-infested persons.

Important roundworm parasites are lungworms, stomach worms and intestinal threadworms of which there are numerous species. All these worms are acquired by picking up the infective larvae while grazing. Roundworms cause unthriftiness, anemia and digestive disturbances, especially diarrhea. The injurious effects are most pronounced in calves and in animals under two years of age.

Sanitation, pasture rotation and avoidance of overstocking tend to control worm parasites. Medicinal treatment with anthelmintic drugs, especially phenothiazine, is of value in controlling stomach and intestinal roundworms.

The arthropod parasites include the ticks, mites, lice and flies. Aside from ticks and certain flies that transmit tick fever, anaplasmosis and other protozoan blood diseases, the most injurious arthropod parasites are the warble flies, *Hypoderma lineatum* and *H. bovis*. These flies lay their eggs on the legs of cattle. In a few days the eggs hatch and the young larvae penetrate the skin. They then migrate through the tissues of the body and eventually reach the back. There the larvae or grubs, as they are sometimes called, complete their growth and produce swellings. The skin over each swelling becomes perforated and the holes so formed permit the larvae to breathe and to escape when they have completed their growth.

A somewhat similar fly larva (*Dermatobia hominis*), commonly referred to as nuche or gusano, infests cattle in Central and South America. The adult fly does not deposit its eggs directly on the skin as do the warble flies, but lays them on the bodies of mosquitoes and other bloodsucking insects. The eggs hatch and the larvae crawl onto the skin when the insect is feeding. Hatching is stimulated by the warmth of the victim's body. Ox warbles may be controlled to some extent by manual extraction of the grubs or by the use of dusts, dips or washes containing insecticidal substances such as rotenone. Research was underway in the early 1960s on the internal administration of insecticides for the destruction of larvae in the animal tissues. Since the heel fly does not travel far from the place where it emerged from its pupal case, community control programs have been found effective.

Other arthropods such as ticks, mites, lice and bloodsucking flies inflict considerable injury to animals by abstracting blood and causing irritation to the skin. Such parasites living habitually on their hosts may be controlled by the use of insecticidal dips, washes or dusts; flies are best controlled by destruction of their breeding places and by sprays. (E. W. PE.; W. B. N.)

CATTLE POPULATION

Approximately two-thirds of the world's cattle are in Europe, Asia and Africa while slightly less than one-third are found in the western hemisphere. The countries which lead in cattle population are India, the United States, Brazil, the U.S.S.R. and China. Cattle population in most European countries declined during World War II but showed rapid recovery following the war.

On all continents expansion of cattle numbers was noted during the early 1960s. Rapid gains occurred in the U.S.S.R., North America, South America and Africa, with a lower rate of increase in European countries. The cattle population of the world had reached nearly 1,000,000,000 head.

The increase in cattle numbers was reflected in larger outputs of beef and veal in the United States, the U.S.S.R., western Germany, France and the United Kingdom. The United States is by far the largest producer of beef and veal, the output being nearly one-third of the world supply. In Africa and South America the expansion of modern meat-packing facilities and improvement of transportation were incentives toward further development of the cattle industry there. Larger world milk production also accompanied the increase in cattle numbers. After the mid-1950s production was 20% above the 1934–38 yearly average. The United States, France, the Federal Republic of Germany (west Germany) and the United Kingdom are the largest producers of milk. New Zealand produces the most milk per capita, while Denmark, Ireland, Finland and Australia also are intensive dairy countries. Consumption of milk and milk products (milk-equivalent basis) is greatest in Ireland, Finland, New Zealand, Sweden, Australia and Canada.

A marked rise in registered cattle in the United States after World War II reflected a strong market for improved breeding stock. Among the beef breeds, new registrations of purebred Angus, Hereford and Polled Hereford increased from 582,000 to 829,000 in the ten-year period beginning 1950. New registrations of purebred dairy cattle showed a marked rise for Holstein-Friesians, from 184,000 to 274,000 for the same period, reflecting markets favouring milk for bottling rather than milk for buttermaking. Among the dairy breeds registration of males declined markedly during the 1950s and at the end of this period comprised only 8%–12% of the total. Evidently the decline resulted from the increased use of artificial insemination and type-improvement programs sponsored by the breed associations. *See* also references under "Cattle" in the Index volume.

(A. C. Ck.; W. B. N.)

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(E. W. Pe.; W. B. N.; M. S. Sn.)

CATTLEYA, a genus of 40 or more species of tropical orchids that grow on other plants, although not as parasites. These large, showy, brilliantly coloured flowers are grown extensively in greenhouses and are the most popular of the florists' orchids. Several species and a large number of hybrids that are frequently richer in colour and more floriferous than the parents are extensively grown. *See* also Orchid.

(J. M. Bl.)

CATULLUS, GAIUS VALERIUS (84?–54 B.C.) was the greatest lyric poet of Rome. As regards his names and the dates of his birth and death, the most important external witness is that of Jerome, in the continuation of the Eusebian *Chronicle*. Under the year 87 B.C. he states that Gaius Valerius Catullus, lyric poet, was born at Verona and under 57 B.C. he states that Catullus died at Rome when 30 years of age. There is no controversy as to the gentile name, Valerius. Suetonius, in his *Life of Julius Caesar*, mentions the poet by the names "Valerium Catullum." Other persons who had the cognomen Catullus belonged to the Valerian gens; *e.g.*, M. Valerius Catullus Messalinus, an informer in the reign of Domitian, mentioned in the fourth satire of Juvenal.

Inscriptions show, further, that Valerius was a common name in the native province of Catullus and belonged to other inhabitants of Verona besides the poet and his family. Scholars have been divided in opinion as to whether his praenomen was Gaius or Quintus, and in the best manuscripts of the poems the volume is called simply *Catulli Veronensis liber*. For Gaius there is the undoubted testimony, not only of Jerome, which rests on the much earlier authority of Suetonius, but also that of Apuleius. In support of Quintus a passage was quoted from the *Natural History* of Pliny, but the praenomen Quintus is omitted in the best manuscripts, and in other passages of the same author the poet is spoken of as "Catullus Veronensis."

Internal evidence shows that certain poems were written two or three years after 57 B.C., the date of Catullus' death according to Jerome. Thus poem cxiii was composed in 55 B.C., lv either in that year or later, while xi, xxix, and xlv all appear to be written after Caesar's first invasion of Britain (55 B.C.). He is described by Ovid as "hedera juvenalia cinctus tempora" ("his youthful brow crowned with the ivy garland")—a description somewhat more suitable to a man who dies in his 31st year than to one who dies three or four years later. Since no poem is certainly later than 54 B.C., it is best to retain Jerome's reckoning of Catullus' age as 30 years but to suppose him to have lived from 84 to 54 B.C.

Jerome's statement that Catullus was born at Verona is confirmed by other authorities. His father was important enough to act as Caesar's host and it was probably at or near Verona that Caesar accepted the poet's apologies for the attacks on himself and Mamurra in xxix and lvii; xciii may represent Catullus' reply to earlier advances on Caesar's part. The poet's attitude was not due to republican sentiment but the result of personal animosities. In xxix he arraigns Pompeius along with Caesar and in xi he recognizes the latter's greatness.

Catullus' complaints of poverty are not to be taken very seriously. He possessed a villa at Tibur as well as a retreat at Sirmio on Lake Garda, and the poems prove that he had the means to figure in the best society. Still his purse was often, no doubt, as he says, "full of cobwebs" (xiii).

On reaching manhood Catullus was sent to try his fortune at Rome. The premature death of his brother in Asia Minor seems to have recalled him to Verona (*cf.* lxviii). In 57 B.C. he made a belated attempt at a public career by accompanying Memmius, the patron of Lucretius, to Bithynia, of which province Memmius had been appointed governor. His hopes of lining his purse at the expense of the provincials were not realized, and in the spring of 56 B.C. he left Nicaea (xlvi) and returned to Italy, perhaps on his own yacht (*cf.* iv); en route he visited his brother's tomb in the Troad (ci). His delight at seeing Sirmio once more is charmingly expressed in xxxi. The poems show that his last years were divided between Verona and Rome. As a Transpadane, Catullus found many compatriots in the capital, and among them several representatives of the new movement in poetry led by Publius Valerius Cato, himself a native of Cisalpine Gaul.

The poems reveal him on terms of intimate friendship with certain of the younger members of this circle; *e.g.*, Calvus (xiv, l, liii, xcvi), Cinna (x, xcv, cxiii) and Cornificius (xxxviii). He appears to have been acquainted with the two leading orators of the day—Cicero (xlix) and Hortensius (lxv and xcv). Among friends of less eminence he counted a Caelius (lviii) whom some identify with Cicero's protégé M. Caelius Rufus, thinking that lxix and lxxvii, addressed to a Rufus, refer to the same man; this is possible, but in that case another Caelius must be meant in c, since Cicero's friend was not a native of Verona. Particularly dear to Catullus, but otherwise unknown, were two friends, Veranius and Fabullus (ix, xii, xiii, xxviii, xlvii), while in i he dedicates his *libellus* to the biographer and historian Cornelius Nepos, who in later years left it on record that in his opinion Catullus and Lucretius were the two greatest poets of that period. Among Catullus' enemies the most furiously attacked in the poems—apart from Caesar and his lieutenant—are the pair Furius and Aurelius (xv, xvi, xxi, xxiii, xxiv, xxvi), and one Gellius who is the target of no fewer than seven epigrams. Other victims of his invective are Ravidus (xl) and Rufus (*see* above), his rivals in love; a freedman Thallus (xxv); a ridiculous fop Egnatius (xxxvii, xxxix). To a false friend Alfenus he writes more in sorrow than in anger (xxx).

The most important influence in Catullus' life was that of his mistress Lesbia. Her real name was Clodia; Catullus chose the pseudonym for its connection with Sappho (li, a translation of a famous ode of Sappho, was perhaps a first tribute to his mistress' charms). There can be little doubt that Clodia was the notorious sister of the demagogue P. Clodius, married in 63 B.C. to Q. Metellus Celer and suspected of responsibility for his death in 59 B.C. Cicero mentions her several times in his letters and has left a graphic picture of this dangerous beauty in the speech *(Pro Caelio)*, in which he defended M. Caelius Rufus *(see* above), also one of her lovers, against the charge of having tried to poison her. Though Cicero writes as an advocate and Catullus as a lover, their descriptions are not inconsistent and the final proof of identity is contained in lxxix, the *Lesbius* of which poem clearly covers a Clodius, not, however, the demagogue P. Clodius, but Sextus Clodius, a kinsman and associate of Publius, whom rumour represented as having relations with Clodia similar to those attributed to *Lesbius* by Catullus. An attempt to identify Lesbia with a younger sister and namesake of Metellus' wife, who married L. Lucullus and was divorced by him for alleged relations with her brother, appears unconvincing. Catullus was Clodia's lover during Metellus' lifetime *(cf.* lxxxiii); the husband's death apparently brought other rivals on the scene and Catullus' allegiance had been sorely tried before he left for Bithynia, but xi, the final renunciation, is subsequent to his return *(see* above). The data do not suffice to fix the course of the liaison more exactly.

Catullus' poetical activity began soon after his assumption of the *toga virilis* *(cf.* lxviii); references in the poems suggest that he sometimes published his pieces separately or in small groups *(cf.* l; xvi; xlii; xliii; liv). Later *(cf.* i) he formed a collection of his compositions and dedicated it to Cornelius Nepos but it is a moot point what this *libellus* contained, whether it was identical with the present collection, and, if not, how the latter was formed. As arranged in the manuscripts, the poems fall into three sections, viz., (1) i–lx, shorter lyric pieces; (2) lxi–lxviii, longer poems in a variety of metres; (3) lxix–cxvi, elegiac epigrams. The hypothesis most in favour is that the present collection was formed in outline by Catullus himself before his death and that afterward his literary executors inserted in the groups so arranged sundry other material discovered among his remains, including unfinished pieces like lx.

Though Catullus was an Italian of the Italians in character and temperament, it is impossible to appreciate his poetry correctly except in relation to Greek and, more particularly, Alexandrian poetry. Like that of the other *novi poetae*, his work has two aspects. On the one hand there are the shorter pieces in which any and every emotion of the moment finds instant expression, on the other the poems which earned Catullus the title of *doctus* ("learned"), considerably longer than his *nugae* ("trifles") but short when compared with the *Annales* of a Volusius (xxxvi, xcv). The poet's debt to Alexandrian models in these longer compositions, though hard to compute because of the fragmentary survival of later Greek poetry, is universally admitted. Catullus himself declares lxvi to be a translation from Callimachus *(cf.* lxv); lxiv is cast in the mold of a Hellenistic *epyllion* ("narrative poem"); lxviii, a mixture of the personal and narrative elegy, framed as a letter to a friend, also has Alexandrian forebears; lxii adapts an epithalamium of Sappho after the manner of the later Greeks; even lxiii (the *Attis*), which gives an impression of striking originality, probably follows in the track of Callimachus or some other Alexandrian. The most original of these longer poems is probably lxi, the epithalamium for Manlius Torquatus and Vinia (or Iunia) Aurunculeia, since there Catullus has tried to fuse the native *versus Fescennini* with the Greek *hymenaeus;* it contains touches, *e.g.,* 216–220, marked by a tenderness otherwise unknown before Virgil. Even in the *nugae* Catullus' debt to Greece is greater than was earlier realized. Just as the life of the *Neoteroi* ("new poets") with its interest centred on love and letters had been anticipated by that of the later Greeks (compare l with the lines of Hedylus [*fl.* 290 B.C.] preserved in Athenaeus), so the forms, lyric *paignion* and elegiac epigram, to express these emotions had been fixed by the same predecessors. Hellenistic lyric surviving only in meagre fragments, Catullus' originality appears greater here than in his elegiacs, which can be compared with the epigrams of the Greek anthology, but metre (especially the scazon iambic and phalaecan hendecasyllabic), subject matter and often phrasing indicate his obligations. The poems on Lesbia's sparrow (ii and iii) and that on the yacht (iv) had Hellenistic prototypes and an Alexandrian element crops up even in such an ardent love poem as vii. Nevertheless, it is in these shorter pieces that Catullus is most Roman and most himself. The attacks on the smaller fry who had incurred his displeasure often offend modern taste by their gratuitous obscenity, but the *iambi* on Caesar and his associates, which recall but far surpass in bitterness the popular lampoons current at the expense of the *imperator unicus*, were justly considered by their chief victim to have branded him with *perpetua stigmata*. On the other side the Lesbia cycle cannot be paralleled in ancient literature for sincerity of passion, passing through all the stages of joyous contentment, growing distrust and wild despair to the poignant adieu of the disillusioned lover.

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General: Work on Catullus is excellently surveyed by R. G. C. Levens in *Fifty Years of Classical Scholarship*, ed. by M. Platnauer, pp. 284–305 (1954). Of many books mentioned therein attention may be drawn to A. L. Wheeler, *Catullus and the Traditions of Ancient Poetry* (1934); and E. A. Havelock, *The Lyric Genius of Catullus* (1939). (E. A. B.)

CATULUS, the cognomen, or third name, of a distinguished plebeian family in ancient Rome of the *gens Lutatia*. The following are its most important members:

Gaius Lutatius Catulus (3rd century B.C.), Roman commander during the First Punic War, consul 242 B.C. With a fleet of 200 ships, he occupied the Sicilian harbours of Lilybaeum and Drepanum. The Carthaginian relieving fleet was totally defeated near the Aegates Islands off western Sicily, March 10, 241, and Catulus shared in the triumph, though, on account of a wound, he took no part in the operations. (*See* Punic Wars.)

Quintus Lutatius Catulus (2nd century B.C.), Roman general and consul with Gaius Marius (*q.v.*) in 102 B.C. In the war against the Cimbri and Teutoni (*qq.v.*) he was sent to hold the passage of the Alps, but was forced back over the Po river. In 101 the Cimbri were defeated on the Raudine plain, near Vercellae, by the united armies of Catulus and Marius. The chief honour being ascribed to Marius, Catulus became his bitter opponent. He sided with Sulla (*q.v.*) in 100 B.C., was included in the proscription list of 87 and committed suicide. He was distinguished as an orator and writer, and is said to have written the history of his consulship and the Cimbrian War. He figures in the *De oratore* of Cicero.

Quintus Lutatius Catulus (*c.* 120–61 B.C.), son of the above, an influential and consistent supporter of the *optimates*, the conservative senatorial aristocracy. In 78 he was consul with M. Aemilius Lepidus, who proposed the overthrow of the constitution of Sulla. Catulus vigorously opposed this, but Lepidus marched on Rome at the head of an army. He was defeated by Catulus and fled to Sardinia. In 67 and 66 Catulus unsuccessfully opposed the Gabinian and Manilian laws, which conferred special powers upon Pompey. As censor in 64 he opposed the attempt of M. Licinius Crassus to enfranchise the Transpadane Gauls. He consistently opposed Caesar, whose election in 63 to the office of *pontifex maximus*, against his own far stronger claim, was a bitter disappointment and whom he tried to implicate in the conspiracy of 63 organized by Catiline (*q.v.*). Caesar, in return, accused him in 62 of embezzling public money during the reconstruction of the temple on the capitol, though he later dropped the charge.

CAUCA, a department of Colombia, on the Pacific coast of South America; area 11,862 sq.mi., pop. (1961 est.) 520,680. The Western cordillera, traversing nearly its whole length from south to north, and the Central cordillera, forming a part of its eastern frontier, give a very mountainous character to the region. It includes the fertile and healthful valley of the upper Cauca, and a part of the coastal plain. The region is rich in mines and valuable forests, but has made very little progress in agriculture because of inadequate transportation facilities. Cattle raising and sugar, coffee and tobacco growing are the main activities. Capital of the department is Popayán (*q.v.*), pop. (1961 est.) 61,490.

CAUCA RIVER, Colombia. From its headwaters near Popayán the Cauca river flows in a northerly direction between the Central and Western cordilleras for 838 mi., joining the Magdalena river near Mompós. In its middle reaches the Cauca flows through the broad, fertile intermontane depression, the Valle del Cauca (elevation, 3,100–3,300 ft.) and continues below Cartago to the Caldas region, where it plunges through a box canyon cut into ash deposits. Through much of Antioquia it is also confined to a deep gorge, emerging onto the forested Magdalena lowlands near Cáceres, from whence it is navigable. The Valle del Cauca sector of the river, together with the adjacent coffee-growing uplands, has been organized under a regional authority, modeled after the Tennessee Valley authority, to promote a balanced agricultural, commercial and industrial development. The volcanic uplands drained by the Cauca river produce two-thirds of Colombia's coffee. (Js. J. P.)

CAUCASIAN LANGUAGES. This term is applied to the languages used on the Caucasian isthmus which do not belong to the Indo-European, or to the Semitic, or to the Ural-Altaic families. They are spoken by about 4,000,000 people.

It has been held, but not proved, that they may be a modern relic of an ancient Mediterranean stratum of languages. Even the most cogent presentations of this view (by Oštir, Vladimir Georgiev, Albert van Windekins and others) are adjudged inconclusive by objective critics. The Soviet linguist Nikolai Marr, who advocated it, has been discredited in Russia itself. While the theory has some evidence to make it plausibly attractive, it lacks extensive factual support.

They are divided into three groups—the east Caucasian, the west Caucasian and the south Caucasian. The east Caucasian group may be divided into eight branches: (1) The Chechen branch (the chief being the Chechen language of the middle course of the Terek and Dagestan); (2) Avaro-Andi (12 languages in west Dagestan, the chief being the Avar language); (3) Darghi (east Dagestan); (4) Samur (south Dagestan, the chief being the Kuri language, near Derbent); (5) Lakk or Kasi-Kumuk (central Dagestan); (6) Artchi (one village in central Dagestan); (7) Hinalugh (one village near the mountain Shah-Dag); and (8) Udi (two villages near the town Nukha). The west Caucasian languages have three branches: (1) Abhaz—region of Sukhum-Kale; (2) Ubykh—formerly dominant in the region of Sotchi, but now spoken only by a few families in Asia Minor; (3) Adyghe, with two dialects—Kabardi (in the so-called Kabarda, principal town Naltchik) and Kiakh or Cherkess (region of Kuban and the Caucasian shore of the Black sea). The south Caucasian languages are: (1) Georgian with its dialects; (2) Mingrelian and Laz; (3) Svanetian.

East Caucasian and west Caucasian are related and may be considered as two branches of the north Caucasian group. The relationship between this and the south Caucasian group has not, as yet, been scientifically proved, and in the present state of our knowledge the north Caucasian and south Caucasian groups must be considered as separate.

The north Caucasian languages are distinguished by an extraordinary abundance of consonants. Very characteristic of the system of north Caucasian languages are the lateral consonants, as well as a great number of consonants of the type *k*, pronounced in the deep back part of the palate. This superabundance of consonants is moderated in the east Caucasian group where consonants rarely come into contact with each other; but in west Caucasian languages the contact and combination of consonants occur very frequently, and the most complicated combinations, very difficult to pronounce for nonnative speakers, are admitted.

In the east Caucasian languages substantives are divided into classes or "genders"; their number varies in different languages (from two to six). In most cases, neither from the meaning of the word nor from any outward formal symptom is it possible to know to which class the substantive belongs. Very often the same substantive belongs in the singular to one class and in the plural to another. A consonant, specific for each group (*w, b, d, r, y*), is added as prefix, infix or suffix to the adjectives, verbs, pronouns, adverbs, etc., connected with the substantive. For example, the Avars say: *Dow tchi wugo roqow*—"this man is in the house"; *Dob keto bugo roqob*—"this cat is in the house"; *Doy thladi Yigo roqoy*—"this wife is in the house." Substantives, adjectives and pronouns are declined; an extraordinary number of cases is used to express ideas that in other languages are expressed by a combination of words with prepositions. The Tabassaran language has 35 cases. The system of declension is based on the opposition of Casus Agens to Casus Patiens. The Casus Agens is used for the logical subject of transitive verbs, and Casus Patiens for the logical object of transitive and logical subject of intransitive verbs. The outward distinction between Casus Agens and Casus Patiens is expressed in a different way by different substantives. Thus, in the Kuri language *Lam*—"ass"—has Agens *Lamra* and *ghum*—"smoke"— has Agens *ghumadi*. All other cases are derived from the Agens by adding different endings. The plural is also formed differently from different substantives, so that the declension of substantives in east Caucasian languages is full of irregularities. The same is true of conjugation in most of these languages. The verbal root, *i.e.*, the invariable part of all verbal forms, consists mostly of one consonant. Before it are the prefixes, indicating the aspect of the verb (*i.e.*, whether the action is considered as a lasting process or as a concluded action) and the gender signs mentioned above which agree with the Patiens of the sentence. After the root consonant come the elements, indicating time, mood and sometimes the person. There are many verbal forms and the difference of their meaning is often very subtle and difficult to define. The east Caucasian languages have therefore a complicated grammar with a great abundance and prodigality of forms. The same prodigality is found in the vocabulary; there are for instance special adverbs to indicate such notions as "five years ago," "four days later," etc.—these words having nothing in common with the corresponding numerals.

In the west Caucasian languages, declension is reduced to a minimum; the Adyghe and Ubykh languages have only three cases, the Abhaz has no declension at all. There are fewer verbal forms than in the east Caucasian languages. The basic vocabulary is small, so that many notions are expressed by compounds, *e.g.*, in Adyghe the beard is designated as "tail of the mouth." The characteristic peculiarity of west Caucasian languages is a fondness for combining words. Notwithstanding these differences between east and west Caucasian languages, there are still important similarities in both these groups—viz., in the most elementary words, personal pronouns, numerals, simple verb roots, so that there can be no doubt as to their relationship. There are also isolated similarities in the grammar, for instance the opposition of Casus Agens to Casus Patiens, traces of the different classes of substantives.

The phonological system of south Caucasian languages is simpler than that of the north Caucasian; there is a striking fondness for the agglomeration of consonants (*e.g.*, the Georgian, *mghwdl* is genitive for "priest"). There is only one gender. The declension is rich in case forms, but their formation is regular. The verb has a developed conjugation; the means of expressing personal forms through combination of certain prefixes and suffixes is complicated. In the south Caucasian languages the agreement of the verb with its subject and object varies with the tenses of the verb. In the present the subject is in the nominative and the object in the dative-accusative.

In the Aorist the subject is in a special case (Agens?) and the object in the nominative, in the perfect the subject is in the dative and the object in the nominative.

Georgian alone has an ancient written literature, beginning with the 5th century A.D., and in recent years books and newspapers have begun to appear in other Caucasian languages. *See* also GEORGIAN LANGUAGE.

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(N. S. T.; J. Wh.)

CAUCASOID, a term used to designate one of the major racial stocks of mankind, others including Mongoloid (*q.v.*) and Negroid (*see* Negro). From the shores of the Arctic ocean to Africa north of the Sahara, and from the Azores in the north Atlantic to Samarkand, in Soviet central Asia, there is a single geographical unit of mankind, comprising a large number of local races. Called the "Caucasian" race by J. F. Blumenbach (*q.v.*) in honour of the women of the Caucasus whom he admired, and often termed the "white" race, a more appropriate designation is the "European geographical race." In this way, the original geographical centre is defined, and the inclusion of purely local races is more clearly understood.

Growth of the European Geographical Race.—During much of the present era, growth of the European geographical race was limited by warfare, the food supply and disease. Then, rather suddenly, a number of events led to rapid population increase, especially in western and northwestern Europe. One was the discovery of the new world, which yielded new sources of wealth and important new crops including corn (maize) and the potato. A second event was the increasing control of communicable diseases. A third was the improved level of subsistence following the Industrial Revolution. There are over 600,000,000 members of the European geographical race, including 230,000,000 in the Americas, Australasia and South Africa.

Over the last 6,000 years there have been differential increases in the size of various local races of the European geographical race. At first, maximum population growth was attained in the middle east, then in the Mediterranean basin. In post-Columbian times northwestern Europe has seen the greatest expansion, spilling over into North America and Australia. The relative size of different local races has therefore been shifting in the wake of technological advancement and improved conditions of life.

Physical Characteristics.—Physically, the European geographical race is most varied, including such short-statured populations as the Lapps and such tall groups as the adjacent peoples of Scandinavia. Morphologically, there is the widest possible range in body build, and considerable variability in nose form, facial hair, balding and the form of the mouth and lips. Skin pigmentation varies from a near lack of melanin among some individuals of northwest European origin to considerable pigmentation in the southern and eastern limits. It is easier to describe the European geographical race, so variable within itself, by exclusion. Near-black skins, the spiral-tuft hair form, extremely broad noses and coarse straight hair are not native to this broad geographical area. (*See* also Face; Hair.)

Blood Groups and Biochemistry.—With respect to many of the blood groups, the European geographical race is indeed unique. The A_2 subgroup (in the ABO series) and the Rh-negative blood type (r) are practically limited to Europe. In contrast, the Rh_0 blood type (characteristic of Africa), the Diego positive (Di^a) blood type and the U-negative blood type are absent from Europe, north Africa and the middle east. Of the known haptoglobin types, Hp_1 and Hp_2, the former is commoner in Europe. Members of the European geographical race do not regularly excrete β-amino isobutyric acid (BAIB) as do Amerinds, Asians and some Oceanic peoples. (*See* also Blood: *Individuality of Human Blood;* Blood Groups.)

Comparison of Europeans (Caucasoid), Asians (Mongoloid) and Africans (Negroid) in the Frequency of Seven Gene-Determined Traits

Trait	Europe (frequency)	Asia and Africa (frequency)
Blood type A_2 (a subtype of A) .	3%–15%	Rare in Asia, under 5% in Africa
Blood type B	About 15%, lower in west, higher in east	Up to 30% in Africa, up to 40% in some Asian populations
Rh-negative blood type . . .	About 15%, highest among Basques	Rare in Africa and Asia
Diego⁺ (Di^a) blood type . . .	Rare	Up to 30% in various Asian populations, absent in Africa
Excretion of BAIB	Rare	Common in Asians, Amerinds and some Micronesians
Carabelli's cusp.	40%–80%	Rare in Africans, 1%–10% in Asians
Inability to taste PTC . . .	17%–30%	Under 5% in Africans, under 15% in Chinese and Japanese

Regional Differences.—Nevertheless, there are marked regional and local differences in pigmentation, hair form and distribution, tooth size and morphology, middle-phalangeal hair patterns and frequencies of the various blood types. Type O blood, for example, is marginal and coastal in Europe, increasing in a south-north gradient. Blood group B increases along a west-east line, being most prevalent in the U.S.S.R. and the middle east. Rh-negative individuals are commonest among the Spanish Basques (*q.v.*), and the inability to taste various antithyroid drugs reaches a maximum in the Baltic.

Of particular importance is the distribution of various genetically determined traits apparently conveying some immunity to malaria. Among these may be listed thalassemia, primaquine type drug sensitivity or sensitivity to the broad (fava) bean—all at a maximum in the Mediterranean region or the middle east. Other inheritable disorders, particularly disadvantageous in warm climates, reach their peak frequency in the north and northwest.

Origins.—As is true for all geographical races, the origins of the European geographical race are shrouded in archaeological uncertainty. However, there is no real gap between the Paleolithic and the present. Some of the Upper Paleolithic peoples unquestionably lived on, and certain of their characteristics are reflected in the living populations of the United Kingdom, north Germany and Scandinavia. The origins of the "Mediterranean" peoples who appeared together with agriculture, domestic animals and cats in the Tigris-Euphrates and Nile valleys are problematic, but their subsequent migrations across Europe are archaeologically well documented.

Diversity of form and feature can to some extent be explained by waves of migrations across Europe from European Asia and the Mediterranean, and coastally through the Strait of Gibraltar to England and Ireland. Nevertheless, evidence favours the selective force of local environment as a prime cause of local differences, especially those involving the hemoglobins, the blood enzymes and the hemoglobin-fixing proteins. Residents of the cold climate areas evidence genetic adaptations to cold, while those from the warmest climates do not.

The past history of the European geographical race and its numerous local races has been facilitated by historical records, covering a 4,000-year span in some areas, and by archaeological remains which document human habitation for nearly 1,000,000 years. Many a city has been built over Neolithic villages, Mesolithic shell heaps and the bones and artifacts of fossil men. Investigations of these phenomena are being supplemented by studies of contemporary racial evolution. As in other parts of the world there are problems of origins, relationships and continuing change.

See also Anthropology: *Physical Anthropology;* Races of Mankind.

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(S. M. G.)

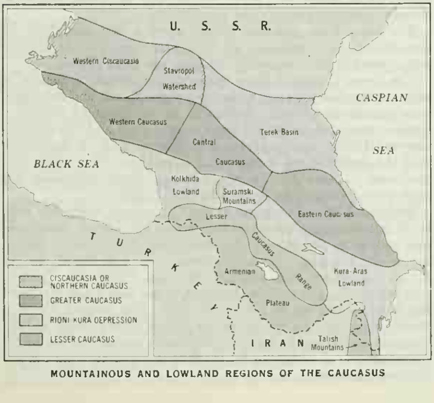
CAUCASUS (Kavkaz), a range of mountains extending for about 750 mi. from Anapa on the Black sea coast to the Apsheron peninsula on the western shores of the Caspian sea. In its broader meaning, the Caucasus region is usually taken to include a much more extensive part of the southern U.S.S.R., stretching from the plains of the Kuban and Terek in the north to the frontier with Turkey and Iran in the south. This area falls naturally into four main zonal divisions, two of lowland, two of mountains. Passing from north to south, these are: (1) The district of Ciscaucasia, otherwise known as the Northern Caucasus or, in Russian, Predkavkazye. There the northern foothills of the Caucasus range grade down into the plains of the Kuban and Terek, which are themselves separated by a low plateau in the region of Stavropol. (2) The Caucasus mountain range, termed in Russian geography the Greater Caucasus (Bolshoi Kavkaz). (3) The long depression drained by the Rioni and Kura rivers, which links the coasts of the Black sea and the Caspian. In its central part the Suram range forms a low watershed and connects the mountain system of regions (2) and (4). Together with the Lesser Caucasus, this district is conventionally known as Transcaucasia (Zakavkazye). (4) The term Lesser or Minor Caucasus is sometimes applied in a strict topographical sense to the range of mountains which limits the Rioni-Kura depression on the south and separates it from that part of the Armenian plateau which lies within the borders of the U.S.S.R. However, following the general usage in Soviet geography, the Lesser Caucasus (Maly Kavkaz) will here be taken to include all those mountainous districts, mostly falling within the basin of the Aras (Araks) river, which lie between the Rioni-Kura trough and the Turkish and Iranian borders.

TOPOGRAPHY AND GEOLOGY

Ciscaucasia.—The western part of this region drains to the Black sea through the Kuban river. It is an area (*see* map) of rich black soils and of adequate summer rainfall, and like the adjacent plains of the lower Don it is well suited to the growing of cereals. By contrast, to the east of the Stavropol watershed, the steppes of the Terek basin are semidesert and suffer extremes of temperature. The soil is of inferior quality, sandy and salty and of little use to the farmer. The Terek basin, which drains to the Caspian, was at one time occupied by an arm of that sea, and many districts of it are very poorly drained. For the most part it is given over to pastoral nomadism, but on its south side, near the Caucasus foothills, the rainfall increases and more permanent settlement is possible.

The Greater Caucasus.—About 750 mi. long and somewhat more than 100 mi. wide at its broadest, the main Caucasus range is generally considered to be the boundary between Europe and Asia. It resembles the Pyrenees rather than the Alps by reason of the straight lie of its main crest line and the general simplicity of its geological structure. Basically it is a single great anticlinal fold, thrown up at the start of the Miocene, partially worn away by erosion and later uplifted again and eroded afresh in the Pliocene period.

Erosion has exposed the oldest rocks, which form the core of the fold, along its highest part, made up of a belt of crystalline granites and gneisses. Intruding through these most ancient rocks and overlying them are some volcanic outpourings dating from the latest phase of folding and uplift in Pliocene times; the two highest peaks, Elbrus and Kazbek, are entirely composed of these recent lavas. Passing to the north and south of this central core, the geologic succession reveals metamorphosed schists of Paleozoic age, and after them various strata, successively more recent, of Jurassic, Cretaceous and Miocene age. These strata include marls, clays and limestones of varied degrees of hardness, and they have been worn by differential erosion into a series of stepped escarpments which are breached in gorges by the rivers on their way to the outlying plains. This effect is much more noticeable, however, on the northern slopes of the range where the angle of folding is relatively regular and gentle. In the process of folding the mountain range was pressed on its south side hard against a resistant block, the Dzirula massif, so that its slope on this side is much more abrupt and sheer than on the north. In detail, the Caucasus range falls naturally into three sections, the west, centre and east.



MOUNTAINOUS AND LOWLAND REGIONS OF THE CAUCASUS

The Western Caucasus begins as low hills in the vicinity of Anapa, just south of the mouth of the Kuban. The range becomes wider and higher as it is followed eastward, and beyond the Tuapse-Maikop railway it never falls below 3,000 ft. In the longitude of Sochi the main range is 7,000 ft. high, and beyond there it separates farther from the coast and rises to an average height of 11,500 ft. as far as Mt. Elbrus, where the Central Caucasus may be said to commence. The Western Caucasus receives a heavy rainfall at all seasons and is the wettest part of the entire range. In consequence it carries a dense cover of forest, snow fields and many glaciers. The snow line is at its lowest in this part of the range, sometimes descending to 8,000 ft. East of the Tuapse-Maikop railway this part of the range forms a singularly effective barrier to communication and is crossed by only one main road, the most westerly of the three great military highways over the Caucasus range. This is the Sukhumi military highway, running from Cherkessk to Sukhumi, along the valley of the Teberda, a tributary of the Kuban, across the Klukhori pass (9,239 ft.) to the valley of the Kodori. All the way from Anapa to Sukhumi the Western Caucasus skirts close to the Black sea coast. There is no natural harbour of significance along this shore except the wide bay of Novorossisk at the low western extremity of the range.

The Central Caucasus extends for more than 125 mi. between the two great volcanic peaks of Elbrus (18,481 ft.) and Kazbek (16,558 ft.). In this section the range reaches its highest and most impressive dimensions. The central range becomes split into two, consisting of parallel upfolds of granite separated by a syncline of soft black schistose rocks. Of these two chains, that to the north includes the highest peaks, having, in addition to Elbrus and Kazbek, the granitic heights of Koshtan-Tau (16,876 ft.) and Dykh-Tau (17,054 ft.). The southerly range, from Ushba to Uilpata, although it is on the average lower than that to its north, is the more continuous of the two, and forms the main watershed of the range. This is because the erosive power of the streams which flow to the north from the central section of the range is greater than that of those which flow southward, and as a result they have cut back through the northern range and dissected it into its separate peaks.

The Central Caucasus, being the highest section of the range, feeds many glaciers, especially on the southern slopes where the rainfall is heavier and the snow line higher. Two of the three great military highways of the Caucasus cross the range in this division. They are the Ossetian military highway, from Alagir to Kutaisi, which runs from the valley of the Ardon, a tributary of the Terek, across the Mamison pass to the valley of the Rioni, and the Georgian military highway from Ordzhonikidze to Tbilisi, leading from the valley of the Terek across the Krestovy pass (also known in earlier writings as the Darial pass or Caucasian Gates) to the valley of the Aragvi, a tributary of the Kura.

The Eastern Caucasus begins east of Mt. Kazbek and the Krestovy pass, which lies just to the south of it. At this point, two chains take off from the main range toward the south and southeast, the Kakhetia range and the Kartali range. They soon fall in height and become low plateaus of the foothills. The main range retains an elevation of about 10,000 ft. and broadens out on its northern slopes into the wide plateau of Dagestan (the "Abode of Mountains"). This is a limestone tableland, much dissected by erosion and difficult of access. It attracts little rainfall and with its wide expanses of arid plain, broken up by occasional interior ranges, it resembles the central plateaus of Iran more closely than the wooded ranges of the Western and Central Caucasus. This Dagestan region is one of the most isolated and remote parts of the Caucasus and has provided a retreat for a great variety of fugitive ethnic types. Near the Caspian, the Caucasus breaks down sharply into a series of arid ranges which abut very close to the coast. The route from the north along the shore to the Apsheron peninsula is particularly constricted at the town of Derbent, where in the middle ages a defensive wall was built with the object, as in the case of the Great Wall of China, of restricting the passage of nomadic hordes. The Pass of Derbent is sometimes called the Iron or Caspian Gates, though this last usage may lead to confusion with the defile just east of Teheran which was known by that name in classical times.

The Rioni-Kura Depression.—This natural corridor across the Caucasian isthmus is clearly of the first importance as a routeway. It consists of a downfold between the main ranges of the Greater and Lesser Caucasus, but its structure is complicated by the intrusion in its central section of a block of ancient crystalline rock which reaches the dimensions of a small plateau. It does not bar communications, however, though the railway has to tunnel through it at the Suramski pass. To the west of the Suramski mountains and behind a very straight alluvial coast line lies the Kolkhida (Colchis) lowland, drained by the Rioni and its tributaries. This area is heavily watered at all seasons and its rich soils have often been reclaimed from marsh and forest. In sharp contrast, the Kura-Aras lowland to the east of the Suramski divide consists of parched steppe country, often eroded by streams and wind into forbidding "badland" topography. Much of this plain, which was at one time an arm of the Caspian, lies below sea level. Its summers are warm enough for subtropical crops and it has been in part reclaimed by means of irrigation.

The Lesser Caucasus.—Bordering the Rioni-Kura depression on its south side, the Lesser Caucasus range is not so much a distinct mountain system as a buttress which marks the northern limit of the high volcanic plateau of Armenia. Narrowest in the west but broadening out in the east into the Karabakh plateau, the Lesser Caucasus range reaches heights of between 10,000 and 12,000 ft. Its rocks are mainly of Secondary and Tertiary age, but it contains no Paleozoic core such as is found in the Greater Caucasus. Its folding and subsequent erosion followed much the same course as these processes in the major range, but the Lesser Caucasus underwent more rifting and fracture in the later stages.

Beyond the Aras river a small part of a distinct fold range, the Talish, is included within Soviet territory. Reaching a height of 8,182 ft., this range is structurally continuous with the Elburz chain of Iran, which runs along the southern border of the Caspian.

Behind these fold ranges to the south and west, the Armenian plateau is a region of wide tablelands and generally unaccentuated relief, the irregularities having been buried under immense outpourings of volcanic rocks, mainly andesites and basalts, of relatively recent Quaternary age. The greater part of this plateau stands at an elevation of more than 6,000 ft. and the highest point, the extinct volcano of Aragats, reaches 13,435 ft. There are, however, some sunken faulted troughs which sometimes lie at a lower level, notably the valley of the Aras, the main river of the plateau. The basin of Lake Sevan is also a slumped fragment of a once higher plateau, the outlet of which has been sealed by a flow of lava behind which the waters of the lake have accumulated. Surrounded by heights of up to 12,000 ft., the lake level stands at 6,279 ft. It may, however, be artificially lowered when the water of the lake is used for irrigation and for generating electricity.

Volcanism.—Although there are now no active volcanoes in the Caucasus region, the mineral springs of the area and the frequent earthquakes from which it suffers are legacies of its volcanic past. The best-known mineral springs, some of which are radioactive, are found in the Pyatigorsk region of the northern foothills and have long been used as spa resorts. There are other such springs in Transcaucasia. Earth tremors are particularly common on the south slope of the main Caucasus range near Tbilisi and on the Armenian plateau. The town of Shemakha on the southern Caucasus slopes was destroyed by an earthquake in 1902.

VEGETATION AND ANIMAL LIFE

Vegetation.—The plains of Ciscaucasia are prairie country with feather grass and needle grass, but for the most part the natural vegetation has been replaced there by cereal crops. On the Stavropol plateau, however, the rainfall increases to about 30 in. and woodlands of oak and ash will thrive. In the drier northeastern parts of Ciscaucasia, behind Kizlyar bay, the wormwood steppes are of little value except as seasonal pasture, and near the coast they grade into even more repellent salt marshes and sand dunes.

The Greater Caucasus mountains carry one of the richest forest reserves in the whole Soviet Union. The range of tree types is very wide, for these mountains formed a refuge where many Tertiary species survived the Ice Age and continued to thrive. The forests are particularly rich and extensive in the wetter western parts of the range, but farther east they become progressively thinner and many parts of Dagestan are completely treeless.

In the western part of the range the timber line stands at 6,600 ft., while in the eastern regions it is 600 ft. higher. Above this level birch thickets give way to clumps of Pontic azalea or trailing juniper, and these in turn to an alpine cover of low sedges and grasses with a whole range of flowers, including gentian, primrose, forget-me-not and violet. The alpine zone stretches from 7,000 ft. to the snow line about 3,000 ft. higher.

Between 4,000 and 6,300 ft. a belt of fir forests is sometimes found, including Caucasian fir and spruce with an intermixture of beech, maple and hornbeam. Below the fir zone, and occasionally replacing it as far up as the subalpine zone, lies the broadleaf deciduous forest which is the richest timber resource of the mountains. This forest is most luxurious at elevations between 2,000 and 4,000 ft., but on occasion it is found down to sea level. Sometimes it consists of almost pure stands of beech, with only occasional admixture of chestnut. Elsewhere it takes the form of a more mixed cover, dominated by oak but including the commercially valuable box and yew, which the Russians call redwood.

These broadleaf forests, which are particularly extensive on the southern slopes of the Caucasus range, once also covered the plain of the Rioni river, but there they were largely cleared to make way for cultivation. The Russian geographers class them as the Colchis type of liana forest, grouping them with the Crimean and far eastern forests which also contain climbing plants. The chief climbers in the Colchis forest are ivy, vine and clematis.

On the lower elevations near the coast, especially in the far western Caucasus above Novorossisk, low and dry scrub often replaces the broadleaf forest and gives a more Mediterranean aspect to the landscape. Scrub oak, oriental hornbeam and occasionally pistachio are its chief components.

The lower Kura and Aras valleys carry a very xerophytic or drought-resistant vegetation of *Astragalus,* camels-thorn, licorice and, where the soil is especially alkaline, species of *Salsola.*

The Lesser Caucasus range bordering the Armenian plateau is rather drier than the main range, and supports oak and hornbeam woods better than beech. Behind it, on the Armenian plateau, a prairie vegetation of feather grass, needle grass and fescue is interspersed with occasional patches of common pine. It is probable that the scattered oak woods which sometimes form a parkland landscape, as below Mt. Aragats, were once more widespread, but have been decimated by lopping for leaf fodder.

Animal Life.—The fauna of the Caucasus is extremely rich, for it is a meeting place of mediterranean and central Asian species and, as in the case of the vegetation, it provided a refuge during the Ice Age. Palearctic species found in the Caucasian forests include the bear, roebuck, elk, boar, fox, marten, badger, lynx and wolf. The squirrel, however, is not found and the bison was finally wiped out by hunters in 1928. The leopard, which is found along with the wildcat in the higher forests, there reaches the northern limit of its habitat. Within the alpine zone are found the mouflon or mountain sheep, the ibex or mountain goat and the Caucasian chamois.

The Caucasian National park, 384 sq.mi. in area, lies in the extreme north of the Caucasus mountains. It is a forested mountain area, with spruce, oak, beech and yew, and provides a refuge for red and roe deer, chamois, ibex, bear, Caucasian grouse and black cock. There also the Caucasian bison has been reintroduced.

The Rioni lowland contains, among other endemic forms of mediterranean type, the pheasant, which takes its name from the river, the Phasis of classical geography. The fauna of the lower Kura valley, by contrast, includes several central Asian species such as the gazelle antelope, the jackal, hyena and jumping mouse. On the Armenian plateau the Kurdistan fox, the wild goat and the Armenian mountain sheep are all species which this region shares with the mountains of Asia Minor.

HISTORY

Archaeology.—Food-gathering cultures of Mesolithic type, as represented by the discoveries at Nalchik in the Central Caucasus, continued in this region until quite late. They were replaced in the later part of the 3rd millennium B.C. by the Kuban culture, which left its remains in many thousands of burial mounds or kurgans on the steppes of Ciscaucasia. This Kuban culture, which lasted through the Late Bronze Age into Early Iron Age times, was undoubtedly stimulated by contact with the higher civilization of Mesopotamia. The grave furniture of the kurgans, as in the famous royal grave of Maikop, included metalwork of great refinement, often ornamented with animal motifs. A common weapon was the shaft-hole battle-ax of copper, of a type also found in central and northern Europe. There is evidence that the distribution of this weapon resulted from a migration of horse-riding folk, the so-called Battle-Ax people, who spread Indo-European speech. Their place of origin is not certain, but it was more probably in the east than in the west of their area of spread.

A South Caucasian or Kura-Aras culture, again associated with rich metalwork and characterized also by tholoi, cyclopean masonry and burnished black pottery with incised spiral decoration, dates from the late 3rd millennium B.C. It has been found particularly in the kurgans of the Trialeti district, notably that of Beshtasheni. Pottery comparable with that of this culture has been found at Karaz near Erzurum (Turk.), at Geoy Tepe in Iranian Azerbaijan, in the Amuq plain near Antioch in Turkey and as far away as Khirbet Kerak in Palestine.

Transcaucasia contains some fine church architecture dating from the 4th century onward including some very early pendentives. Ashlar masonry was used there instead of the bricks more common in Byzantine architecture. The most extensive remains of this kind are in the ruins of the city of Ani in the Armenian Soviet Socialist Republic. (*See* CAUCASUS, PEOPLES OF.)

Early History.—The Caucasian isthmus, and more precisely the road which passes across it along the shores of the Caspian, is one of the two great routes along which nomadic peoples have moved at various times from central to southwestern Asia. The other route runs from Merv over the Elburz to Meshed or Herat. The chief significance therefore of the Caucasus in Asian history is as a gateway of migration. It also plays the part of an ethnic museum, for very many of the peoples who have passed this way have left detachments in the remoter parts of the mountains, particularly in Dagestan. Like Afghanistan farther east, Caucasia, along with Armenia, has often appeared in the role of a buffer zone between rival empires, Roman and Parthian, Byzantine and Arab, Ottoman, Persian and Russian.

The two greatest and longest lived of the many semi-independent states of the Caucasus in classical and medieval times were Georgia (earlier, Iberia) in the north and Armenia in the south. The culture and ethnic character of both can be traced back to the period of the breakup of the Hittite empire in the 12th century B.C., and both were converted to Christianity quite early.

Greek contact with the Caucasus region dates from the colonizing period between the 8th and 6th centuries B.C. when many settlements, like the Milesian outpost of Dioscurias, were set up on the Caucasian coasts of the Black sea. Prometheus was said to have been chained in the Caucasus mountains and Colchis was the setting for the Argonauts' search for the Golden Fleece. The conquests of Alexander the Great freed Georgia from Persian Achaemenid suzerainty, and despite Pompey's (Pompeius') imposition of Roman control in 65 B.C. after his defeat of Mithradates, the incursions of the Khazars in the 3rd century A.D. and Arab occupation of Tiflis (Tbilisi) in the 8th century, the state survived to reach its golden age between the 10th and 13th centuries. The country was overrun and devastated by the Mongols in 1234 and the following years, and again by the hordes of Timur at the end of the next century. Thus weakened, it was on many occasions obliged to submit in the later middle ages to Islamic rule, Persian or Ottoman. In 1783 the king of Georgia concluded an alliance with Russia in the hope of gaining protection from Islamic expansion. However, Russian demands became increasingly importunate and in 1801 it annexed the Georgian state. From that time, the history of Transcaucasia in the 19th century is one of ever-expanding Russian conquest.

Russian Penetration.—Russian interests in the Caucasus began early. In A.D. 943 Varangian or Russified Norse adventurers had sailed down the Caspian from the Volga and captured the fortress of Barda in Caucasian Albania. Subsequently certain marriage alliances were concluded between the Russian and Georgian royal families and in the 17th century Caucasian rulers were on several occasions constrained to ask for Russian help against their enemies. Peter the Great was the first to take advantage of the opportunities thus afforded to take possession of Caucasian territory. He occupied Derbent in 1722 and Baku in the following year. In 1770 Russian troops for the first time crossed the Caucasus range and took possession of Kutaisi. By 1785 all the northern region of the Caucasus was designated as a Russian province and, as already mentioned, Georgia was absorbed at the opening of the next century.

Two large groups of tribes in the middle Caucasus then acknowledged their subjection to the Russians, the Ossetes in 1802 and the Lezgians in 1803. Mingrelia fell in 1804 and the kingdom of Imereti in 1810. By the treaty of Gulistan in 1813, Persia ceded to Russia a wide area of the khanates of the eastern Caucasus, from Lenkoran northward to Derbent. Russia had little difficulty in acquiring by conquest from Persia in 1828 a stretch of the north Armenian plateau, including the entire plain of Yerevan, and was able to take over more territory in the same area from Turkey in the following year.

The resistance of the mountain tribes, particularly of the Circassians of Abkhasia and the Lezgians of Dagestan, was more fierce and protracted. During 30 years, from 1815 to 1845, the Russians could do little more than hold these mountain peoples at bay. Some were sustained by patriotic feelings, others by religious fervour. The Circassians of the Western Caucasus were largely quelled between 1832 and 1839, but farther east in Dagestan resistance by the Muslim tribes was carried on longer. A holy war was declared by the sheikh Kasi-Mullah and, after he was killed by the Russians, the struggle was continued by his son Shamil. He was finally captured in a remote fortress of Dagestan in 1859, though the main fighting had ceased four years before. The country was completely pacified by 1864, after which almost the entire Circassian nation, numbering perhaps 400,000, preferring exile to subjection, emigrated into Ottoman territory, leaving the Western Caucasus empty and desolate.

Without doubt, the protracted resistance of the peoples of the Caucasus delayed Russian plans for an attack on the Turks of Asia Minor. When these nations eventually came to conflict in the Russo-Turkish War of 1877–78, the Russian lines of communication in Armenia were ill prepared and the Turks were able to support an attempt by Circassian exiles to reoccupy their homeland. But this failed, and by the peace of Adrianople Russia succeeded in adding to its Transcaucasian territories the districts of Kars, Batumi and Ardahan. During the next 40 years the peoples of the Caucasus, and particularly the Armenians, endured Russian rule with increasing discontent and after the October Revolution of 1917 they cherished strong hopes for an independent Armenian republic and a federal republic to be governed by a Transcaucasian diet. These ambitions were thwarted after the Turks reoccupied, late in 1920, the districts of Batumi and Kars, and the Russians hurried to counter by entering Yerevan.

Post-Revolutionary Period.—Under the Soviet system Transcaucasia was administered until 1936 as a single unit, the Transcaucasian Soviet Federated Socialist Republic. Under the new constitution of that year, it was subdivided into the three major partitions of the Armenian, Azerbaijan and Georgian Soviet Socialist Republics. Lesser nationalities, such as the Abkhaz, Adzhar and Ossete, are administered as autonomous soviet socialist republics or as *oblasts*.

The district of Ciscaucasia is included in Soviet geography in the regional complex known as the Lower Don and Northern Caucasus. Except in its western part, in Dagestan, the population of Ciscaucasia is predominantly Russian and Ukrainian, elements which entered the territory during its rapid period of development after the building of the Rostov-Baku railway line late in the 19th century. Over the 25 years after the arrival of the railroad, the population of the Kuban district doubled and the area under cultivation increased fivefold. The great cities of Ciscaucasia also largely grew up or expanded during this period and particularly after the Revolution, as the oil fields of the area increased their output.

At the extreme limit of their penetration into Russia, in the autumn of 1942, the German armies overran parts of Ciscaucasia and, in a drive toward the oil fields, they had by the end of October in that year reached the Georgian military highway leading to Tbilisi. The tide turned in November, when the Germans began to pull out of Caucasia to strengthen their forces on other sectors of the Russian front.

The attack left its mark on the economic geography of Ciscaucasia; in particular, there was much destruction in the oil fields of the Maikop district. More serious were its repercussions on the political geography of the area. Unlike the Crimea and the Lower Don, which are each administered as a single unit, the Crimean and Rostov *oblasts* respectively, the Northern Caucasus is composed of several Russian and autonomous non-Russian regions. These were reorganized as a result of the alleged collaboration with the German troops of four ethnic groups, which by way of punishment were deprived of their identity and deported to other parts of the U.S.S.R. Thus the autonomous *oblast* of the Karachai was partitioned in 1943 between the Stavropol *krai* and the Georgian S.S.R. In the same year, the Balkar part of the Kabardino-Balkar A.S.S.R. (*q.v.*) was handed over to the Georgian S.S.R. and the name Balkar was deleted from the title of the republic. Also, the Chechen-Ingush A.S.S.R. (*q.v.*) was dissolved, most of its territory becoming part of the newly established Grozny *oblast*. All these were subsequently restored.

ECONOMIC SIGNIFICANCE

Production.—The Caucasus region is rich in raw materials for industry and includes many prosperous agricultural districts. Within it lie a number of large towns and the whole area supports a population of relatively high density. It is, however, remote from the capital and has only indifferent communication with the rest of the country. To the north of Ciscaucasia, moreover, there is a barrier of arid and thinly peopled steppe in the Manych depression, which separates the Caucasian region from the fertile plains of the lower Don and Volga. For these reasons it has been the policy of the central government to develop the Caucasus as an independent region, supplying as many as possible of its own wants, and to make it independent of heavy products in particular which would otherwise have to be brought from a distance.

Agriculture.—The steppes of the Kuban valley are given over to an economy of mixed farming and, in addition to winter sown wheat and barley, are able to export a surplus of sunflower seeds, tobacco, sugar beet and dairy produce. The drier eastern parts of Ciscaucasia were formerly inferior pastureland, but parts of these steppes around Salsk have been converted, by dry-farming techniques and by irrigation from the Terek, into valuable grain fields.

The Armenian plateau of Transcaucasia is another region where grain growing is combined with pastoralism. The plateau provides summer grazing, but in the cold season the animals are driven down to the lower valley of the Kura. From these regions there is a considerable surplus of cheese, for which Armenia is noted, as well as of wool, meat and hides. The development of the irrigation scheme at Mingechaur on the Kura was expected to reclaim wide areas of pasture in the Kura-Aras lowland for grain production, while on the Armenian plateau Lake Sevan was to be used as a natural reservoir and its waters drawn off to supply cotton plantations, vineyards and orchards by the Razdan river and middle Aras, especially around the town of Yerevan. Farther north, by the 1960s sugar beet was being grown successfully with the aid of irrigation near Leninakan, where it is refined.

Cotton is grown extensively on those parts of the Kura lowland in Azerbaijan which are irrigable, particularly on the Mugan, Mil and Shirvan steppes. The district specializes in high grades of cotton and Azerbaijan ranks second in the country to the Uzbek S.S.R. in the volume of its output. The crop is usually rotated there with lucerne.

Transcaucasia is particularly famous for its subtropical crops which cannot be grown elsewhere in the Soviet Union. These are raised along the Black sea littoral eastward from Gagra and widely in the lower Rioni valley or Kolkhida lowland of Georgia. They also thrive along a small section of the Caspian coast, the Lenkoran lowland, near the Iranian border. They include tea and citrus fruits, the two most important crops, and also tobacco, rice, camphor, prunes, almonds, olives, peaches and mulberries for sericulture. The wines of Georgia are well known and some are exported. The principal vineyards lie in the district of Kakhetia in the upper basin of the Alazani river. In the contribution it makes to the Soviet economy, Georgia may be compared to Florida in the United States.

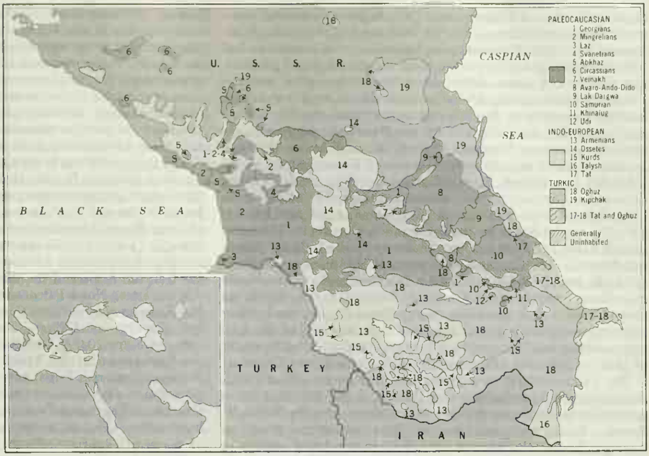
Fisheries.—A small amount of fishing is carried on along the Black sea coast and the port of Yeysk has a canning factory. But the Caspian fisheries are more important and play a significant part in the economy of Azerbaijan. The most productive waters are around the mouth of the Kura river and just north of the Apsheron peninsula. Herring, carp and sturgeon form the main part of the catch, the bulk of which is destined for canning.

Forestry.—The forest reserves of the Caucasus region are carefully husbanded and are chiefly cut to supply some light industries in Georgia, where shuttles and spindles for textile machines are made from box. The great agricultural-machinery factories at Rostov-on-Don take their timber partly from the mountains in the vicinity of Maikop.

Minerals.—Iron is found at Dashkesan in Azerbaijan, and coal at Tkibuli and Tkvarcheli in Georgia. Armenia produces copper from Alaverdi and Zangezur and some of its volcanic rocks are quarried for building. To the east of Kutaisi, the manganese deposits of Chiatura in Georgia are the best in the world for quality and are second in quantity only to those of Nikopol in the Ukraine. Alunites, a source of aluminum, are mined at Zaglik in Azerbaijan. The chief mineral resource of the Caucasus region is its crude oil. There are fields of moderate size at Maikop, Grozny and in the district of Dagestan in the Caucasus, but the largest are in the Apsheron peninsula near Baku. For long this was the most productive field of Russia, but after World War II it was superseded in importance by the so-called "Second Baku" field of the southern Urals. Pipelines carry Baku oil to Batumi on the Black sea and that of the Caucasus foothills to Rostov and Makhachkala.

Water Power.—There are abundant reserves of power in the rivers of Georgia, and stations were set up on the Rioni and Sukhumi rivers and, largest of all, on the Khrami river, a right-bank tributary of the Kura. In Azerbaijan the largest enterprise is the hydroelectric installation at Mingechaur, built after World War II. An ambitious project was also begun to lower the level of Lake Sevan to reduce evaporation and to build eight hydroelectric stations along its outlet, the Razdan river.

Industries.—As part of the plan to make the Caucasus region self-sufficient, the Transcaucasian metallurgical plant was established at Rustavi near Tbilisi. Using iron ore from Dashkesan in Azerbaijan and coal from Georgia, this installation produces iron and steel for the machine-building industries of the area and for pipelines for the transport of oil and irrigation water. Machine



DISTRIBUTION OF THE THREE MAJOR ETHNO-LINGUISTIC GROUPS OF THE CAUCASUS

building is carried on at Baku, and at Sumgait nearby a large tube-rolling plant was set up, using metal from Rustavi. The chemical industry of the Baku district relies on the by-products of the oil refineries, and the output of fertilizers has rendered the region largely independent of the rest of the U.S.S.R. in this respect. The Baku district in the Apsheron peninsula contains the largest concentration of industries in the Caucasus region, but many of the larger towns elsewhere have factories. Kirovabad and Leninakan turn out textiles, Ordzhonikidze in the Caucasus foothills is a centre of production of nonferrous metals, Novorossisk manufactures farm machinery and cement and Grozny and Tuapse, equipment for the oil industry.

Recreation.—The Black sea littoral may be considered as the Soviet Riviera. Shielded by the mountains from cold continental winds, it enjoys an exceptionally mild winter. The picturesque situation with mountains rising from close by the shore, the abundance of subtropical fruits and the proximity of medicinal springs are additional appeals. Sochi, Matsesta and Anapa are all well-known resorts. The medicinal mineral springs about Pyatigorsk in the northern foothills of the main Caucasus range have also for long been the basis of a tourist industry.

Communications.—The area was first firmly linked with the more central districts of Russia by the railway from Rostov to Ordzhonikidze, which was laid in 1876. However, it was not until 1900 that this was extended beyond the Caucasus range, through the Pass of Derbent to Baku. Meanwhile in 1883 a railway was completed across the isthmus from Batumi to Baku, to serve the oil fields which were opened in the 1870s and to confirm the military control of these recently annexed districts. Before World War I branches were thrown forward from Tbilisi, by way of Leninakan to Kars and Tabriz (Iran) in the remoter parts of Transcaucasia. After the Russian Revolution the lower Aras valley was served by a railway and the Rioni lowlands were linked with the Ciscaucasian line by way of Tuapse. This last connection was completed during World War II. In that war, too, a new line was opened from Kizlyar to Astrakhan to replace the route to Rostov which had fallen into German hands. By the 1960s no railway crossed the main range of the Greater Caucasus.

See also separate articles on the republics.

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CAUCASUS, PEOPLES OF. The Caucasus (*q.v.*) is one of the most complex ethnic areas in the world. It harbours more than 50 separate peoples, ranging from language communities with only a few hundred speakers to large national groups numbering millions. This diversity is not of recent date. The Greek geographer Strabo mentions (*Geography* xi, 2, 16) that representatives of 70 peoples, all speaking different languages, used to gather in Dioskurias (Sukhumi) for their trade. Pliny the Elder relates (*Natural History* vi, 5, 1) that the Romans carried on their business there through 80 interpreters. Arab geographers called the Caucasus *Jabal al Alsine,* "Mountain of Languages."

The peoples of the Caucasus belong to four different language families: Paleocaucasian (*see* CAUCASIAN LANGUAGES), Indo-European, Turkic and Semitic. Whereas the representatives of the latter three groups are known to have immigrated to the Caucasus in historical times, the Paleocaucasian peoples already inhabited the area at the dawn of history. They fall into a northern and a southern group, which are generally assumed to be related to each other, though this has not been proved conclusively.

The South Paleocaucasian (or Kartvelian) peoples comprise the Georgians (lowland tribes: Kartlians, Kakhetians, Ingilo, Imeretians, Gurians and Adzhar; highlanders: Pshav, Tush, Khevsur, Racha, Lechkhum), the closely related Mingrelians and Laz, and the Svanetians. These peoples together constitute the Georgian nation (2,600,000). Their area of distribution is western Transcaucasia. Most of the Laz live on Turkish territory.

The North Paleocaucasian peoples, all highlanders, fall into a western and an eastern group. The western group contains the Circassians (*q.v.*; 305,000) along the Kuban and upper Terek basins (the latter group known as Kabardians) and the Abkhaz (80,000) south of the mountains on the Black sea coast, with the closely related Abazinians (20,000) north of the divide. The eastern group falls into six subgroups: (1) Veinakh (520,000) in the central Greater Caucasus, comprising the Chechen, Ingush and Bats; (2) Avaro-Ando-Dido (260,000) in western Dagestan: (*a*) Avar, (*b*) Andi: Andi proper, Botlikh-Godoberi, Karata, Bagulal, Tindi, Chamalal, Akhvakh; (*c*) Dido: Khvarshi, Dido proper, Kapucha-Khunzal-Ginukh; (*d*) Archi; (3) Lak-Dargwa (210,000) in central Dagestan, comprising Lak and the Dargwa dialects: Dargwa proper, Kaitak, Kubachi; (4) Samurian (235,000) along the Samur river in southern Dagestan: Lezgian, Agul, Rutul, Tsakhur, Tabasaran, Budukh, Dzhek; (5) Khinalug (1,500); and (6) Udi (3,000) in a few villages in northern Azerbaijan.

The oldest references to peoples of Paleocaucasian stock are found in Assyrian sources and in the Bible; *e.g.*, the name of the biblical Meshech (Ezek. xxxix, 1; in Assyrian sources, Mushki) survives in the present-day Meskhi, one of the southernmost subdivisions of the Georgian Kartlians. In antiquity the Paleocaucasian peoples were known by a whole series of ethnic names: in western and central Transcaucasia the Colchi and Iberi (ancestors of the Mingrelians and Georgians); in eastern Transcaucasia the Albani; on the Black sea coast the Abasgi (Abkhaz), Cerceti (Circassians) and many others; in Dagestan the Leges (Lezgians); etc.

Of the Indo-European peoples, the ancestors of the Armenians

(2,500,000) entered Transcaucasia from Anatolia in the first quarter of the first millenium B.C.; their language has been strongly influenced by local (Paleocaucasian) elements. A second ancient Indo-European group in the Caucasus are the Ossetes (370,000), who live on both slopes of the central Greater Caucasus; they are a remnant of the eastern Iranian nomads who roamed in the south Russian steppes from the 7th century B.C. until the 4th century A.D. (when they were dispelled by the Huns) and who were successively known as Scythians, Sarmatians and Alans. Western Iranian elements include a small group of Kurds (50,000 in the U.S.S.R.) in southern Transcaucasia (including 15,000 Yezidis, distinguished by their peculiar religion); the Talysh (89,000 in the U.S.S.R.) in the southeast on the Caspian sea coast; and the Tat (86,000) on the Apsheron peninsula and in Dagestan. The latter include 8,000 Tat-speaking Jews known as *Dagh Chufuti* ("Mountain Jews"). The Caucasus harbours a sizable number of Greeks (153,000, mostly in Georgia) and a few thousand gypsies, known as Bosha in Armenia and as Karachi in Azerbaijan. The Slavic element (Russian and Ukrainian, partly Cossacks and partly more recent immigrants) accounts for more than one-third of the total population of the Caucasus (*c.* 6,500,000 out of 15,000,000); most of these (5,500,000) are concentrated in the northern Caucasus.

The Turkic world is represented first of all by the Oghuz-Turkic Azerbaijanians (2,800,000 in the U.S.S.R.); the Turkification of Azerbaijan was completed in the 11th century with the Seljuk invasion. In the northern Caucasus there are several groups of Kipchak Turks: the Kumyk (110,000) in the lower regions of Dagestan; the Noghai (35,000), concentrated mainly between the lower Kuma and Terek rivers; and the Karachai (70,000) and Balkar (40,000) in the highlands of the western Greater Caucasus. These groups immigrated between the 10th and 15th centuries. In the 17th century a small group of the Oghuz-Turkic Turkmens migrated from central Asia to the Kuma region in the northeastern Caucasus, where they are known as Trukhmen (15,000).

The only Semitic people in the Caucasus are the Aisor (or Assyrians, *c.* 20,000), who fled to Russian territory at the end of World War I; their language belongs to the Aramaic group of western Semitic. They live mainly in the cities.

The traditional economy of the peoples of the Caucasus is based on agriculture and cattle raising, supplemented by homecrafts. The main crops are millet, barley, wheat and corn. Wine growing is highly developed in Transcaucasia (especially Georgia, homeland of the famous Kakhetian wine). In addition, horticulture and beekeeping are engaged in, especially in the west. Pastoralism (mainly sheep raising) plays an important role in the higher and dryer areas (Dagestan, highland Armenia, Azerbaijan). The Kabardian breed of horses is famous. Crafts are especially developed in Dagestan; the goldsmiths of the village Kubachi are widely renowned. Dagestan, Armenia and Azerbaijan are centres of rug weaving.

In the treeless highland areas the villages consist of stone houses clustered together and built into the mountain slope, so that the roof of one house forms the front yard of the house above it. In the Western Caucasus the villages consist of individual homesteads surrounded by fences; the buildings are made of wood or of wattles coated with clay. A third type of house, found in central and eastern Transcaucasia, is the *darbazi*, characterized by a cupola-shaped, stepped vault (*gvirgvini*) on pillars, with an opening at the top which serves as a window and smoke flue. The Svanetians, Ossetes and the Georgian highlanders built defense towers into which the population could flee in case of an attack.

The common Caucasian men's costume is the *cherkeska*, a coat-like garment, cut to the figure, with wide sleeves and with cartridge holders sewn on the breast. This costume was borrowed by the Cossacks and through them became widely known abroad. The women's costume shows much local variation.

Everywhere in the Caucasus there are traces of a patriarchal clan system and a tribal organization of society. These features have been best preserved among the mountaineers. The tribal system gradually gave way to a system of village communities. Feudal relations developed especially in Georgia, Armenia and Azerbaijan (in Armenia they were soon obliterated by foreign domination) and in the northern Caucasus among the Kabardians and Kumyk. In older times, extended families of 50 persons and more lived together in one house. Exogamous rules were strictly observed, except in the highlands of Dagestan, where local endogamy is common. Adoptive relationships, including the so-called "milk-relationship," played a large role. Among the highlanders the customs of acquiring brides by abduction and of paying a bride-price (*kalym*) existed. Further typical Caucasian traditions were blood vengeance, respect for superior age, hospitality, a chivalrous attitude toward women and stress on military virtues.

The major religions in the Caucasus are Christianity and Islam. The Georgians are Eastern Orthodox Christians (except for some Islamicized groups on the periphery: Adzhar in the southwest, Ingilo in the east), while the Armenian-Gregorian Church split off from Byzantine orthodoxy as a result of the monophysite controversy (A.D. 451). In the struggle for survival of both nations the church has played a major role. Other Christian groups are the Udi, the Aisor and the majority of the Abkhaz and Ossetes. The remaining North Paleocaucasians and all the Turkic groups are Muslims—in the northern Caucasus, Sunnites; in Transcaucasia, both Sunnites and Shi'ites. Besides the Mountain Jews of Dagestan there are 20,000 Georgian-speaking Jews in Georgia. The peculiar religion of the Yezidis contains elements of Mazdaism, Judaism, Nestorian Christianity and Islam. Before the spread of Christianity (4th–5th centuries) Mazdaism was widespread in the Caucasus. Pagan beliefs and rites persisted especially among the highlanders. Typical features are the cult of ancestors, of trees, of the hearth (particularly the hearth chain), and a pantheon of patrons of various economic activities, including hunting and smithery.

Outstanding elements of Caucasian folklore are the north Caucasian epic of the Narts (mythical heroes) and the Prometheus legend known to many peoples of the Caucasus; *e.g.*, the Georgian legend of Amirani. The folk music of the Circassians and Georgians is remarkable for being polyphonic. The folk instruments comprise representatives of the violin and lute family, flutes, drums and castanets, the latter especially used for the accompaniment of a wide variety of dances, the best known of which is the *lezginka*. *See* also ARMENIA; AZERBAIJAN SOVIET SOCIALIST REPUBLIC; GEORGIAN SOVIET SOCIALIST REPUBLIC.

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CAUCHON, PIERRE (*c.* 1371–1442), French ecclesiastic who presided over the trial of Joan of Arc, was born near Reims. He was educated at the University of Paris, of which he became rector in 1403. Having taken part in the Cabochien riots, he was banished from Paris on May 14, 1414, and took service with John the Fearless, duke of Burgundy. In 1420 he became bishop of Beauvais. In 1422 Cauchon, as a councilor of Henry VI of England, became a servant of his regent in France, the duke of Bedford. The capture of Joan of Arc in the diocese of Beauvais on May 24, 1430, gave Cauchon an excellent opportunity to serve the English. He took care to disguise the political revenge by conducting the trial according to inquisitorial procedure and by attempting to obtain from the Maid a confession which would save her life.

In 1432 Cauchon became bishop of Lisieux. He took part in the council at Basel in 1435. He died on Dec. 18, 1442, at Rouen.

CAUCHY, AUGUSTIN LOUIS, BARON (1789–1857), one of the greatest of modern French mathematicians, was born in Paris, on Aug. 21, 1789, and died at Sceaux (Seine) on May 23, 1857. He studied at the École Polytechnique and the École des Ponts et Chaussées, and practised for some time as an engineer.

His health failed in 1813, and his father's friends, Lagrange and Laplace, persuaded him to devote himself entirely to mathematics. From 1816 onward he held three professorships in Paris, which he lost at the revolution of 1830, on declining to swear allegiance to Louis Philippe. A chair of mathematical physics was created for him at the University of Turin. He spent some time traveling with the duke of Bordeaux, grandson of Charles X, and in 1838 returned to France, resuming his chair at the École Polytechnique. Although acting only from the highest motives, Cauchy made himself objectionable to his colleagues by a self-righteous obstinacy and an aggressive religious bigotry.

The genius of Cauchy was promised in his simple solution of the problem of Apollonius (*i.e.*, to describe a circle touching three given circles), which he discovered in 1805, and in his generalization of Euler's theorem on polyhedra in 1811. More important is his memoir on wave propagation, which won the Institut de France *grand prix* in 1816. His greatest contributions to mathematical science, characterized by the clear and rigorous methods that he introduced, are mainly embodied in his three great treatises, *Cours d'analyse de l'École Polytechnique* (1821); *Le Calcul infinitésimal* (1823); *Leçons sur les applications du calcul infinitésimal à la géométrie* (1826–28). He clarified the principles of the calculus by developing them with the aid of limits and continuity and was the first to prove Taylor's theorem rigorously, establishing his well-known form of the remainder. Thus the first phase of modern rigour, giving a satisfactory basis for the calculus, originated in Cauchy's lectures and researches in analysis during the 1820s. To the same period belongs the development of his version of the theory of functions of a complex variable, today indispensable in applied mathematics from physics to aeronautics. With equal originality, he made substantial contributions to the theory of numbers where, however, he went astray on Fermat's last theorem. He was one of the originators of the theory of permutation groups. In astronomy, he gave a shorter account than Leverrier's of the motion of the asteroid Pallas. In mechanics, he made many researches, substituting the notion of the continuity of geometrical displacements for the principle of the continuity of matter. In optics, he developed the wave theory, and his name is associated with the simple dispersion formula. In elasticity, he originated the theory of stress. His collected works, *Œuvres complètes d'Augustin Cauchy*, have been published in 27 volumes. *See* also references under "Cauchy, Augustin Louis" in the Index volume.

See C. A. Valson, *Le Baron Augustin Cauchy: sa vie et ses travaux* (1868); E. T. Bell, *Men of Mathematics* (1937).

CAUCUS, a political term used in the U.S. of a special form of party meeting, and in Great Britain of a system of party organization. The word originated in Boston, Mass., in the early part of the 18th century, when it was used as the name of a political club, the Caucus or Caucas club. There public matters were discussed and arrangements made for local elections and the choosing of candidates for offices. A contemporary reference to the club occurs in the diary of John Adams in 1763; but William Gordon (*History of the Independence of the United States of America* [1788]) speaks of the Caucus as having been in existence about 50 years before the time of writing (1774) and describes the methods used for securing the election of the candidates. The derivation of the word has been much disputed. The most plausible origin is an Algonkian word, *kaw-kaw-was*, meaning "to talk," Indian words and names having been popular in America as titles for societies and clubs (*cf.* "Tammany"). In the United States "caucus" is used strictly of a meeting either of party managers or of duty voters, as for instance a "nominating caucus," for nominating candidates for office or for selecting delegates for a nominating convention. The caucus of the party in congress nominated the candidates for the offices of president and vice-president from 1800 until 1824, when the convention system was adopted. At the same time, the candidates for governor and lieutenant governor were nominated by the party members of the state legislatures in what was known as the legislative nominating caucus. Occasionally districts unrepresented in the legislature sent delegates to sit in with the members of the legislature when these nominations were made, and this was termed the mixed legislative nominating caucus. (*See* PRIMARY.)

The word is used in the United States to denote meetings of the members of a party in congress or in a legislature or a city council to determine matters of party policy on proposed legislation or legislative offices. "Caucus" first came into use in Great Britain in 1878 in connection with the organization of the Liberal Association of Birmingham by Joseph Chamberlain and F. Schnadhorst on strict disciplinary lines, more particularly with a view to election management and the control of voters, which became the model for other Liberal associations throughout the country. It was to this supposed imitation of the U.S. political "machine" that Lord Beaconsfield gave the name "caucus," and the name came to be used, not in the U.S. sense of a meeting, but of a closely disciplined system of party organization, chiefly as a stock term of abuse applied by politicians of one party to the controlling organization of its opponents.

CAUDATE, any of the salamanders and newts, amphibians of the order Caudata (from the Latin meaning tail-bearing). The earlier Greek derived names urodele and Urodela are also in use. The presence of a tail sets caudates apart from frogs and toads, and the presence of limbs sets them apart from caecelians (wormlike amphibians).

They are adapted to humid regions of the north temperate zone, and are not often found in the tropics. Caudates are usually inoffensive and secretive; most of them are small—three to eight inches long—although the giant salamander of the orient, *Megalobatrachus*, reaches a length of five feet.

Of the living caudates the following suborders may be mentioned: Cryptobranchoidea, containing 8 genera found in Asia and eastern North America; Meantes, consisting of 2 genera restricted to eastern North America; and Salamandroidea, containing about 50 genera found in all continents except Australia. The fossil record is scanty, the earliest representative caudate being *Prosiren elinorae* from the Lower Cretaceous of North America. *See* also AMPHIBIA; NEWT; SALAMANDER. (A. B. GR.)

CAUDINE FORKS, the *furculae Caudinae*, a narrow pass in the mountains in ancient Samnium near mod. Montesarchio in the *regione* of Campania, southern Italy (or possibly near Forchia) where the Samnites under Gavius Pontius defeated the Romans in 321 B.C. during the Second Samnite War.

See E. T. Salmon in *Journal of Roman Studies*, vol. 19 (1929).

CAUL, a portion of the amnion, or bag of waters, which is sometimes found remaining around the head of a child after birth. The term also is applied occasionally to the serous membrane covering the heart, brain or intestines. It is derived from the original meaning of a close-fitting woman's cap, especially one made of network. Many superstitions were attached to the infant caul; it was looked on as a sign of good luck and, when preserved, was kept as a protection against drowning.

CAULAINCOURT, ARMAND AUGUSTIN LOUIS DE, DUC DE VICENCE (1773–1827), French diplomat, ambassador and ultimately foreign minister under Napoleon, was born on Dec. 9, 1773, at Caulaincourt in Picardy, son of Gabriel Louis de Caulaincourt, a general of high social position. Gen. Lazare Hoche picked him out as a cavalry conscript in western France in 1795. Gen. J. B. A. Aubert-Dubayet took him as aide-de-camp at the ministry of war and in 1796–97 on his embassy at Constantinople. In 1799 Gen. J. Bernadotte made him colonel of a crack cavalry regiment, the 2nd Carabiniers, which he led at the battle of Hohenlinden (1800). Talleyrand, his father's friend, employed him in Russia (1801–02), where he greatly impressed Alexander I. Napoleon took him as aide-de-camp on his return. In March 1804 he was sent to Strasbourg to deal with royalist agents from beyond the Rhine; this led to the arrest of the duc d'Enghien. Caulaincourt was shocked at Enghien's execution and resented that Napoleon had exposed him to the charge of being an accomplice. As the emperor's grand equerry from 1804, Caulaincourt was at his side in the great battles. From Nov. 1807 to Feb. 1811 he was ambassador to Russia, working incessantly for peace against his master's arbitrary policy. Napoleon created him duc de Vicence (Vicenza) on March 19, 1808. Recalled in 1811, Caulaincourt had a seven-hour interview with Napoleon, who angrily called him a "Russian." Suffering the same taunts after the invasion of Russia began (1812), he asked to be sent to Spain, as far away from the emperor as possible. Yet he alone accompanied the emperor on his return in a sledge from Russia to Poland and on the dangerous journey through Germany to Paris. His statement that Napoleon was surrounded by capable men who told him the truth deserves record; yet with all his devotion he never liked Napoleon personally.

Caulaincourt negotiated the armistice in Silesia (June 1813) and went to the abortive congress at Prague. After the battle of Leipzig, he replaced J. H. B. Maret as foreign minister. He was the "man of peace," but Napoleon was not, and by mid-March 1814, the congress of Châtillon also failed. Finally Caulaincourt reached Alexander I and, on April 10, 1814, signed the treaty which sent Napoleon to Elba; he was with him in the last grim week at Fontainebleau. In 1815, he resumed the hopeless task of being Napoleon's foreign minister. After Waterloo, Alexander's intervention saved him from the Bourbon proscription. Henceforth he lived in retirement, still trying to clear his name of complicity in the Enghien case. He died of cancer in Paris on Feb. 19, 1827.

His *Mémoires*, ed. by J. Hanoteau, three volumes (1933; Eng. trans. 1950), are important. (I. D. E.)

CAULICULUS, in architecture, a form like a stalk, crowned with leaves supporting scrolls, more leaves or other stalks; especially in the Corinthian capital, and in the branching scroll or rinceau. *See* CAPITAL; ORDER.

CAULIFLOWER: *see* CABBAGE.

CAULLERY, MAURICE JULES GASTON CORNEILLE (1868–1958), French biologist famous for his work on invertebrates and on evolution, was born at Bergues, Nord, on Sept. 5, 1868, and was educated at Douai and at the École Normale Supérieure, Paris. In 1909 he succeeded Alfred Giard in the chair and the directorship of the laboratory of "Evolution des êtres organisés" of the University of Paris (Sorbonne) and in the directorship of the marine zoological station of Wimereux, Pas-de-Calais, founded by Giard in 1874 but destroyed during World War II. He held these posts until 1939. In 1928 he was elected member of the French Academy of Sciences and in 1948 he became foreign member of the Royal society, London. Caullery's numerous papers deal with the structure, life history and biology of parasitic protozoa and marine invertebrates; and he published books on different aspects of general biology, including *Les Problèmes de la sexualité* (1918), *Le Parasitism et la symbiose* (1923), *Le Problème de l'évolution* (1931), *Les Conceptions modernes de l'hérédité* (1935), *Les Progrès récents de l'embryologie expérimentale* (1939), *Organisme et sexualité* (1942) and *L'Histoire des sciences biologiques* (1925) forming part of *L'Histoire de la nation Française* by G. Hanotaux. He also became a co-editor of the *Bulletin biologique de la France et de la Belgique*. He died in Paris on July 15, 1958. (D. KN.)

CAULONIA, an ancient Greek city in southern Italy, in the country of the Bruttii, on Cape Stilo on the eastern coast of modern Calabria, 9 mi. from modern Caulonia. It was the southernmost of the colonies founded in Italy by the Achaeans (*q.v.*), established perhaps in the first half of the 7th century B.C. as an outpost of Croton (Crotone). It was always a small city, but its copious and beautiful coinage (from the second half of the 6th century B.C.) shows its importance. It took the side of Athens in the Peloponnesian War (431–404 B.C.). Destroyed by Dionysius of Syracuse in 389 B.C. but soon afterward restored, it was captured by Campanian troops during the invasion of Pyrrhus, king of Epirus (280–275 B.C.) and submitting to Hannibal in 215 B.C., stood a siege (209 B.C.) on Hannibal's side in the second Punic War. After this it declined, and Strabo mentions it as deserted. Excavations have revealed remains of the fortifications with towers of the Hellenistic period. Near the shore remains of a large Doric temple, a small temple and terra-cotta fragments of architectural structures were found. The excavated houses belong to a later period than the temples. The tombs date from the 6th to the 3rd centuries B.C. but are poor.

See P. Orsi in *Monumenti Antichi,* vol. xxiii, 685 *et seq.* (1914), and vol. xxix, 409 *et seq.* (1923).

CAUPOLICÁN (QUEPOLICÁN) (d. 1558), an Araucanian Indian chief, born in Palmaiquén, Chile, early in the 16th century. With Lautaro, he led Indian resistance against the Spanish conquest of Chile. The Indians captured and executed Pedro de Valdivia after defeating him at Tucapel in Dec. 1553 Following Lautaro's defeat and death at the hands of Francisco de Villagrán at Mataquito in April 1557, Caupolicán organized his warriors to attack a powerful invading army under Don García Hurtado de Mendoza. Don Garcia defeated the Indian chief at Monte Pinto, and soon afterward in another battle where the Indians lost 6,000 men. Caupolicán retired to the mountains near Cañete where he was captured by Capt. Alonso de Reinoso. He suffered a crúel death at Cañete in 1558. Much of the fame that Caupolicán has acquired is owed to the verses which the poet Alonso de Ercilla y Zúñiga dedicated to him in *La Araucana.* (J. L. TR.)

CAUSALITY (CAUSATION). The word "cause" is derived from the Latin *causa,* the standard translation of the Greek *aition* and *oitia*. By the time it came into English, in the 13th century, the word already had a wide range of uses, some of them highly sophisticated, since it was a key term in science, philosophy and the law.

Sense I: Human Agency.—Both *causa* and its Greek equivalents were used in legal contexts to refer to the voluntary action of an agent for which he could be held responsible. The responsible person is the person whose action could have been otherwise and but for whose action the event under investigation would not have occurred. One can already detect here the idea of the point of application of a remedy, an idea which, as we shall see, is an important element in later uses.

Divorced from its association with the law courts, the word "cause" is used for any action which an agent performs in order to bring about an event or state of affairs (the effect), whether in nature or in another agent. Thus a man can cause a statue to be unveiled by pressing a button or cause another man to do something by offering him a bribe. In this sense (sense I), to cause an event to occur is to perform an action with the expectation and intention that the event will follow. The words "produce" and "bring about" are synonyms of "cause" and can be used either of the agent or of his action. We also have a vast number of more specialized verbs such as "hit," "kick," "lift" and "move" which may be said to express causal ideas.

When one man causes another to do something, the second man is, under some circumstances, said to act, not "of his own free will," but "under compulsion" or "under constraint." To have power over someone is to be able to constrain, compel or oblige him to do something. We shall see that the idea of compelling, like that of producing, plays a part in later senses of "cause."

In ordinary life we are often concerned to produce, prevent or counteract events and states of affairs, but our actions are limited to the movements of our own bodies. I can move my own foot; I cannot, in the same sense, move a stone; but I can cause a stone to move by kicking it. To bring about any change in natural objects, it is necessary for us to know what action that we can perform will be followed by the desired change. Thus I cannot, of my own volition, heat water; but I can put a kettle on the fire, and I know that, if I do this in suitable circumstances, the water will be heated. It is often the case that the same change can be brought about by any of a number of alternative actions. Thus I can light a room either by pressing a switch or by drawing back the curtains or by striking a match. Each of these actions is called a "sufficient condition" of producing light; and since, in practice, it is usually required to know only that an action will be *sufficient,* not that it is *necessary,* to produce the effect, the word "cause" usually means sufficient condition. It is important to notice that, when we use "cause" in this way, the effect must be very broadly conceived. The sort of light produced by pressing a switch is very different from that produced by striking a match. The more narrowly the effect is specified the fewer will be the possible alternative sufficient conditions. Beheading, shooting through the heart and administering a dose of arsenic are all ways of causing death; but if the condition of the corpse is specified more narrowly than by the word "dead," a number of these possible causes will be excluded.

A cause, in this sense, must clearly be prior in time to its effect. It need not be contiguous in space and time; but since we know from our everyday experience that the transmission of movement from one body to another only occurs when the bodies are in contact, common sense always assumes that cause and effect are linked by a continuous substance. By igniting one end of a fuse I can cause an explosion to occur several minutes later and several yards away; but only if the fuse is unbroken.

Sense II: Causes in Nature.—By a natural transition the word "cause" is also used (sense II) for a natural event that stands in the same relation to some other event or state of affairs as the action stood in sense I. Thus the explosion that I caused (sense I) by lighting the fuse could have been caused (sense II) by some sparks from a locomotive. For a reason to be given later, the ideas of "producing" and "compelling" which belong naturally to "cause" in sense I were retained for "cause" in sense II. A cause (sense II) was thought to be, not merely the sufficient condition of its effect, but something which had the power to produce it.

A great part of our early education consists in the discovery of causes in these two senses. Thus, in order to achieve our most elementary aims, it is necessary for us to know that fire burns, that food nourishes and that bodily injury causes pain. The idea of cause has its roots in purposive activity and is employed in the first instance when we are concerned to produce or to prevent something. To discover the cause of something is to discover what has to be altered by our own activity in order to produce or to prevent that thing; but once the word "cause" comes to be applied to natural events, the notion of altering the course of events tends to be dropped "Cause" is then used in a nonpractical, purely diagnostic way in cases where we have no interest in altering events or power to alter them. Thus we can speak of the cause of an eclipse or of an earthquake. The connecting link between the practical and the purely diagnostic uses is the idea of "sufficient condition." To discover the cause of an event is to discover something among its temporal antecedents such that, if it had not been present, the event would not have occurred.

Cause in the Practical Sciences.—The concept of cause is widely employed in the practical sciences, such as medicine and engineering. For in these sciences we are largely interested either in bringing about a certain state of affairs (*e.g.*, building a bridge) or in locating the sufficient condition of a state of affairs with a view to its removal (*e.g.*, discovering the cause of a disease or of the breakdown of a machine). The procedure of a practical scientist differs from that of an ordinary intelligent man only in that he needs to be more careful and accurate in his diagnosis of causes and in that he is assisted in his diagnosis by being able to draw on a large fund of theoretical science (*e.g.*, physiology or mechanics).

From this it has been concluded that all science is the search for causes. This conception has been popular with philosophers such as Francis Bacon and J. S. Mill, who regarded science primarily as a means of acquiring power over nature. But to conclude that the statements of theoretical science must be fundamentally causal in form is to make the error of introducing into theoretical science a concept which has its roots in practical activity and which always bears the mark of its origin. Causal explanations necessarily (from the meaning of the word) spotlight a particular event or state of affairs and explain it in terms of temporally prior sufficient conditions; but theoretical sciences are not limited to this mode of explanation and have in fact tended to discard it in favour of other modes. (See *Historical Development*, below.)

Sense III: Cause as Explanation.—The word "cause" has also a wider use (sense III) in which it is equivalent to "explanation," whether or not the explanation is causal in senses I or II. Thus the word "because" can be used to introduce any type of answer to a question beginning "Why?" In this sense a cause need not be an action or event, but may be a state of affairs, a trait of character or, indeed, anything such that, if it were not present, the effect would not occur. Thus a husband's jealousy might be the cause of the breakdown of a marriage and the weakness of a link in a chain the cause of the chain's breaking. In the latter case the weakness of the link is not thought to be the sole cause; for, in calling it the cause, we do not intend to imply that no other conditions were necessary. We know that many factors must be present in the antecedent other than that called "the cause"; for example, the weak link would not have broken if no strain had been put on it. For this reason Mill thought that the selection of one factor as cause from a total set of antecedents was arbitrary.

There is, however, always a reason for our choice. We single out, as cause, that factor which it is possible or convenient for us to alter in order to produce or to prevent the effect. The breaking point of a chain is a function both of the strength of its weakest link and of the load put on it; consequently we can prevent the weak link's breaking again either by replacing it by a stronger one or by refraining from subjecting it to such heavy loads. We select the weakness of the link or the weight of the load as cause according to the remedy which it is most desirable to apply. Similarly, mosquitoes are said to cause malaria, although, for malaria to occur, there must be human bodies as well as mosquitoes; but it would be impolitic to try to abolish malaria by eliminating the human race. In this sense of "cause" alternative explanations do not exclude each other; any number of them can be true, and the cause will be relative to the interests and abilities of the investigator.

Historical Development.—The connection between the three senses seems probably to lie in the historical fact that, when the serious investigation of nature began in the 6th century B.C., it was customary to couch all explanations of natural events in anthropomorphic terms. The pattern of explanation appropriate to human action, which already contained the idea of cause (sense I), was thought applicable to natural phenomena; and, this being so, it was inevitable that the idea of cause (sense II) should retain the anthropomorphic elements of producing and compelling. The idea that a cause (sense II) is an agent which has the power to produce its effect or to compel it to occur bedeviled philosophical and scientific accounts of causation until the matter was clarified by David Hume (see *Hume's Criticism of the Concept of Cause*, below) in the 18th century.

Cause from Aristotle to Copernicus.—For Aristotle all science was the search for causes (*i.e.*, explanations). His "four causes," which provided the framework of explanation until the 16th century, were four general types of answer to the question, "Why is something what it is?" Two of these causes, the material and the formal, we should regard as pertaining to the description of a thing rather than to a causal explanation of it. The material cause is the matter or "potential" from which the thing is made; the formal cause is, literally, the shape or, metaphorically, the structure or organizing principle which distinguishes it from other bits of the same matter (*see* FORM). Thus the material cause of a statue is a piece of bronze, the formal cause its human shape. A mathematical formula, for example the equation of a circle in Cartesian geometry, would be a formal cause.

Aristotle's efficient and final causes, on the other hand, correspond more closely to our uses of "cause." The efficient cause is the agent (*e.g.*, the sculptor) who brings the thing into being or imposes the form on the matter; the final cause is the purpose for which the thing is produced. That the whole scheme is anthropomorphic is shown both by the presence of the idea of "producing" in efficient cause and also by the fact that the final cause was thought to be, in the last resort, the only complete and satisfactory explanation of why a thing is what it is. The underlying idea is that everything does what it does because it is trying to achieve its purpose. In particular, all motion is explained as being due to a thing's attempt to come to rest at its natural resting place.

Cause in Renaissance Science.—In the period from Copernicus to Sir Isaac Newton the concept of causation underwent a change that may be described as the progressive elimination of the anthropomorphic elements in the Aristotelian conception. Two main strands can be detected in this change: (1) the attempt to refine the concept of cause (sense II) in such a way as to make it suitable for the purposes of theoretical science (see *The Refined Concept of Cause*, below); and (2) the transition from explanations in terms of efficient causes to explanations in terms of law.

Although the Aristotelian conception of explanation dominated the middle ages, a minority of mathematically minded scientists continued to follow the tradition of Pythagoras and Plato. According to this tradition, to explain a phenomenon is to discover the laws which it obeys. The astronomer Ptolemy, in the 2nd century A.D., maintained that it was legitimate to interpret the facts of planetary motion by means of any mathematical scheme which would "save the phenomena"; and Copernicus' heliocentric theory was accepted in the first instance, not because it was experimentally verified, but because it saved the phenomena with greater mathematical elegance than did its rivals. The 15th and 16th centuries witnessed a great revival of Platonism; Johann Kepler equated "causes" with "reasons" and regarded the cause of planetary motion as a set of laws from which the observed movements of the planets can be deduced. This view introduces the idea of necessity into that of causation, first in an anthropomorphic sense as the necessity by which objects are compelled to obey God's laws and secondly as the logical necessity which relates premisses to conclusions.

The transition from explanations in terms of efficient causes to explanations in terms of law was largely the work of Galileo. From the point of view of an analysis of causation the importance of his work is threefold. In the first place, he undermined Aristotelian explanations of why things move as they do by showing in a series of experiments that they do not move in the ways which the explanations presuppose. This discredited the whole enterprise of explaining phenomena in terms of final causes and thereby opened the way for other types of explanation. Secondly, the substitution of exact description for explanation (or, as it is sometimes put, of the question "How?" for the question "Why?") led eventually to a conception of science in which all explanation just *is* description. A phenomenon is now said to be explained when the regularity which it exemplifies is able to be incorporated into a system of laws, for example, by being shown to be a logical consequence of those laws. In this way Kepler's laws of planetary motion, which are compendious ways of describing the movements of the known planets, are said to be explained when they are shown to follow from Newton's general laws of motion when constants are substituted for the variables in Newton's laws. Thirdly, Galileo and his contemporaries limited their descriptions to those aspects of phenomena that can be measured, and the spectacular success of physics resulted in its being taken as a model for all the theoretical sciences. Hence scientific explanation came to be thought of as the discovery of functional correlations between variables, a conception from which the idea of efficient cause has disappeared.

Cause in Newton's Philosophy.—The full implications of this revolution in theoretical science were not, however, appreciated at the time. In Newtonian physics, the concept of efficient cause, with its attendant idea of "production" and the contrast between "caused" and "free," still survives as an anomalous element. In the first law of motion, "free motion" is said to be uniform motion in a straight line, and forces are introduced as the causes of deviation from free motion. All observed motions can be analyzed into two components, a free component (inertia) and a component due to a force acting. The second law states that the force acting on a body is always proportional to the product of its mass and acceleration; but Newton never regarded the word "force" just as a name for this product. As a natural scientist he eschewed speculation into the nature of forces, thinking it sufficient for scientific purposes that we should be able to calculate and observe their effects. But he always regarded a force as an unknown somewhat which is the efficient cause of observed motion.

In a modern statement of Newtonian mechanics this conception of forces as efficient causes disappears, what remains being a set of differential equations correlating the total state of an isolated system at any one time with its total state at any other time. An example will help to make this clear. Consider a moving billiard ball striking another which is at rest. From the point of view of common sense the movement of the first ball up to the moment of impact is one event (the cause) and the movements of the two balls after impact is another, complex event (the effect). From the standpoint of classical mechanics, however, the system is not divided into two events. It is considered as a single system in which there is at every time the same quantity of momentum. From the equations of motion of the system together with a specification of the position and velocity of each body in it at any given time, we can calculate (if we disregard disturbing factors such as friction) the position and velocity of each body in the system at any other time. Since the laws of mechanics are reversible in respect of time, the division of the system into an earlier and a later phase is irrelevant.

These two explanations do not conflict with one another and it would be a mistake to say that, if the explanation furnished by classical mechanics is true, the common sense explanation must be false. The concept of cause reappears naturally in any practical or diagnostic application of the laws of mechanics. For, if I want to impart a given velocity to the second ball, the laws of mechanics enable me to calculate the momentum that must be introduced into the system by the movement of my arm. Similarly, if I want to explain why the second ball moved as it did, I can calculate by means of the laws of mechanics the velocity with which a ball of known mass must have struck it.

The Refined Concept of Cause.—We must now return to the attempt to refine the concept of cause (sense II) for the purposes of theoretical science. It is this attempt that gives rise to most of the traditional philosophical problems about causation. These problems are mainly due (1) to a confusion between cause in sense II and cause in sense III whereby some philosophers have been led to suppose that all explanations of natural phenomena must be causal in sense II; and (2) to the retention of the elements of "producing" and "compelling" from sense I. Hobbes defined a cause as "the aggregate of all the accidents both of the agents how many so ever they be, and of the patient, put together; which when they are all supposed to be present, it cannot be understood but that the effect is produced at the same instant: and if any one of them be wanting, it cannot be understood but that the effect is not produced." The word "accident" is here used in a technical sense in which it is roughly equivalent to "quality."

This concept of cause resembles the unrefined concept (sense II) in that causal statements are made in qualitative, not quantitative, terms and in that it retains the idea of "producing." It differs, however, from the unrefined concept in many important ways. The causal relation is said to be logically necessary: the cause is a necessary as well as a sufficient condition of the effect, and cause and effect are contemporaneous. These ill-assorted elements cannot in fact be comprised within a single concept and it is not difficult to deduce absurdities from a concept so composed.

We have already seen that a cause in sense II is necessarily prior to its effect in time and that it is one element singled out from the total antecedent of the effect, the selection being relative to the interests and abilities of the investigator. We have also seen that the effect had to be more or less vaguely specified. In the refined concept both cause and effect must be precisely specified and the cause is the total necessary and sufficient condition. It now follows that cause and effect must be instantaneous events and must be contemporaneous with each other. For, if the cause has duration, however short, it cannot in its earlier phases be sufficient to produce its effect, since the effect does not occur. The total antecedent only becomes sufficient at the instant the effect occurs: at any prior time the supposed cause is not sufficient to produce the effect, and it follows that cause and effect must be contemporaneous. If this is so, the cause of the cause must be contemporaneous with it; so all causes and effects will be contemporaneous.

From argument such as this some philosophers have tried to prove the unreality of time and change; but all such arguments are illegitimate in that they depend on employing a concept of cause that contains self-contradictory elements. We cannot employ both the idea of producing and the idea of a total set of necessary and sufficient conditions in the same concept, since the idea of producing is essentially that of an action which, supervening on a given set of conditions, is followed by an event which would not have occurred if the action had not supervened, while the idea of a total set of necessary and sufficient conditions requires cause and effect to be contemporaneous.

Hume's Criticism of the Concept of Cause.—The full implications of the revolution in physics outlined above were first appreciated by David Hume, who showed in the first place that the relation of cause and effect is neither logically necessary nor observable in a single instance. It is not logically necessary since we can conceive of an event's being preceded by any other event whatsoever, and what we can conceive could (logically) occur. If in fact an event of a certain type is always preceded by the same other type of event, we only know this from experience.

Equally, the relation is not observable in a single instance since all that we observe in an instance is a succession of events; we do not observe in the earlier event that "power" or "agency" which is essential to the concept of cause. And if we cannot observe this in a single instance we cannot observe it in any number of instances. Nevertheless, Hume knew that when we call something a cause we intend to assert more than temporal priority and contiguity in time and place. The third element, which he called "necessary connection," had been thought to lie in the "efficacy" or "productive power" of the cause. But Hume saw that, divorced from their associations with human action, words such as "efficacy," "agency," "power" and "production" are mere synonyms for the necessary connection that they are supposed to explain. Finally Hume came to the view that for an assertion of causality we require, besides contiguity and succession, only that the succession should have been repeated many times without any contrary instance; and he held that the idea of necessary connection was the determination of the mind to pass from the idea of the cause to that of the effect. An assertion of cause is an expression of confident expectation based on habit.

As a contribution to the problem of induction Hume's analysis was of the greatest importance; but as an explanation of the idea of necessary connection it seems inadequate. Hume failed to notice that this idea is really that of logical necessity transported from its proper place in a deductive system to an improper place in causal (sense II) explanations. When we say that the planets "must" move as they do, we do not mean that they are compelled to do so by efficient causes; we mean that the description of their observed motions follows logically from the laws of motion that we have adopted. The planets must move as they do, *if* Newton's laws are true and if the observations from which their movements are predicted were correct.

Following Hume, J. S. Mill defined the cause of a phenomenon as "the antecedent or concurrence of antecedents on which it is invariably and unconditionally consequent." The word "unconditionally" reintroduces the confusions inherent in the refined concept of cause. Since Mill was mainly interested in the social sciences, his theory represents a trend away from explanations in terms of mathematically formulated laws toward the older view of causation as a relation between events qualitatively described. His canons of induction require the analysis of complex events into factors and the discovery, by observation and experiment, of those factors which are invariably and unconditionally present when a certain phenomenon occurs and absent when it does not occur. Such an analysis, however, cannot be exhaustive without introducing the absurdities involved in the concept of an unconditional cause. Mill's canons of induction are useful in ordinary life and in the practical sciences, in fact wherever we are operating with the concept of cause (sense II) and do not attempt to refine it by requiring the cause to be necessary, sufficient and unconditional.

The Present State of the Question.—The notion of efficient cause survives in our ordinary language in such words as "produce," "bring about," "make," "due to," "result of" and "consequence of" and in the host of more specialized causal verbs. When the subject of these verbs is an inanimate thing the anthropomorphic element is a mere linguistic survival and does not (for most people) express anything present in thought: the cause is simply thought of as a sufficient condition discovered to be sufficient by experience.

In ordinary life we are not troubled by the logical problem of induction; that is to say, we do not stop to ask why the fact that a succession of events has been observed to occur many times should justify our expectation that it will occur again. The examination of this problem is beyond the scope of this article. (*See* INDUCTION.)

In the sciences, explanations are mostly of the type known as "hypothetico-deductive," according to which observation suggests a generalization or law from which consequences can be deduced. The consequences can then be verified or falsified by controlled experiment or, where this is impossible, by observation. In the theoretical sciences, generalizations and laws usually take the form of functional correlations between variables, and the idea of efficient cause does not appear. Any set of laws which saves the phenomena is considered legitimate; but since a given set of phenomena can be saved by any of an infinite number of alternative sets of laws it is necessary to provide criteria for choosing one set rather than another. The usual criteria are mathematical simplicity (which is largely a matter of taste), comprehensiveness and predictive fruitfulness. The concept of efficient cause still appears within this framework in those sciences which depend largely on qualitative analysis and, especially, in the practical sciences. *See* SCIENCE; SCIENTIFIC METHOD; *see* also references under "Causality" in the Index volume.

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(P. H. N.-S.)

CAUSE AND EFFECT: *see* CAUSALITY.

CAUSSES, the name given to districts of limestone plateaus in southwestern France. The name is derived from *cau,* the local form of *chaux (i.e.,* "lime"). The Grands Causses, in the *départements* of Aveyron and Lozère, form part of the Massif Central (*q.v.*) and over extensive areas lie between 3,000 and 4,000 ft. above sea level. They are dissected by the gorges of the Tarn and Aveyron rivers and present waterless, boulder-strewn surfaces with a scanty vegetation, though their present denuded character is the result of the ravages of sheep and goats that graze the plateaus. Settlement is concentrated within the narrow, sheltered valleys. The chief resource, apart from the tourist industry, is the rearing of sheep whose milk is used to make Roquefort cheese. The lambskins are made into gloves at Millau, formerly a woolen manufacturing town, situated on the western margin of the Causses at the exit of the Tarn gorge. Farther west, in Quercy and Périgord, are lower limestone plateaus, sometimes known as the Petits Causses and renowned for their cave remains of prehistoric man.

(AR. E. S.)

CAUSTIC, that which burns (Gr. *kaustikos,* "burning"). In medicine, the term refers to substances that destroy living tissues and so inhibit the action of organic poisons, as in bites, malignant disease and gangrenous processes. Such caustic substances include silver nitrate (lunar caustic), potassium and sodium hydroxides (the caustic alkalis), zinc chloride, an acid solution of mercuric nitrate, and pure carbolic acid (phenol).

In optics (geometrical optics) the term "caustic" is applied to the envelope of luminous rays after reflection or refraction. In the first case the envelope is termed a catacaustic, in the second a diacaustic. Catacaustics are observed as bright curves when light is allowed to fall on a curved polished riband of steel, such as a watch spring, placed on a table. By varying the curvature of the riband of steel or moving the source of light a variety of patterns can be obtained. The investigation of caustics, based as it is on the assumption of the law of the rectilinear propagation of light and the validity of the experimental laws of reflection and refraction, is essentially of a geometrical nature, and as such attracted the attention of mathematicians of the 17th and succeeding centuries.

CAUSTIC SODA: *see* ALKALI MANUFACTURE; SODIUM.

CAUTERETS, a health resort of southwestern France in the *département* of Hautes-Pyrénées, 30 km. (19 mi.) S.W. of Lourdes by road. Pop. (1954) 1,033. It lies in the beautiful valley of the Gave de Cauterets, and is well known for its hot springs and as a resort for winter sports, to which thousands of visitors are attracted annually. The mineral waters have been known at least since the 10th century. They became famous in the 16th century when Margaret of Angoulême, queen of Navarre, composed the *Heptameron,* on the model of Boccaccio's *Decameron,* while visiting the spa with her court. Cauterets also is a centre for excursions, the Pic du Monné (8,937 ft.), the Cabaliros (7,654 ft.), the Pic de Chabarrou (9,596 ft.), the Pic de Vignemale (10,820 ft.) and other peaks being in its neighbourhood. The town is 9 km. (6 mi.) from Pierrefitte-Nestalas station on a secondary railway from Lourdes. Air services fly from Tarbes-Ossun airfield (40 km. [25 mi.] N.N.E.) to Barcelona, Brussels and Dublin.

(Je. La.)

CAUTÍN, a province of southern Chile, bounded north by Malleco and Arauco, east by Argentina, south by Valdivia and west by the Pacific. Area 6,707 sq.mi.; pop. (1960) 393,041, including many European immigrants, principally Germans. Cautín lies within the temperate rain forest region of the south; its chief products are timber, cattle, grain and apples. The state railway from Santiago to Puerto Montt crosses the province from north to south; branch lines to such places as Cherquenco, Cunco, Tolten and Carahue provide good rail service to most parts of the province. Two partially navigable rivers cross the province from east to west, the Tolten and the Cautín, the lower reaches of the latter being known as the Río Imperial. The province once formed part of the territory occupied by the Araucanian Indians, and Temuco (*q.v.*), the capital of the province, long remained the centre of greatest concentration of these people. Temuco, a city of 111,641 (mun.) inhabitants in 1960, is on the Río Cautín. It is an important rail centre, market town, and gateway to the famous lake district of south Chile.

CAUVERY (Kaveri), a river of southern India. Rising in Coorg district, Mysore, high amid the Western Ghats, it flows generally southeast across the plateau of Mysore, and finally enters the Bay of Bengal through two principal mouths in Tanjore district of Madras state. Its length is 475 mi. Its uppermost course is tortuous, and its bed generally rocky with high banks covered with luxuriant vegetation. After passing through a narrow gorge, it widens to a breadth of 300 to 400 yd. across the plateau surface of Mysore but the bed is too rocky for navigation. In its plateau course the channel is interrupted by a number of anicuts or dams for irrigation. In Mysore the Cauvery forms the two islands of Seringapatam and Sivasamudram, which vie in sanctity with Srirangam Island lower down in Tiruchirapalli (Trichinopoly) district. Around Sivasamudram Island are the celebrated falls of the Cauvery, where the river branches into two channels, each making a descent of about 320 ft. After entering Madras state, the Cauvery forms the boundary between the Coimbatore and Salem districts, until it reaches Tiruchirapalli district. Sweeping past the historic rock of Trichinopoly, it again breaks at Srirangam Island into two channels, which enclose between them the delta of Thanjavur (Tanjore), the garden of southern India. The northern and larger channel is called the Coleroon (Kolidam). On the seaward side of the delta are the open roadsteads of Negapatinam (Nagapattinam, Negapatam) and Karikal. The only navigation on any part of its course is carried on in basketwork boats.

There is an extensive irrigation system in the delta. The Grand anicut (or weir), built in the 2nd century where the Cauvery divides into two channels, feeds the deltaic irrigation system of Thanjavur. A second anicut across the Coleroon (1836–38) was necessary to save the old system from the disaster of silting, but it also added to the irrigated area. The Mettur project, a dam and canal more than 200 mi. from the sea, was completed in 1938. It improved the water supply to more than 1,000,000 ac. already irrigated, added another 300,000 ac. and provided 50,000 kw. of electric power, thus creating an important industrial area. The Cauvery falls, under an older power scheme, provide electricity to Mysore and Bangalore and the Kolar gold mines.

The Cauvery is known to devout Hindus as Dakshini Ganga, or the Ganges of the south, and its entire course is holy ground.

(T. Her.; L. D. S.)

CAVA DE' TIRRENI, a town and episcopal see of the Campania region, Italy, in the province of Salerno, 6 mi. N.W. of the town of Salerno by rail. Pop. (1957 est.) 41,092 (commune). It lies in a rich cultivated valley surrounded by hills where cylindrical towers are used for pigeon shooting, a tradition derived from Lombardy. It is a favourite resort and centre for international sporting events.

One mile to the southwest is the village of Corpo di Cava with the Benedictine abbey of La Trinità della Cava. St. Alferius, who came from Cluny in 1011, founded the abbey in 1025 in a cave, naming it Trinità after a vision. Although most of the buildings were modernized in 1796, the Gothic cloisters remain. The archives contain parchments dating from the 8th century, and the library contains valuable manuscripts including a Visigothic Bible of the 7th century and the 11th-century Lombard Laws. (M. T. A. N.)

CAVAIGNAC, a French family, originally from Rouergue, that rose to prominence in the century following the Revolution. Jean Baptiste Cavaignac (1762–1829) was a lawyer in Toulouse before 1789 and then member of the Convention for his native *département* of Lot. A member of the committee of general security (*sûreté générale*), he was sent by the Convention to the western army fighting the Vendean insurrection. Having voted for Louis XVI's death, he was proscribed at the Restoration and died exiled in Brussels. His brother Jacques Marie Cavaignac (1773–1855), who entered the army as volunteer in 1792 and commanded the cavalry of the XI corps in Napoleon's invasion of Russia (1812), served under the Restoration and the July monarchy as general inspector of the cavalry and was made a peer in 1839. Jean Baptiste's elder son, Godefroy Cavaignac (1801–1845), was one of the leaders of the republican secret societies under the Restoration. His chivalrous character made him one of the most popular democratic chiefs during the July monarchy. Representing the tradition of the first republic and the young opposition, he was also well known as a journalist, being a contributor to *La Réforme.* His participation in all Parisian risings from 1830 to 1834 was an additional reason for his celebrity.

The most famous member of the family was Jean Baptiste's younger son Louis Eugène Cavaignac (1802–1857). He entered the army during the Restoration but was removed for republicanism in 1831. His uncle's protection helped his recall to the service in 1832, but he was sent to Algeria (as were many other opposition officers). He remained 16 years in Africa, with a very normal career. After the revolution of Feb. 1848, the provisional government designated him governor-general of Algeria and offered him the post of minister of war. He refused, at first, however, because the government would not allow him to bring troops to Paris, but he accepted some weeks later—probably on a personal appeal from Alphonse de Lamartine, who wanted to strengthen the moderates against the extremists. Public banquets and other demonstrations then provided a pretext for calling troops into Paris. After Louis Blanc and Albert (*qq.v.*) had been removed from the provisional government by the national constituent assembly, Cavaignac could perfect his plan, which was to exploit the next manifestation of the "reds" in order to crush them. The closing of the national workshops (*q.v.*) on June 22, 1848, and the consequent revolt gave him the opportunity that he wanted. Profiting from the lessons of the last revolution, he massed his troops in quiet parts of the city and waited for further regiments summoned from the provinces and being transported (for the first time) by railway. The delay and some local successes of the insurgents increased the panic in the assembly, and Cavaignac obtained the resignation of the provisional government and dictatorial powers for himself. He then attacked the insurgents with all his forces. After four days of fighting, systematic reprisals were begun against all socialist movements. This was the end of hopes for a democratic and social republic. In Dec. 1848, Cavaignac stood for the presidency, but Louis Napoléon Bonaparte was elected instead. Cavaignac went on to opposition and was even imprisoned in Dec. 1851. He retired into private life when Louis Napoléon became emperor. His son Godefroy Cavaignac (1853–1905) was also active in politics. He was minister of marine under Émile Loubet (1892) and minister of war under Léon Bourgeois (1895–96) and under Henri Brisson (1898), after which he retired from politics.

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Schmidt, *Les Journées de juin 1848* (1926); G. Renard, *La Révolution de 1848* (1904); R. Postgate, *Story of a Year, 1848* (1955). (Je. V.)

CAVALCANTI, GUIDO (*c.* 1255–1300), outstanding member of a group of Italian poets often referred to as the "poets of the *dolce stil novo*" (*see* ITALIAN LITERATURE). He came of a distinguished Florentine Guelph family and married the daughter of the Ghibelline leader, Farinata degli Uberti. During the struggle between Black and White Guelphs in 1300, he was banished, was recalled when ill and died of malaria in Florence. He was a close friend of Dante, but they were eventually estranged.

Intelligent, sensitive and keenly interested in philosophy, Cavalcanti is one of Italy's finest lyric poets. His subject is love, and he is sometimes gay, but more often tormented or despairing, expressing a poignant sense of the spiritual destructiveness of unrequited love.

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CAVALCASELLE, GIOVANNI BATTISTA (1820–1897), Italian writer on art and, with Giovanni Morelli (*q.v.*), a founder of modern Italian art-historical studies, was born at Legnago on Jan. 22, 1820. He became a student at the Accademia delle Belle Arti in Venice, and from early youth studied the art treasures of Italy. He visited the cities of Tuscany, and then set out to see the masterpieces of Italian art in foreign countries. During a stay in Germany in 1846 and 1847 he made the acquaintance of Joseph Archer Crowe (*q.v.*) in a post carriage between Hamm and Minden. The two young men felt drawn to each other and met again in Berlin, where they studied together in the museum. On his return to Venice Cavalcaselle took an active part in the revolution of 1848 against Austrian rule. He was arrested by Austrian gendarmes and narrowly escaped being shot. He then joined the forces of Garibaldi and was taken prisoner by the French in 1849. He arrived in miserable plight in Paris, where by good fortune he again met Crowe, and with his help went to London. The two friends occupied rooms together and worked on a history of early Flemish painters, published in 1857. In the same year Cavalcaselle returned to Italy. In 1864 Crowe and Cavalcaselle published their great work, *A New History of Italian Painting*, which was followed by the *History of Painting in North Italy*. Other joint works were *Titian* (1877) and *Raphael* (1882–85). Cavalcaselle's independent writings are of less importance but his sketch books and notes, preserved in the Marciana library in Venice, are evidence of his method and range of knowledge.

Cavalcaselle was for some time secretary to Giovanni Morelli, and his traveling companion when Morelli compiled the inventory of the works of art in the Marches of Ancona for the Italian government. Toward the end of his life Cavalcaselle held office as inspector of fine arts in the ministry of education in Rome. He died on Oct. 31, 1897.

See vol. 1 of the 2nd Eng. ed. of A. Crowe and G. B. Cavalcaselle's *History of Painting in Italy*, ed. by L. Douglas (1903–14), which includes a biography. (P. J. My.)

CAVALIER, JEAN (1681–1740), French Protestant soldier, who made his name as the guerrilla leader of the Camisards in one of the most terrible partisan wars in his country's history, was born at Mas Roux, near Anduze (in the modern *département* of Gard), on Nov. 28, 1681, the son of a local shepherd. Brought up as a Protestant by his mother despite persecution, he went to Geneva in Sept. 1701 to avoid arrest for having participated in the early assemblies of the Protestant enthusiasts and prophets in Languedoc (*see* CAMISARDS). Shortly after his return the Camisards broke out in revolt (July 1702). Cavalier, then an apprentice baker 21 years old, showed not only gifts of his own as a prophet but also a genius for war and soon became the chief commander in the insurrection.

Cavalier held religious meetings at the very gates of Alès on Christmas day 1702 and won a victory at Vagnas on Feb. 10, 1703. The victim of a surprise attack at Tour-de-Billot (April 30, 1703), he took terrible reprisals (Sept.–Oct. 1703) and even threatened Nîmes itself. Finally, at Martignargues (March 4, 1704), he defeated one of Louis XIV's best regiments. A serious reverse at Nages (April 16, 1704) and the loss of his arsenal at Euzet (April 19) forced him to agree to an armistice at Pont-d'Avesnes (May 12). He made his submission at Nîmes on May 16, 1704. As he failed to secure liberty of conscience for his soldiers, they accused him of treachery and left him. Only about 100 of them accompanied him on his way to Neu-Brisach in Alsace, which he was now sent to garrison (June 21). From Mâcon, he went alone to Versailles, where Louis XIV refused to see him. Fearing arrest, he rejoined the Camisards and crossed with them to Switzerland (Aug. 26).

Thenceforward the soldier in him predominated over the religious enthusiast. He fought for Savoy in the Val d'Aosta (Sept. 1704–Oct. 1705) and under the British command in Spain, where in the battle of Almansa (April 25, 1707) he was wounded a dozen times during a savage hand-to-hand fight. After some years in the Netherlands as a colonel on half pay, he retired to a Huguenot colony at Portarlington in Ireland. His *Memoirs of the Wars of the Cévennes* appeared in 1726, at Dublin (2nd ed. 1727). Finally he was made a brigadier in the British army (1735), appointed lieutenant governor of Jersey (1738) and promoted to major general (1739). He died at Chelsea (London) on May 17, 1740.

See A. P. Grubb, *Jean Cavalier* (1931); M. Pin, *Jean Cavalier* (1936). (L. Ma.)

CAVALIER (Late Lat. *caballarius*, "horseman"), a word with the same origin as the French *chevalier* (*q.v.*), designating originally a rider or cavalryman. In English the word "knight" was at first generally used to imply the qualities of chivalry associated with *chevalier* in French and with the kindred *cavaliere* in Italian and *caballero* in Spanish (*see* KNIGHTHOOD, CHIVALRY AND ORDERS), "cavalier" having rather the pejorative sense of "swashbuckling" and "overbearing" (as now when it is used as an adjective). In the English Civil War, however, it came to be adopted as their own specific designation by Charles I's supporters, who contemptuously called their opponents Roundheads; and at the Restoration the court party preserved the name, which survived until the rise of the term Tory (*see* WHIG AND TORY). In fortification, a cavalier was a work of great command constructed in the interior of a fort; bastion or other defense, so as to fire over the exterior parapet. The height of the cavalier made it an easy target, and it fell out of use late in the 19th century with the introduction of high-explosive shells.

CAVALIERI, (FRANCESCO) BONAVENTURA (1598–1647), Italian mathematician, who contributed to the development of geometry in the Renaissance, was born at Milan; his name also occurs in the forms Cavallieri, Cavaglieri, Cavalerius and de Cavaleriis. He became a Jesuit at an early age and later was inspired to study mathematics by reading a copy of Euclid. He was made a professor at Bologna in 1629 and held the post until he died.

In 1635 he wrote *Geometria indivisibilium continuorum nova quadam ratione promota*, in which he first stated his principle of indivisibles. The form of the principle was unsatisfactory and was attacked by Paul Guldin. In reply to this attack Cavalieri wrote *Exercitationes geometricae sex* (1647), stating the principle in the more satisfactory form in which it was used by 17th-century mathematicians. This work also contained the first rigorous proof of Guldin's theorem relating to the volume of a solid of revolution. The theorem had occurred in the writings of Pappus and had been used in an unsatisfactory fashion by Kepler. Using the principle of indivisibles as a sort of integral calculus, Cavalieri solved a number of problems proposed by Kepler. Other books by Cavalieri are: *Lo specchio ustorio ovvero trattato delle settioni coniche* (1632), *Directorium generale uranometricum, in quo trigonometriae logarithmicae fundamenta ac regula demonstrantur* (1632) and *Trigonometria plana et sphaerica* (1643). Cavalieri died at Bologna on Dec. 3, 1647.

The life of Cavalieri was written by P. Frisi (1776) and by F. Predari (1843). *See* also C. B. Boyer, "Cavalieri, Limits and Discarded Infinitesimals," in *Scripta Mathematica*, vol. viii (1941).

CAVALIERI, EMILIO DE' (*c.* 1550–1602), one of the first Italian composers of dramatic music, was born in Rome about 1550.

On the accession in 1589 of the grand duke Ferdinand I of Tuscany, whom he had known in Rome, Cavalieri followed him to Florence, where he became a leader of the artistic life of the Medici court and a rival (rather than a colleague) of other dramatic composers such as Giulio Caccini and Jacopo Peri. He wrote music for pastorals and masques but is historically most important for *La Rappresentazione di Anima e di Corpo*, given in 1600 in Rome after his return there. This sacred allegorical drama, didactic in intention, has often been mistakenly called the first oratorio. Although varied with recitatives, arias, ensembles and choruses, it is undeniably monotonous, since Cavalieri's invention is never very lively.

Cavalieri died at Rome, March 11, 1602. (N. Fo.)

CAVALLI, (PIETRO) FRANCESCO (1602–1676), the most important Italian opera composer of the mid-17th century, was born at Crema, Feb. 14, 1602, the son of Gian Battista Caletti-Bruni. He assumed the name of his Venetian patron, Federigo Cavalli. In 1617 he became a singer in the choir of St. Mark's, Venice, directed by C. Monteverdi and subsequently held various posts there, becoming *maestro di cappella* in 1668. He died in Venice on Jan. 14, 1676. During his lifetime Cavalli had a considerable influence on European taste. *La Didone* (1641) is perhaps his most interesting work, but it was his *Egisto*, given in Paris in 1646, that initiated the rivalry between French and Italian styles. As a dramatic composer Cavalli ranks with J. B. Lully as a true successor of Monteverdi. His music is intended for a small string orchestra, and his operas require no trained chorus. He wrote few concerted numbers for soloists, but his works have signs of the beginnings of the formal recitative aria technique, sometimes even with a *da capo* section. Compensation for the level character of his music was provided by the brilliant costumes and lavish sets, devised by Jacopo Torelli and others, without which, in spite of their dramatic power and grotesque humour, Cavalli's works are incomplete. Although performed throughout Italy, these *dramme per musica* were generally written especially for the public opera houses that flourished in 17th-century Venice like the modern motion picture theatres. Although 27 of his 42 operas are preserved in manuscript in the library of St. Mark's, only the first act of *Giasone* (1649) and some extracts are available in a modern edition (*Gesellschaft für Musikforschung*, edited by R. Eitner, vol. xi, 1883).

See H. Prunières, *Cavalli et l'opéra italien au 17^e siecle* (1931); E. Wellesz, "Cavalli und der Stil der Venezianischen Opera von 1640–60" in *Studien zur Musikwissenschaft* (1913). (S. T.)

CAVALLINI, PIETRO (*c.* 1250–*c.* 1330), Roman painter, ranks with Cimabue and Giotto as one of the founders of Italian painting. Much of his work has been destroyed, but his activity can be reconstructed through the careful description of his work given in the *Commentaries* of Lorenzo Ghiberti. Mentioned in 1273 in connection with work in Sta. Maria Maggiore, Rome, and in 1308 in Naples, he was responsible for fresco cycles in S. Paolo fuori le Mura, Rome (about 1282–97, known through copies), Sta. Cecilia in Trastevere (1291–93, traces survive), S. Giorgio in Velabro (after 1295) and for the apse mosaic in Sta. Maria in Trastevere (1291).

Cavallini's later style is represented by frescoes in Sta. Maria Donna Regina, Naples. Both in his treatment of space and in his figure style, Cavallini appears as an innovator of great significance, whose influence dominates the decoration of the upper section of the walls of the nave of S. Francesco at Assisi (*see* GIOTTO). (J. W. P.-H.)

CAVALLOTTI, FELICE CARLO EMMANUELE (1842–1898), Italian journalist and political leader of the extreme left, was born in Milan on Dec. 6, 1842. In the campaigns of 1860 and 1866 he fought in the Garibaldian corps, but he first attained notoriety by his antimonarchical lampoons in the *Gazzetta di Milano* and the *Gazzettino rosa* between 1866 and 1872. Elected to parliament in Sept. 1873, he succeeded to the leadership of the extreme left in 1886 on Agostino Bertani's death. His eloquent invective and his advocacy of democratic reform made him the most popular man in Italy next to Francesco Crispi, against whom he waged an unceasing campaign. He was killed in Rome in a duel with Ferruccio Macola, editor of the *Gazzetta di Venezia*, on March 6, 1898.

See A. de Mohr, *Felice Cavallotti: la vita e le opere* (1899).

CAVALRY, a military force mounted on horseback, formerly an important element in the armies of all major powers. When employed as part of a combined military formation its main duties included observing and reporting information about the enemy; screening movements of its own force; pursuing and demoralizing a defeated enemy; maintaining a constant threat to an enemy's rear area; striking suddenly at detected weak points; turning exposed flanks; and exploiting a penetration or breakthrough. A force on horseback could move faster than foot soldiers and could traverse terrain that was too rough for tanks or other combat vehicles. But during the latter part of the 19th century, largely as a result of the introduction of repeating rifles and machine guns, cavalry lost much of its former value. By the time of World War I a cavalry charge against a line of entrenched troops armed with rapid-firing small arms was simply suicidal. Cavalry organizations soon abandoned horses for armoured fighting vehicles and became known as mechanized cavalry or armoured cavalry, but even the name was eventually dropped.

The U.S. army organization act of 1950 eliminated cavalry as a branch and established a new branch named "armour," specifically describing it as a continuation of the cavalry. All traditions, honours, missions and the role of cavalry were inherited by armour. In the U.S. army there still existed armoured cavalry units that were assigned reconnaissance and screening missions similar to the missions formerly given cavalry units, but by the 1950s there were no horse-mounted cavalry units in either the U.S. or British armies. The U.S.S.R., however, had about 12 horse cavalry divisions numbering approximately 4,500 men each.

Cavalry Tactics.—The two most primitive types of soldier are the foot soldier and the horse soldier, the first being characteristic of early European warfare and the second of early Asian warfare. In southern Europe (countries south and west of the Danube and the Rhine) few suitable breeds of war horses existed in ancient times; hence the weakness of Roman cavalry and of early Grecian cavalry. When infantry met infantry, battles were decided by superior numbers, armament, discipline or tactics. When cavalry met cavalry, as in Scythia, battles were seldom decided at all, but usually degenerated into skirmishes, forays and scattered pursuits. In hilly country, such as most of Greece, cavalry was normally impotent to attack infantry, as exemplified in the Greco-Persian Wars (490–479 B.C.); while in open plain land, so frequently found in Asia Minor, it could destroy infantry by besieging it in the field, as happened to Crassus at Carrhae in 53 B.C. The truth of the matter is that the two arms were complementary, each providing the other with powers not inherent in either separately. Infantry in an advance was useless unless its rear services were protected, and so also was cavalry in the advance, unless the positions won by it could be held so that its forward movement might not be interrupted.

The art of making an advance through a hostile country has always depended on the power of pushing forward a secure and movable base in order to develop additional offensive power from it. Once infantry and cavalry were combined, the first formed the movable base and the second provided the offensive power. The function of cavalry in any armed force was to provide mobility near and on the battlefield, and at the same time be able to engage in offensive and defensive fighting, whether independently or in conjunction with other arms.

When the advance merged into the attack, three targets would present themselves: the enemy's infantry, his cavalry and his baggage train. If the baggage train could be seized and held, the severest possible blow could be dealt the enemy's organization; commanders therefore tried to make sure that their supply services would be well protected by the battle front. Infantry could oppose frontal attacks by enemy infantry but if it were attacked in flank or rear by the opposing infantry or cavalry it would be taken at a tremendous disadvantage.

Throughout history flank protection was furnished by cavalry. The infantry front may be pictured as a slowly moving wall behind which were assembled the supply services, and on the flanks of which were hinged two cavalry wings, which, like doors, could swing forward and backward, "flapping" away any hostile force which might attempt to raid the baggage train or attack the infantry in the rear.

The first objective in battle, therefore, was to destroy one or both of the hostile cavalry wings, for then the opposing infantry wall would be open to attack on its flanks and rear. If, meanwhile, its front could be so vigorously attacked by the infantry that it would be unable to turn to right or left, a cavalry attack on its flanks or rear would be likely to prove decisive.

In brief, the object of infantry was to provide a base of operations for cavalry. The power of cavalry lay first in its ability to overcome the enemy cavalry, and second in its ability to develop enough speed to circumvent an infantry front and attack it in the rear before it could face about. In the case of an organized army, facing about from front to flanks or rear was an extremely difficult and dangerous operation—impossible while the front was being vigorously attacked. (*See* TACTICS.)

Early Cavalry.—During the early classical age tactical organization was based on the nature of the country rather than on any idea of weapon co-operation or combination between the arms. Thus, in Sparta there was practically no cavalry, while in Scythia mounted bowmen alone existed. Nevertheless, as soon as the Asian horsemen came into contact with European foot soldiers, as they did in the 5th century B.C., the problem of tactical co-operation, namely, how to equip, arm and maneuver a body of men so that offensive power could be developed from a protective base, was thrust to the fore. This problem was solved by Philip of Macedon, whose solution was put to use and further developed by his son Alexander the Great.

The backbone of Philip's army was the phalanx, or infantry mass. Armed with the *sarissa*, a pike from 18 to 21 ft. long, it formed an impenetrable hedge of spears to cavalry attack, though it offered a somewhat vulnerable target to archers, either mounted or on foot. Recognizing the strong protective power of the phalanx, Philip was one of the first among the ancients to grasp the fact that stability of organization alone is insufficient to guarantee that disruption of the enemy force would be followed by its annihilation. The phalanx could not pursue without breaking its formation. It was not armed for the pursuit, and in the pursuit the pursued almost invariably moves faster than the pursuer, whether both are on foot or mounted. To render the act of annihilation possible, Philip added to the phalanx a superb force of cavalry in the proportion of one trooper to every six heavy foot soldiers. This cavalry he organized in three bodies: heavy armoured cavalry for the charge, his companion cavalry being the most notable corps; light cavalry, or hussars, for reconnaissance and outpost work; and dragoons who could fight either on foot or on horseback.

The tactics that Alexander developed from this organization were equally simple and astonishingly effective. Advancing in parallel order against the enemy, he would push forward his right wing while his centre, protected on its left by the left cavalry wing, held the enemy to his ground. Alexander would then deliver a series of terrific punches at his opponent's left with his right wing cavalry in an effort to penetrate or envelop the enemy's flank. At the battles of the Granicus (334 B.C.), Issus (333 B.C.) and Gaugamela (331 B.C.) his companion cavalry decided the day, and at the battle of the Hydaspes (326 B.C.) his cavalry so completely dislocated the Indian army that his phalanx was able to disrupt it. (*See* ALEXANDER III THE GREAT.)

The Roman Period.—From the days of Alexander onward, cavalry, because of its mobility, became the decisive arm. Hannibal's use of cavalry was superb, as the battles of the Trebbia (218 B.C.) and of Cannae (216 B.C.) testify. In both of these the Carthaginian cavalry completely dislocated the Roman legions by a rear attack. In the Roman armies the lack of good cavalry proved their ruin, and it was not until such a force was raised and trained by Scipio Africanus that the Carthaginians were eventually defeated at the battle of Ilipa (206 B.C.) and annihilated at that of Zama (202 B.C.). At Ilipa Scipio defeated Hasdrubal by a double envelopment carried out by infantry and cavalry, and at Zama he smashed Hannibal by holding him in front with infantry and striking his rear with cavalry. (*See* PUNIC WARS.)

During the days of Julius Caesar, the most serious defeat sustained by the Romans was that of Crassus at the hands of Surenas, the Parthian general, whose entire force was composed of mounted archers and heavy cavalry. The Parthians, adopting an improved form of Scythian tactics, won a decisive victory in the battle of Carrhae (53 B.C.); of the 40,000 Romans who crossed the Euphrates, 20,000 were killed and 10,000 made prisoners. The Parthian success resulted from the inability of the Romans to develop offensive power from a moving base. Their organization did not enable them to ward off shock and envelopment, while that of their enemy did permit enveloping and charging. In this battle the heavy Parthian cavalry provided the necessary stability for the attack of their mounted bowmen, and the distraction effected by this attack enabled the heavy cavalry of the Parthians to dislocate and disrupt the Roman legions.

From the battle of Pharsalus (48 B.C.) the legion learned for a time how to hold its own against cavalry, mainly by employing cavalry. Under Diocletian (A.D. 245–313) cavalry rose from one-tenth to one-third of the infantry, and numbered about 160,000; but this great mass of horsemen was withdrawn from the infantry, and by being formed into a frontier guard lost its offensive spirit. Meanwhile a steady decline took place in the infantry. Mercenaries were enlisted, discipline was relaxed, pay increased and armour discarded because of its weight. Of the latter Vegetius wrote: ". . . to avoid fatigue, they allow themselves to be butchered shamefully like cattle."

This separation of infantry and cavalry was the main tactical cause of the decline of Rome's military power. The unsupported Roman cavalry, trained as frontier police and for protective duties, was no match for the fierce barbarian horsemen who were then harassing the empire. From the first irruption of the Goths, in the year 248, the Roman cavalry was steadily increased until by the reign of Constantine (288–337) cavalry composed the principal part of the Roman armies; but all in vain. At Adrianople (*see* EDIRNE) in 378 three Roman legions sent against the Visigoths were overwhelmed and practically annihilated. The Gothic horsemen, having perfected a newly devised stirrup, rode and fought with a vigour and deadliness new to the mounted warrior. Caught massed under a blazing sun, the Roman flank was struck relentlessly by the Gothic horse, and again the dislocation of the Romans, which heralded their disruption, was effected by a cavalry rear attack. The emperor Valens lost his life, and 40,000 legionnaires perished. From that day cavalry was to become the predominant arm for a thousand years, while the infantry deteriorated into a mere auxiliary.

In Europe the hardy and warlike barbarian tribes, fighting chiefly on horseback, soon flooded the Roman provinces. By A.D. 410 the Goths under Alaric captured Rome, and the "mistress of the world" was handed over to the licentious fury of the Huns. The barbarian advance culminated in the battle of Chalons (451), where Attila, after uniting Germany and Scythia, was met and defeated by Aetius and Theodoric. This was the last victory won by imperial Rome in the west; the dark ages descended upon western Europe, and in the conduct of war that area entered the epoch of the iron-clad lancer.

The Dark Ages.—From the days of Justinian (483–565) to those of the fourth crusade, which resulted in the sack of Constantinople (1204), highly organized armies comprising well-equipped heavy and light cavalry were maintained by the eastern empire. In Africa, Belisarius in 533 won the decisive victory of Tricameron (*q.v.*) over the Vandals primarily by the use of cavalry. In the west, however, military art virtually disappeared, and as principalities took form and feudalism was established the common folk were virtually prohibited from taking part in the "noble" trade of war, which was carried on by raiding and pillaging barons. Cavalry remained the predominant arm and sought perfection not through improved tactics or organization but through armour. By the opening of the 9th century the old military organization of Rome had been replaced by comparatively small bands of mailed knights followed by a mob of retainers who pillaged the countryside. In England, in the Low Countries and in Switzerland infantry was still maintained but was so ill-equipped that when confronted by cavalry in open or even semiopen country it was forced to seek protection behind palisades, as was the case with the Saxons at Hastings (1066).

To the knight of the middle ages the protective base of his offensive power was not the infantry mass, as it had been with the Romans, but the armour he wore, his mobility being provided by his horse. (*See* ARMOUR, BODY.) As long as he was not met by equally well mounted and armoured antagonists this combination of mobility and protection proved tactically irresistible, though seldom did it lead to profitable strategical results. But as soon as he was so met, it became neutralized; tactics then were utterly deteriorated and were replaced by mob fighting.

The Crusades.—The self-contained protective power of cavalry was demonstrated during the crusades, for in spite of the poor discipline of the Christian knights and their very rudimentary knowledge of tactics, normally their casualties were remarkably small. At the battle of Hazarth (1125), Baldwin lost only 24 men, while the Turkish losses amounted to 2,000; at Jaffa (Joppa) (1191) 2 crusaders were killed on one side and 700 Turks on the other. The crusaders, however, lost large numbers of horses, and as the rabble of beggars and vagrants who accompanied them were useless as infantry (further, the code of chivalry did not sanction their use), at times it became necessary for knights to fight on foot or to abstain from fighting altogether.

This involuntary change in tactics caused the crusaders to rediscover the value of the protective infantry base as a mobile fortress from which mounted knights could sally forth. In 1248 Louis IX of France adopted this change intentionally. Near Damietta he landed his knights and drew them up on foot in order of battle to cover his disembarkation. The interesting point to note in these operations is that the action of these knights foreshadowed the approaching revival of infantry: "They formed up in serried ranks, placed their bucklers upright in the sand before them, and resting their long lances on the top of their shields, presented an impenetrable array of steel points, before which the Muslim horse fell back in confusion."

Another trend during this period was the reintroduction of plate armour. It rendered the knight on foot practically invulnerable to infantry attack, but when he was mounted it sacrificed his mobility to protection. This seriously influenced the value of the dismounted base, for armour had become so heavy that the dismounted knight was unable to move far on foot. At the battle of Tagliacozzo (1268), Conradin's Ghibelline knights were so heavily armoured that Charles of Anjou's cavalry, after having exhausted them by repeated charges, rolled them out of their saddles by seizing them by their shoulders.

Mongol Cavalry.—With signs of cavalry power diminishing in the west, there appeared in the east the highest development of the mounted warrior. In the latter part of the 12th century there arose on the plains of Mongolia the most formidable cavalry warrior of human annals, Genghis Khan (*q.v.*). Utilizing the horsemanship and spirit of conflict which permeated the character of his people, he created vast organized mounted hordes that swept the entire northern and eastern areas of Asia. It is alleged that a mounted force of 700,000 men, held together by iron discipline, rode to his will. Death was the penalty for turning back during action without an order or for neglecting to pick up equipment dropped by a front-file man. The khan recognized the powers of co-ordinated and disciplined cavalry. Vigilant and ceaseless training perfected a standard for tactical measures. "A man of my bodyguard," Genghis Khan had announced, "is superior to a regimental commander of another division."

The tactical skill of the Mongols had been developed in the stress of war. They had learned to keep track of an enemy's movements while concealing their own. In maneuver for battle they had learned not to depend on commands given by a voice, which often cannot be heard in the uproar of moving mounted men. Regiments signaled their movements by raising black or white flags during the day and by a similar use of coloured lanterns at night. Other signals were given by the use of whistling arrows, which emitted sound through a hollow pierced head. They hid their formations at times behind a drifting smoke screen. The Mongol hordes, unlike the crusaders, formed movements of deadly intensity by virtue of their disciplined co-ordination. Followed by immense trains of wagons and great herds of cattle, they could exist for years off the country invaded. They fought mainly with arrows, avoided close struggle and strove to destroy their enemies from afar with projectile weapons. There was a fluidity and flexibility in their movements found wanting in the fixed, cumbersome ranks of European forces.

After the death of the great khan, 150,000 Mongols under the able Sabutai in 1235 marched westward and threatened to conquer all of Europe. In the next six years this enormous horde had marched one-fourth the distance around the world. Sabutai swept through present-day Russia and on to the plains of Hungary and Poland. Eastern Europe from the Carpathians to the Baltic fell under his domain.

Armour and Archery.—The leaders of western Europe learned little concerning the capacity of highly mobile cavalry in great numbers presented to them by the Mongolian mounted men. They continued to increase the thickness of their armour, largely because of improvements in the longbow and the crossbow.

At the siege of Abergavenny, in 1182, it is recorded that Welsh arrows could penetrate an oak door four inches thick. As no chain mail could withstand such a blow, plate armour was worn over the mail shirt. But as armour increased in weight, natural obstacles began to play a decisive part on the battlefield. When ground could not be crossed on horseback it had to be crossed on foot, and the knight deprived of his horse lost much of his tactical value; consequently an able enemy sought every means in his power to compel him to dismount. One of these means was choice of ground; another was archery.

At the battle of Dupplin (1332), Edward Balliol and Henry de Beaumont defeated the earl of Mar not by reckless charges but by skilful weapon co-operation. The majority of their knights were dismounted and formed into a phalanx, their flanks protected by archers, while 40 mounted knights were kept in reserve. The earl of Mar charged the phalanx, which remained unshaken; his knights, immobilized by the archers on the flanks, were routed by Balliol's mounted squadron. This battle was the birth of a new era in tactics —the tactics of bow, pike and lance combined. It formed the mold in which all the English operations of the Hundred Years' War were cast, a war which proved disastrous to the French chivalry, as the battles of Crécy (1346), Poitiers (1356) and Agincourt (1415) testify.

Providing suitable protective armour for horses proved to be an insurmountable problem for the cavalry. At Crécy (where gunpowder was first introduced) the horse proved the weak link in the French organization. Of Poitiers, the next great battle, Jean le Bel wrote of the French knights: "All fought on foot, through fear that, as at the battle of Crécy, the archers would kill their horses."

Meanwhile in Switzerland infantry armed with pike and halberd, fighting in phalangeal order, were taking toll of German and Austrian cavalry; and in Bohemia, Jan Zizka employed wagons to create a movable fortress known as the *Wagenburg* ("wagon fort"), against which his enemy's cavalry shattered itself in vain. As wealth increased, mercenaries once again came to the fore. Being professional soldiers whose pay as well as whose lives depended on their art, they developed sound tactics.

From the battle of Poitiers onward cavalry fell into a rapid decline. The French knights learned nothing, and as the bow and pike destroyed them a new weapon arose in the crude bombards of the 14th century which was destined to revolutionize the whole art of war, to reduce cavalry to the position it held in the days of the Scythians and to advance infantry to the heyday of the Spartan phalanx. At the battle of Formigny (1450), three small culverins threw the English archers into disorder, and at Morat (1476) Charles the Bold of Burgundy was defeated by the Swiss who made good use of 6,000 hand guns.

Cavalry in the Age of Gunpowder.—For 1,000 years cavalry had sought to combine protection and mobility. When this was no longer possible, because armour could be penetrated by the bullet, a solution was sought by arming the cavalry with firearms. Armour grew lighter and the knight exchanged his lance for the petronel, a type of hand cannon, in order to fire on infantry in place of charging them. This form of attack was used by the French at the battle of Cerisoles, in 1544, and proved effective because the attack could be prolonged indefinitely. Against such organized Scythian tactics the infantry was powerless until the arquebus was improved. Soon the petronel was replaced by the arquebus-à-rouet, and a little later by the wheel-lock pistol, said to have been used by the German cavalry at the battle of St. Quentin in 1557. (*See* SMALL ARMS, MILITARY.)

The lance then vanished, and attempts were made to develop cavalry mobility by mixing squadrons with infantry units. As early as the battle of Pavia (1525), the marquis of Pescara had adopted this organization, and though in a clumsy way it linked firepower with shock, the mobility of cavalry was so limited by the pace of the infantry that the cavalry attack was reduced to a walk. About 1550, Marshal Charles de Brissac mounted a number of his infantrymen on horseback, and the era of the modern dragoon, or mounted infantryman, was initiated.

During the Thirty Years' War (1618–48) the employment of cavalry increased, cavalry mobility being sought not through its own firepower but through that of infantry, and especially artillery. Supported by artillery, Gustavus Adolphus' cavalry rode forward, fired their pistols and charged home with the sword. At Breitenfeld (1631) and at Lutzen (1632) his cavalry played the decisive part. In England he was emulated by Oliver Cromwell—the battle of Grantham (1643) was decided by the sword, as were Marston Moor (1644) and Naseby (1645). In France the reversion to shock tactics was also followed as Henri Turenne issued instructions to his cavalry to use the sword alone. The impetuous prince de Condé did likewise. In Germany, however, Raimund Montecuccoli still favoured firearms for cavalry; he considered the lance useless and looked upon the horses of his dragoons solely as a means of conveyance.

This change is significant and cannot alone be attributed to the genius of such cavalry leaders as Gottfried Pappenheim and Gustavus. The underlying reason for it is probably to be found in the universal adoption of the matchlock and the consequent reduction in the number of pikemen. The matchlock was a slow-loading and unreliable weapon, especially in rainy weather when infantry was likely to be surprised in mist or fog. It was on such occasions that cavalry frequently proved itself the decisive arm, up to the adoption of the percussion cap in the 1830s.

During the 18th century the idea of the shock effect of cavalry continued to grow. The duke of Marlborough used cavalry in mass. Blenheim (1704) was decided by cavalry, and so was Malplaquet (1709).

Under Frederick the Great, cavalry once again reached its zenith. Out of 22 of his battles at least 15 were won by the cavalry arm working in close co-operation with gun and musket. In his regulations for cavalry Frederick wrote: "They will move off at a fast trot and charge at the gallop, being careful to be well closed together. His Majesty will guarantee that the enemy will be beaten every time they are charged in this way." The exploits of F. W. Seydlitz and H. J. von Zieten proved that Frederick was not wrong. Rossbach (1757) was a great cavalry victory, and so, in a lesser degree, was Zorndorf (1758). The secret of Frederick's success lay not only in the artillery preparation which heralded the charge nor in his system of attack but in the training of his troopers.

The American Revolution (1775–81) provides no example of outstanding cavalry work, nor do the French Revolutionary Wars, except for the brilliant charge of the English 15th hussars at Villers-en-Couché (1794), where 300 British and Austrian cavalry charged and routed 10,000 French infantry and cavalry, driving them into Cambrai with a loss of 1,200 men. The slowing down of the shock first became perceptible in Napoleon Bonaparte's campaign in Egypt, when the world-famed mameluke cavalry failed to make any real impression on his infantry squares. At Mt. Tabor (1799) 6,000 French infantry under Jean Kléber gained a decisive victory over 30,000 Turks and mamelukes. From that battle onward to World War I the power of cavalry steadily declined.

The Napoleonic Wars.—Napoleon relied on all arms, but particularly on firepower. In spite of the many cavalry charges executed during his wars, his cavalry was pre-eminently a strategic force for observation and protection and a tactical force for pursuit. Because of his strategic employment of cavalry, no commander was ever more completely informed at all times of the movements and composition of the hostile army than was Napoleon.

His early maneuvers, conceived after careful synchronization of time and space factors, were made practical by skilfully led cavalry. Far-flung columns, well in advance of his main armies, not only kept him posted of hostile movements but were influential in maneuvering an enemy into an area of Napoleon's own selection. Once contact was gained by main bodies, the cavalry invariably was withdrawn to the flanks or to the rear in reserve. While mounted charges were executed, they were made at that period in battle when the enemy was shattered by fire and the keen discernment of Napoleon foresaw conclusive results. From the flanks and rear his cavalry was able to deliver the decisive thrust or to pursue a routed enemy, which meant destruction rather than an orderly retirement and the ability to fight again after reconcentration and reorganization. At Eylau (1807) Napoleonic cavalry, encountering the Russian Cossacks, was confronted for the first time by a mobile element of its own quality; pursuit proved impossible, and strategic reconnaissance ineffective.

In the emperor's subsequent campaigns of 1812–14, superior enemy cavalry nullified any real victory, and in the retreat from Moscow was responsible mainly for the gradual disintegration of the Grande Armée. The freedom of maneuver, the basis of Napoleon's success, had been reversed.

The Napoleonic Wars were followed by 40 years of profound military coma. In 1823 Capt. John Norton of the 34th English regiment invented the cylindroconoidal bullet. He received no encouragement, for the duke of Wellington considered that the Brown Bess could not be bettered, yet Norton's bullet was the greatest military invention since the flintlock. In 1849 Capt. Claude Minié, of the French army, invented a rifle and a similar projectile. In England Sir William Napier opposed the adoption of the new bullet, as he considered that it would destroy the infantry spirit by turning infantry into "long-range assassins." It was adopted, however; it had a range of 1,000 yd., and it sealed the doom of the cavalry charge.

The Crimean War (1853–56) taught soldiers nothing new regarding cavalry except to emphasize its misuse by ill-informed commanders of combined arms and to demonstrate the gallantry and spirit of the arm. The battle of Balaklava gave to the world only the famed epic of the charge of the Light brigade and evidence of the courage, discipline and combative will to close with an enemy so characteristic of the British mounted warrior. (*See* BALAKLAVA, BATTLE OF.) (J. F. C. F.; J. K. H.; X.)

The Mounted Rifleman.—In the American Civil War (1861–65), a pronounced transition in cavalry tactics took form. The evolution of its tactics switched radically from the accepted European tenets of that day. The Confederate states, largely rural and agricultural, were able to create promptly a powerful mounted force to be used in cavalry roles. The Union, largely of urban population, organized cavalry at a slower pace and employed it, at first, on the futile assignments of outpost, convoy, messenger and other associated activities. Employing cavalry in large units, Robert E. Lee was able to reap the benefit of decisive victories during the first two years of the war. His own intentions were always screened from the enemy, while their movements and dispositions habitually were known to him. By May 1862 the Union, finally awake, assembled 10,000 horse into a cavalry corps. At Chancellorsville (*q.v.*) this formidable cavalry force was dispatched southward on a useless raid. Lee's cavalry, under Gen. J. E. B. Stuart, discovering an open flank on the Union right, skilfully screened the movement of Gen. "Stonewall" Jackson's corps, which launched a powerful surprise attack resulting in one of the most complete victories of Confederate arms.

By 1863 cavalry tactics on both sides had become concerned principally with dismounted action, which proved so effective that the mounted charge was a rarity thereafter. The eventual defeat of Lee was made possible in part through the able employment of a highly mobile cavalry and infantry force under Gen. Philip Sheridan. Repeated attacks against the Confederate lines of supply effected their dislocation by depriving them of a protected base. Increased power of weapon fire forced a new development of the cavalry dragoon or mounted rifleman—not to be confused with mounted infantry, which utilized horses only as transportation and habitually fought dismounted; the mounted rifleman was trained and equipped to fight either dismounted or mounted. The revolver, introduced in this war, proved to be a formidable cavalry weapon.

Both before and after the Civil War, from the early 1830s until 1890, as settlement moved westward, U.S. cavalry forces were employed to protect the expanding frontiers from the American Indian, the Mexican raider and the American bandit. The thinly held outposts were kept constantly on the move.

The wars that occurred in Europe after 1865 were marked by a complete disregard of the cavalry lessons learned from the American Civil War. The Austro-Prussian War (1866) saw 56,000 cavalrymen still armed with the lance and sabre charging in the face of the breech-loading needle gun and the Minié rifle. In the Franco-German War (1870–71) a cavalry force of 96,000 took the field similarly equipped. Its tactics called only for mounted action. French cavalry had learned nothing since Waterloo. The Germans were bold and resourceful, using their cavalry strategically with good effect to cover their own movements and to discover those of the enemy. The massed charge was attempted—Jean A. Margueritte failed, Adalbert von Bredow succeeded, but at terrific cost. His was the last successful massed boot-to-boot cavalry charge in military history.

Theodore Roosevelt and his Rough Riders were not only overpublicized during the Spanish-American War in 1898 but were credited with gaining valuable ground through mounted charges which never actually took place. For example, at the charge up San Juan hill the only man mounted was Colonel Roosevelt.

In South Africa (1899–1902) the Boers, accepting the lessons of the American Civil War, fought with large numbers of mounted riflemen who moved hither and yon, came and went, attacked and retired almost at will. The British faced this type of action initially with a force in which infantry predominated. The few cavalry regiments included were armed with swords or lances and depended mainly on these weapons for combat. Not until British mounted elements were reorganized on a dragoon basis were the British able to conquer a people immeasurably their inferior in numbers and resources.

In the Russo-Japanese War (1904–05) cavalry action of little consequence occurred. The outstanding note was the absence of the lance and sword, which were nowhere seen. In combat the rifle was supreme; any thought of reliance on the sword was banished. The few achievements of Russian cavalry in this war came through the effect of firearms. Little use was made of the cavalry masses which Aleksei Kuropatkin organized and equipped on the European model of massed action. Japanese cavalry, with few exceptions, carried out its duties with the carbine (a shortened rifle) and usually in close touch with its own infantry.

World War I.—During World War I, little use was made of the potential power of cavalry available to both sides. The limitations which the bullet placed on cavalry movement begot the trench; for had cavalry been able to move, the construction of entrenched fronts would have been all but impossible. On the western front, ten German cavalry divisions (approximately 70,000) faced ten French cavalry divisions and one British. The tool was there for the appearance of a master of the art of war capable of visualizing the power and capabilities of a numerous cavalry on missions of inspired and skilful design. There was need for mounted riflemen, not the European cavalry of that day relying principally on the sword and lance in mounted action. The French cavalry was split into useless detachments. The only sizable force, under Sordet, was marched futilely over the whole of southern Belgium and northern France; his operations availed nothing. The single British cavalry division, operating collectively as a unit, rendered invaluable assistance to the main forces by employing ground fire to delay the German advance south of Mons until reorganization behind it was effected. While its grand plan conceived a powerful enveloping thrust southward through northwestern France, the Germans made little use of the potential power of their cavalry to aid that operation. Their mounted forces were scattered over the fronts of several field armies rather than assembled for a decisive effort.

On the eastern front, Russia produced initially 24 cavalry divisions (approximately 200,000 horsemen), but like the leaders of ancient Rome the Russian commanders expended the potential power of this force by scattering it along an entire frontier. The armies of Alexander Samsonov and Paul Rennenkampf invaded East Prussia with forces totaling 400,000 combined arms to meet the most crushing defeat of the war at Tannenberg. The decisive victory of the Germans was made possible largely by the success of a single German cavalry division in delaying the army of Rennenkampf.

Later Russia increased its cavalry to 54 divisions; but with military leaders unable to cope with the requirements of massed co-ordination, this vast force accomplished little. It was, indeed, the indirect cause of breaking down the transportation system of the country by the requirements of forage.

Cavalry achievements in this war reached their highest plane in Palestine under Marshal Edmund Allenby, an outstanding commander of mobile troops. At Armageddon, Sept. 1918, Allenby faced a strong Turkish army with a superior force of combined arms including three cavalry divisions and bombardment aviation. Crushing the enemy right, he dispatched his cavalry not against the hostile flank but against the rear. Fleeing Turkish elements crowded into the ravines and defiles which characterized the terrain. Halted and confused by combat aviation, they were annihilated when struck by the charging cavalry columns. The lesson of Armageddon lay not so much in the prowess of ground mobility as in the example of the formidable power of such forces when supported by fire from the air.

Four years of stabilized warfare on the continent of Europe contributed little to the concept of cavalry tactics, but a wholly new element came into the picture with the tank and other motor vehicles. After the war, armoured divisions were formed to include all supporting arms needed in modern warfare: infantry, artillery, signal, engineers, etc. These divisions were organized for missions requiring independent action, using great mobility and firepower. They had to win their way against bitter opposition by cavalry enthusiasts and at the same time develop their tactics and improve their equipment, which included tanks, armoured cars and trucks.

World War II and After.—Cavalry tactics and traditions lived on in the dashing advances made by armoured units in World War II, but the day of horse cavalry had passed. The United States army employed only one cavalry regiment, and that was during the early weeks of the war in the vain defense of the Philippine Islands. The reorganization of the U.S. army that took place in March 1942 abolished the office of chief of cavalry and greatly strengthened the air force and the newly created armoured force. The British army had earlier taken similar steps. The U.S.S.R. employed 39 divisions of horse cavalry to advantage in special situations where terrain features were unfavourable for armoured vehicles. But at no time in World War II or in the Korean war was cavalry the decisive factor it had been in earlier ages, and in most campaigns it played no part at all. In view of climatic and geographic conditions in the European republics of the Soviet Union, the Caucasus and especially in Turkestan and the far east, conventional cavalry divisions were maintained in the U.S.S.R. during the 1950s. However, a high proportion of the World War II divisions were superseded by mechanized formations. In spite of a few dissenting voices, most military men were in agreement after World War II that horse cavalry was obsolete.

See ARMY; TANK; *see* also references under "Cavalry" in the Index volume.

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(J. K. H.; C. W. He.; W. H. Z.)

CAVAN (Cabhán), one of the three counties of the old province of Ulster (*q.v.*) which are part of the Republic of Ireland, is bounded on the northeast by County Monaghan, southeast and south by Meath and Westmeath, and southwest by County Longford, while the long northwestern spur of Cavan runs between County Leitrim and the Northern Ireland frontier, on the other side of which is Fermanagh. The land area is 728 sq.mi. In 1961 the population of the county was 56,597, compared with 243,158 in 1841. Three-quarters live outside villages and towns, of which the largest are Cavan (3,207), the county town, Cootehill and Belturbet. Administration is by a county manager advised by an elected county council. The diocese of Kilmore, resembling the ancient kingdom of Brefni, has a Roman Catholic cathedral in Cavan and a Church of Ireland cathedral in the parish of Kilmore. County Cavan returns four members to *dail eireann* (house of representatives).

In the northwest is part of the Carboniferous upland stretching from Sligo to Monaghan, consisting of sandstones, shales and limestones with plateaulike upper surfaces rising to at least 1,500 ft. (Cuilcagh mountain, 2,188 ft.). The uplands are intersected by deep valleys, such as those of the river Swanlinbar and Lough Macnean. As the uplands cease toward the main valley, that of the Erne, the landscape becomes dominated by the drumlins which alternate with lakes, rivers, peat bogs or drained lowland pastures. On the east of the Erne valley the countryside is floored by Ordovician and Silurian shales and slates, which form lines of hills rising to 1,100 ft. There, too, however, the drumlins persist as low whale-backed hills, and in the hollows there are countless lakes, some covering several square miles, others mere ponds, while yet others have been completely infilled by silt; probably all have been substantially reduced by this means. Around Kingscourt, in the east, some Triassic rocks are exposed, including a clay used for brickmaking and a gypsum deposit used for wallboard and plaster. The winters are mild with January average temperatures of 40°–41° F. and July averages of 57°–59° F., with 30–40 in. average annual rainfall.

The farms are mainly small or medium-sized, averaging 30–40 ac. Of the improved land about one-tenth is used for crops, chiefly oats and potatoes, one-fifth for hay and the rest is pasture. Cattle are raised for meat and milk. County Cavan shares the Ulster tradition of home industries and flax processing, but, although flax growing was revived during and after World War II, little was being grown in the early 1960s. In Cavan there is a bacon factory, while creameries are scattered through the countryside. The towns are market centres with some small industries, such as shoe factories at Belturbet and at Bailieborough, where there is also a sawmill. Near Cootehill there is an estate now largely forested.

Main roads converge on Cavan from Belfast, Dublin and Athlone, but the railway line from Belfast through Cavan to Inny junction and the light railway through Belturbet to Arigna are now only used for freight. (T. W. Fr.)

History.—The Cavan district is mentioned in accounts of the life of St. Patrick where it is told how the saint found on the plain of Moyslaught an idol called Crom Cruaich (said to be the chief god of Ireland and worshipped with human sacrifice) surrounded by twelve other idols. Moyslaught was near the village of Ballymagauran on the Leitrim border of Cavan. Cavan formed part of a kingdom of Brefni (this name is given a varied range of spellings) which included Leitrim. At Croaghan, near Killeshandra, successive chiefs of the O'Rourkes were inaugurated as princes of Brefni. In later times Cavan, or east Brefni, became distinctively Brefni O'Reilly; and Leitrim, or west Brefni, became Brefni O'Rourke. Brefni long resisted penetration by Anglo-Norman adventurers; and the O'Reillys of Cavan were not permanently brought under English rule until the Ulster war at the close of the reign of Elizabeth I. Although previously regarded as part of Connaught, Cavan was designated part of Ulster in the reign of James I and was brought within the scheme for the Plantation of Ulster in the years following 1608. The chief incoming landlords were English and Scottish in about equal numbers.

(Hu. S.)

See Philip O'Connell, *The Diocese of Kilmore* (1937), *The Schools and Scholars of Breiffne* (1942).

CAVAN (Cabhán, "The Hollow Place"), an urban district and county town of County Cavan, Republic of Ireland, 85½ mi. N.W. of Dublin by rail. Pop. (1961) 3,207. Cavan was the seat of the O'Reilly chieftains whose principal residence was on Tullymongan hill. O'Reilly of Breifne (d. 1491) and Owen Roe O'Neill (d. 1649) were buried in the Franciscan friary founded in 1300 by Giolla O'Reilly, of which only the belfry tower remains. In 1690 the town was sacked by Gen. William Wolseley's Enniskilleners who defeated James II's troops under the duke of Berwick. Cavan is the seat of the Roman Catholic diocese of Kilmore, which includes parts of counties Leitrim, Fermanagh, Meath and Sligo; its modern Romanesque cathedral was dedicated in 1942. The town has some linen trade.

CAVATINA, a musical form, the diminutive of *cavata* (from the Italian *cavare*, "to dig out"), which in early 18th-century cantatas, notably those of J. S. Bach, was a short, epigrammatic vocal piece following the recitative and preceding the arioso. The cavatina is an operatic song, of which there are examples in the operas of Mozart, Weber and Rossini, generally of brilliant character and in one or two sections but without repetition. The term was also used as a title of songlike instrumental works, such as one movement of Beethoven's string quartet opus 130, and a violin piece by Joachim Raff.

CAVE, EDWARD (1691–1754), English printer and founder of the first English magazine, was born at Newton, Warwickshire, Feb. 27, 1691. He entered the grammar school at Rugby, where his father was a cobbler, but was involved in pranks which cost him the headmaster's favour and the hope of proceeding to the university. After many vicissitudes he became apprentice to a London printer and was sent to Norwich to conduct a printing house and weekly paper. While engaged in printing and journalism, he obtained employment in the post office (1723) and presently a clerkship of franks, retiring only in 1745. He meanwhile undertook the exchange of news between London and provincial papers. In 1728 he was implicated with others in a charge of breach of privilege. In 1731 he bought a printing house and set up a press at St. John's Gate, Clerkenwell, and launched the *Gentleman's Magazine* (*see* Periodical), of which he remained proprietor during his lifetime, editing it under the pseudonym of Sylvanus Urban, Gent. This, the first magazine of modern type, was modeled on Pierre Motteux's *Gentleman's Journal* (1692). It offered extracts and abridgments from the contemporary press, "with some other matters of Use or Amusement that will be communicated to us." In 1732 he began to issue from surreptitious and often scanty reports accounts of the debates in both houses of parliament, and in 1738 was censured for printing the king's answer to an address before it had been announced by the speaker. Thenceforth the debates appeared as those of the "senate of Great Lilliput."

In 1747 he was reprimanded for publishing an account of the trial of Lord Lovat and discontinued the reports, beginning afresh with brief accounts of transactions in parliament in 1752.

From Cave Samuel Johnson got his earliest regular literary employment, on these debates and in other writing and editing. Cave was, moreover, concerned in the publication of several of Johnson's works besides those which appeared (in whole or in part) in the magazine: notably, *London*, the *Life of Savage*, *Irene* and the *Rambler*. On his death in London, on Jan. 10, 1754, Johnson wrote a sympathetic obituary notice.

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(M. M. Ls.)

CAVE, a cavity in rock large enough for human entrance and traverse. Cavern is nearly synonymous, but generally means a large cave or a large connected group of caves. A rock shelter is a cave whose mouth is the largest cross section of the cavity and whose roof has adequate projection out over the floor. Collapse of part of the cave roof to make a hole completely through to the surface constitutes one common type of sinkhole, a cave without a roof.

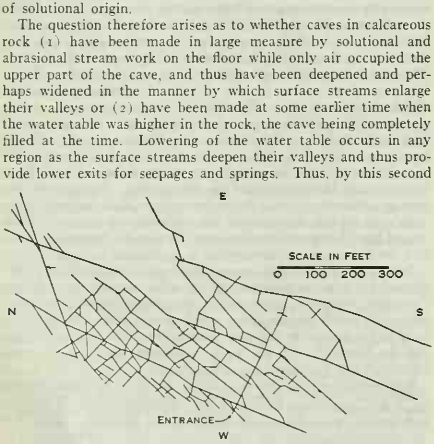
Origin.—Caves may originate with the making of the rock which encloses them or they may be secondary to the rock making. To the first group belong caves in congealed lava flows, made generally by freezing of the surface of the lava stream while the deeper portion remains liquid and continues to flow. Failure of supply under these conditions may allow the fluid lava to drain out and leave a linear hollow tube perhaps tens of feet in diameter.

Most caves belong to the second group, having been made by removal of material after the enclosing rock was made. Some of these occur along exposed coasts where mechanical erosion occurs under vigorous wave attack. These sea caves are not limited to any particular kind of rock and they lack marked linearity and subterranean extent. Rock shelters commonly are the result of crumbling and falling away of weak rock on a hillside beneath stronger rock which forms the roof.

Limestone and Dolomite Caves.—These rocks contain the largest caves and the largest number of caves of the earth's surface. They are all secondary, having been made by the solvent action of circulating ground water. These calcareous rocks, slightly soluble in pure water, are more rapidly attacked if the water has brought organic acid or carbon dioxide down from the surface in it. The circulation occurs chiefly along the usually horizontal bedding planes and the commonly vertical joint cracks, the water moving under gravity to lower levels and to eventual escape as springs and seepages. The sides of these primitive passages are attacked and the dissolved material removed; thus enlargement results. From perhaps a multitude of such early water routes, integration of the subterranean water system proceeds by greater enlargement of more favourably located routes and abandonment of less favoured ones.

Limestone and dolomite caves have been discovered in well drillings below the water table (upper level of saturated rock) and therefore completely filled with water. Some caves are enterable in dry weather only, being completely filled during the rainy seasons. Many are traversable at all times, although they carry perennial streams on their floors. Some lack streams entirely, but possess shapes and wall sculptures that indubitably are of solutional origin.

The question therefore arises as to whether caves in calcareous rock (1) have been made in large measure by solutional and abrasional stream work on the floor while only air occupied the upper part of the cave, and thus have been deepened and perhaps widened in the manner by which surface streams enlarge their valleys or (2) have been made at some earlier time when the water table was higher in the rock, the cave being completely filled at the time. Lowering of the water table occurs in any region as the surface streams deepen their valleys and thus provide lower exits for seepages and springs. Thus, by this second view, enterable limestone and dolomite caves, with streams on their floors, are going through a second episode in their development. They are still water routes, but their enlargement now is occurring only in the basal portions.



PLAN OF MARK TWAIN CAVE, HANNIBAL, MO.

An outstanding example of a cave system in which the ground plan was determined entirely by vertical joints and in which development occurred almost wholly below an earlier, higher water table

The many caves possessing solutional shapes on their ceilings seem to require, for their origin, a tube-full flow, like that of a water main. The ground plan of many caves suggests the street system of a city, a multitude of narrow, linear, intersecting passages having been developed along two or more sets of nearly vertical joints in the rock. This lack of integration into one main water course with tributary courses argues strongly for origin in the saturated zone below the water table.

There are many horizontally extended caves under hills whose catch of rainfall never could have provided the ground-water flow recorded and whose directional control of any ground-water circulation does not fit the cave pattern. Such caves must be older than the hills and valleys of the region and are therefore judged to be products of the second method of origin.

A limestone or dolomite cave therefore is, or once was, a subterranean water course, its length far greater than its width or height. During a large part of its development it functioned like a pipe line, the flow occurring under hydrostatic conditions. After lowering of the water table, the cave became more like a roofed valley, with a free surface stream on its floor for a time, perhaps to the present.

Secondary Deposits.—Most enterable caves have ceased to grow larger; instead, they are suffering decrease in size from the secondary deposition of calcium carbonate in the form of travertine and stalagmites on the floor, draperies and curtains on the walls, and stalactites on the ceiling. The deposited material has been obtained from the roof rock by downward percolating rain water since air came to occupy the cave. To these secondary growths caves owe much of their beauty and most of their interest to the average visitor. Forms of the deposits are extraordinarily varied, chiefly in vertical dimensions, and fancy sees in them an almost unbelievable range of resemblances to forms already in the beholder's experience. The usual pure white of the calcium carbonate may be mottled and shaded with delicate hues of red, yellow and gray. Translucency may characterize some of the deposits and lend added charm.

Primitive Shelter.—Primitive man in all lands has utilized the natural shelter provided by caves, the rock shelter type having been his favourite. His tools, weapons, ornaments, hearths, the bones of his kills, even his wall pictographs and paintings have provided archaeologists with so much information that "cave man" has become a popular term for our early ancestors (*see* ARCHAEOLOGY: *Prehistory*). Ice Age (Pleistocene) extinct carnivores—cave bear, cave lion, cave hyena—also used available caves south of the ice sheets of Europe and North America as refuges and dens, their remains being preserved in earthy floor deposits and beneath secondary floors of travertine.

(J. H. Bz.)

Regions Famous for Caves.—The most famous cave area in the world is probably that which lies in the calcareous Alps of central and southern Europe stretching from France through Switzerland and Austria to Yugoslavia. In this area are found the deepest caves yet descended by man, the Gouffre Berger, near Grenoble, France (3,680 ft.); the world's longest surveyed cave, the Hölloch in Switzerland (more than 37.6 mi.); and some of the world's largest caverns, notably the Elizabeth Casteret cavern in the French Alps (1,300 ft. long, 500 ft. wide and over 150 ft. high). Many caves also contain glacier ice, such as the Eisriesenwelt, near Salzburg, Aus., which is a series of ice caves more than 25 mi. long and at a height of 5,400 ft. The great size and depth of the Alpine caves is due to the highly faulted limestones and to solution caused by the rainy and snowy climate.

In southwestern Europe the outcrops of limestone are less extensive than those in the Alps, and the caves are smaller and horizontal rather than vertical in type; stalactites and stalagmites are usually insignificant, though Aven Armand and Padirac, in the Causses (*q.v.*) of southern France, are exceptions. The Mediterranean regions contain some fine caves, especially in the

Rock of Gibraltar, in Malta and in Lebanon; these caves are now mainly dry, and were probably formed under more pluvial climatic conditions.

In the United States the most famous cave areas are in Kentucky, Missouri and New Mexico. The Mammoth cave and its neighbours, the Flint Ridge (Floyd Collins, Crystal) caves, possess the world's greatest development of horizontal cave passages, over 150 mi. in all having been explored. The deepest caves in the United States are Neff's cave, Utah (1,186 ft.), and Carlsbad caverns, N.M. (1,320 ft.); both occur in desert regions where they have been formed by deep ground-water solution.

Well-known caves also exist in the Himalayas, in Malaya and Indochina, in South Africa and in Australia (Nullarbor plains). Large caves are numerous in the limestone areas of the humid tropics, and they usually contain much travertine and stalagmite; this is a consequence of the high rainfall and temperatures in these areas. Tropical caves are also renowned for the large numbers of bats which inhabit them, as for example in Windsor cave, Jamaica.

Many of the caves mentioned have been opened up and commercialized and are accessible to the general public.

Speleology.—Speleology is the scientific study of caves from all points of view. It includes the discovery of and the technique of exploration in caves; cave surveying and photography; the study of the geological and chemical problems connected with their origin and development; the physical and meteorological conditions in caves; the study of cave fauna and flora; and the study of cave deposits, both calcareous and noncalcareous, except where these form a series of layers important from an archaeological standpoint. Speleology is thus a complex science, involving a knowledge of many disciplines.

Modern speleology dates from the middle of the 19th century and the first speleological society was founded in France in 1895. Most countries of the world, including the United States and the U.S.S.R., have societies for the promotion of speleology. Great advances have been made in the study of caves since 1930 and the first International Congress of Speleology was held in Paris in 1953. The exploration of the world's deepest caves necessitates the use of many different types of ladders and of complex engineering techniques; camping for long periods underground is frequently essential. Submerged passages at the level of the water table can only be explored by the trained members of cave diving groups. Thus speleology is a "sporting" science, involving certain risks; it attracts many amateurs, sometimes known in the United States as "spelunkers."

The study of speleology has many interesting everyday applications. This is particularly true in the field of hydrology where a knowledge of caves and springs and the movements of underground water are often needed to prevent water pollution. The best-known applications are probably those connected with the tracing of underground water flow; for this, fluorescein, a chemical compound which colours water a vivid green, is frequently used. Countries which possess large areas of limestone terrain, such as France and Yugoslavia, engage trained speleologists to help solve many of their distinctive hydrological problems; speleology has been of use in the settlement of at least one international hydrological dispute (at Casteret).

France, Italy and Yugoslavia all possess biospeleological research stations. At these stations, the biological aspects of caves are given particular attention, including the study of cave-dwelling bats and other animals. *See* articles on various caves, such as FINGAL'S CAVE; FLINT RIDGE CAVE SYSTEM; KENT'S CAVERN; LURAY CAVERN; MAMMOTH CAVE NATIONAL PARK; POSTOJNA; WYANDOTTE CAVE, etc.; *see* also references under "Cave" in the Index. (M. M. SG.)

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CAVEAT EMPTOR, a Latin phrase meaning "Let the buyer beware." It represents a legal rule in the purchase and sale of personal property that the buyer purchases at his own risk in the absence of an express warranty, or unless the law implies a seller's warranty or there is found to have been fraud in the transaction. *See* SALE OF GOODS.

CAVELL, EDITH LOUISA (1865–1915), British nurse, famous as a popular heroine of World War I, was born at Swardeston, Norfolk, on Dec. 4, 1865. She entered the nursing profession in 1895, and in 1907 was appointed the first matron of the Berkendael institute, Brussels (which became a Red Cross hospital in World War I). There she did a great deal to raise the standard of nursing. After the German occupation of Belgium she became involved in an underground group, formed to help English, French and Belgian soldiers reach the Dutch frontier. The soldiers were sheltered at the Berkendael hospital, and provided with money and guides obtained by the Belgian, Philippe Baucq. About 200 men had been sheltered when in Aug. 1915 Edith Cavell was arrested, with several others. They were court-martialed on Oct. 7 and 8 and she was sentenced to death on Oct. 9, after making a full confession. Despite the efforts of the American and Spanish ministers to secure a reprieve, she was shot, with Baucq, in Brussels on Oct. 12. Her execution, on a charge which did not include espionage, was considered outrageous and damaged Germany's reputation among the nonbelligerent countries. Edith Cavell gained wide fame for her courage and sincerity, summed up in her celebrated statement "I realize that patriotism is not enough. I must have no hatred or bitterness towards anyone."

See A. A. Hoehling, *Edith Cavell* (1958).

CAVENDISH, LORD FREDERICK CHARLES (1836–1882), English statesman who was murdered by Irish nationalists in Phoenix park, Dublin, the day after his arrival in Ireland as chief secretary, was born at Eastbourne, Sussex, on Nov. 30, 1836, second son of the 7th duke of Devonshire. His family's position took him into parliament as of right; he was M.P. for the West Riding of Yorkshire from 1865. The year before he had married Lucy, daughter of the 4th Baron Lyttelton. She was Mrs. Gladstone's niece, and Gladstone came to admire and trust Lord Frederick, especially after taking him as private secretary in 1872; he looked to him as the future leader of the parliamentary Liberal party. Lord Frederick held minor office in 1873–74 and was financial secretary to the treasury from April 1880, supervising the bulk of the department's business as Gladstone's financial right-hand man. At the height of the Irish crisis in May 1882 Gladstone asked him to undertake the thankless and dangerous office of chief secretary for Ireland. He crossed to Dublin on the night of May 5. On the evening of May 6 he walked across the Phoenix park with T. H. Burke, the permanent undersecretary. Burke was attacked by a party of Irishmen armed with knives; Cavendish tried to defend him, and both were killed. Four of their assassins, members of a secret society called the "Invincibles," were betrayed and hanged in 1883.

Lord Frederick's widow, who outlived him by 43 years, was a noted philanthropist and greatly influenced Gladstone's decision to remain in politics for the sake of Ireland. Her *Diary*, two volumes (1927), gives a striking picture of the Victorian aristocracy. (M. R. D. F.)

CAVENDISH, GEORGE (1500–1561?), won a minor but lasting reputation through a single work, his *Life* of Cardinal Wolsey, a landmark in the development of English biography, an important document to the student of Tudor history and a rare source of information on the character of the author himself. About 1526 Cavendish entered Wolsey's service as a gentleman usher and remained loyal to him from the height of his power to his rapid fall under the disfavour of Henry VIII. This position of trust afforded Cavendish a valuable eyewitness impression of the cardinal, especially in his final days of crumbling magnificence. After Wolsey's death in 1530 Cavendish left public employment and retired to Suffolk, where in 1557 he completed his *Life*, undertaken in his later years partly with the intention of supplying a truthful report of the cardinal's career.

Although the fact that Cavendish was a Catholic and his mention of dangerous political issues obstructed the printing of the complete *Life* during the reign of Elizabeth I, its factual and literary value caused it to circulate freely in manuscript, and it thus provided a source for chronicles such as those of John Stow and Raphael Holinshed, for poems and for plays such as Shakespeare's *Henry VIII*. The first printed version, published in 1641, *The Negotiations of Thomas Woolsey*, was so mangled by party propagandists as to render it a polemical tract; and the reissue of this bad text throughout the rest of the 17th and the 18th centuries fostered the idea that it was a controversial work. Not until 1810 did Christopher Wordsworth attempt to restore the original by issuing in his *Ecclesiastical Biography* a text based upon original manuscripts. In 1815 S. W. Singer published a more completely restored text. At this time also the authorship, long attributed to George Cavendish's brother William, was correctly assigned to George by internal evidence. The question is discussed by Joseph Hunter in a pamphlet reprinted in Singer's edition.

The various acceptable texts subsequently printed reaffirmed Cavendish's gift for biographical writing. Despite his habit of moralizing, his occasional inaccuracies and his limited view of Wolsey's larger policies, Cavendish applied to his subject methods of concrete observation in matters of behaviour, gesture and speech, so that in his shapely and unaffected narrative the figure of the cardinal emerges with an air of life. Besides thus anticipating later biographical principles, Cavendish, though still close to medieval tragedy in conceiving Wolsey's rise and fall as governed by Fortune's wheel, moved away from the older idea that biographies should deal only with saints or royal personages.

See the edition of the *Life* by F. S. Ellis in the Temple Classics (1899) and the first scholarly edition, with notes and introduction, by Richard S. Sylvester (1958); *see* also A. F. Pollard, *Wolsey*, new ed. (1953); Francis Bickley, *The Cavendish Family* (1911); Donald A. Stauffer, *English Biography Before 1700* (1930); P. L. Wiley, "Renaissance Exploitation of Cavendish's Life of Wolsey," in *Studies in Philology* (1946). (P. L. Wy.)

CAVENDISH, HENRY (1731–1810), English chemist and physicist, was a pioneer in the study of gases. Elder son of Lord Charles Cavendish, brother of the 3rd duke of Devonshire, and Lady Anne Grey, daughter of the duke of Kent, he was born at Nice, France, on Oct. 10, 1731. He was sent to school at Hackney in 1742 and in 1749 entered Peterhouse, Cambridge, which he left in 1753 without taking a degree. Until he was about 40 he seems to have enjoyed a moderate allowance from his father (d. 1783), but in the latter part of his life an aunt left him a fortune which, together with his patrimony, made him one of the richest men of his time. It was commonly said that he was the richest of the philosophers and the most philosophical of the rich. He was a regular attendant at the meetings of the Royal society, of which he became a fellow in 1760, and he dined every Thursday with the club composed of its members. Otherwise, he had little intercourse with society; indeed, his chief object in life seems to have been to avoid the attention of his fellows. He had little communication with his relatives, and even Lord George Cavendish, his second cousin, whom he made his principal heir, he saw only for a few minutes once a year. His dinner was ordered daily by a note placed on the hall table, and his women servants were instructed to keep out of his sight on pain of dismissal. In person he was tall and rather thin; his dress was old-fashioned and singularly uniform, and was inclined to be shabby about the times when the precisely arranged visits of his tailor were due. He had a slight hesitation in his speech, and his air of timidity and reserve was almost ludicrous. He never married. He died at Clapham on Feb. 24, 1810.

Cavendish's scientific work was wide in its range. He took for his motto, "Everything is ordered by measure, number and weight." The papers he himself published form an incomplete record of his researches, since many of the results he obtained became generally known only years after his death; yet the Institute of France in 1803 chose him as one of its eight foreign associates. His first communication to the Royal society, a chemical paper on "Factitious Airs" (1766), dealt mostly with "inflammable air" (hydrogen), which he was the first to recognize as a distinct substance, and "fixed air" (carbon dioxide). He determined the specific gravity of these gases with reference to common air, investigated the extent to which they are absorbed by various liquids and noted that the air produced by fermentation and putrefaction has properties identical with those of fixed air obtained from marble. In 1783 he described observations he had made to determine whether or not the atmosphere is constant in composition; after testing the air on nearly 60 different days in 1781 he could find, after 400 determinations in the proportion of oxygen, no difference of which he could be sure, nor could he detect any sensible variation at different places. Two papers on "Experiments on Air," printed in the *Philosophical Transactions* for 1784 and 1785, contain his great discoveries of the compound nature of water and the composition of nitric acid. Starting from an experiment, narrated by Joseph Priestley, in which John Warltire fired a mixture of common air and hydrogen by electricity, with the result that there was a diminution of volume and a deposition of moisture, Cavendish burned about two parts of hydrogen with five of common air and noticed that the only liquid product was water. In another experiment he fired by electric spark a mixture of hydrogen and oxygen in a glass globe, similar to the apparatus now called "Cavendish's eudiometer," and again obtained water. Proceeding with these experiments he found that the resulting water contained nitric acid. In the second of the two papers he gives an account of the methods by which the composition of nitric acid was discovered. He observed also that a small fraction, about $\frac{1}{120}$, of the "phlogisticated air" of the atmosphere differed from the rest. In this residue he doubtless had a sample of the inert gas argon, which was only recognized as a distinct entity more than 100 years later by J. W. Rayleigh and Sir William Ramsay (*qq.v.*). In the meantime, many able chemists, including such masters as J. L. Gay-Lussac and R. W. von Bunsen, had made "complete" analyses of atmospheric air. It may be noted that, while Cavendish adhered to the phlogistic doctrine, he did not hold it with anything like the tenacity that characterized Priestley. Thus, in his 1784 paper on "Experiments on Air," he remarks that not only the experiments he is describing but also "most other phenomena of nature seem explicable as well, or nearly as well," upon the Lavoisierian view; but he did not accept it and continued to use the language of the phlogistic theory. Experiments on arsenic, published for the first time in 1921, showed that Cavendish had investigated the properties of arsenic acid about ten years before K. W. Scheele. He showed that arsenic oxide contained less phlogiston (*i.e.*, more oxygen) than arsenious oxide, which in turn contained less than free arsenic.

Cavendish's work on electricity anticipated the researches of C. A. Coulomb, Michael Faraday and others. He investigated the capacity of condensers and constructed a series of condensers with which he measured the capacity of various pieces of apparatus, using the "inch of electricity" as the unit of capacity. He discovered specific inductive capacity and measured this quantity; he showed that electric charges are confined to the surface of a conductor and that the inverse square law of force between charges holds to within 2%. Cavendish introduced the idea of potential under the name of "degree of electrification." He investigated the power of different substances to conduct electrostatic discharges (*Phil. Trans.*, 1775) and completed an inquiry which amounted to an anticipation of Ohm's law.

Cavendish took up the study of heat, and had he published his results promptly he might have anticipated Joseph Black (*q.v.*) as the discoverer of latent heat and of specific heat. He published a paper on the freezing point of mercury in 1783, and in this paper he expressed doubt of the fluid theory of heat. He regarded heat as a manifestation of internal motion of the smallest particles, whereas Black considered it to be material in nature.

Cavendish's last great achievement was his series of experiments to determine the density of the earth (*Phil. Trans.*, 1798). The figure he gives for the specific gravity of the earth is 5.48, but in fact the mean of the 29 results he records works out at 5.448. Other publications of his later years dealt with the height of an aurora seen in 1784 (*Phil. Trans.*, 1790), the civil year of the Hindus (*Phil. Trans.*, 1792) and an improved method of graduating astronomical instruments (*Phil. Trans.*, 1809). Cavendish also had a taste for geology and made several tours in England for the purpose of gratifying it.

A *Life* by George Wilson (1818–59), printed for the Cavendish society in 1851, contains an account of his writings, both published and unpublished, together with a critical inquiry into the claims of all the alleged discoverers of the composition of water. Some of his instruments are preserved in the Royal institution, London, and his name is commemorated in the Cavendish Physical laboratory at Cambridge.

In 1921 the previously published work, together with a number of unpublished experiments, appeared under the title *The Scientific Papers of the Honourable Henry Cavendish, F.R.S.; Vol. I, The Electrical Researches,* revised with preface and notes by Sir J. Larmor; *Vol. II, Chemical and Dynamical,* edited by Sir Thomas Edward Thorpe, with additions by Charles Chree and others.

See W. R. Aykroyd, *Three Philosophers* (1935); A. Wood, *The Cavendish Laboratory* (1946).

CAVENDISH, MICHAEL (*c.* 1565–1628), English composer whose surviving works show a small but genuine talent, was a member of the landed gentry and therefore an amateur musician. He contributed to Thomas East's *Whole Booke of Psalmes* (1592), and in 1598 published a collection of his own music containing 20 airs with lute accompaniment (and alternative arrangements for four voices) and eight madrigals for five voices; of these the airs have been printed in *The English School of Lutenist Song Writers,* 2nd series, vol. 11 (1920–32) and the madrigals in *The English Madrigal School*, vol. 36 (1913–24), both ed. by E. H. Fellowes. Cavendish died in London on July 5, 1628. (J. J. N.)

CAVENDISH (Candish), **THOMAS** (1560–1592), English navigator and freebooter, was the third circumnavigator of the globe. Born in Trimley St. Martin, Suffolk, he was baptized on Sept. 19, 1560. In 1585 he accompanied Sir Richard Grenville to America. Soon returning to England, he undertook an elaborate imitation of Drake's great voyage. On July 21, 1586, he sailed from Plymouth with 123 men in three vessels, only one of which (the "Desire," of 140 tons) returned. By way of Sierra Leone, the Cape Verde Islands and Cape Frio in Brazil, he coasted down to Patagonia (where he discovered "Port Desire," his only important contribution to knowledge), and passing through the Straits of Magellan fell upon the Spanish settlements and shipping on the west coast of South and Central America and of Mexico. Among his captures was the treasure galleon the "Great St. Anne," which he seized off Cape St. Lucas, the southern extremity of California (Nov. 14, 1587). Touching at the Ladrones, Philippines, Moluccas and Java, he rounded the Cape of Good Hope and arrived at Plymouth on Sept. 9–10, 1588, with much plunder, having circumnavigated the globe in two years and 50 days. In 1591 he planned a fresh American and Pacific venture. John Davis (*q.v.*) accompanied him, but the voyage (undertaken with five vessels) was an utter failure. Cavendish died and was buried at sea, on the way home, probably in May 1592.

See E. S. Payne, *Voyages of the Elizabethan Seamen to America,* 2 vol. (1893–1900).

CAVIAR (Caviare), the roe (eggs) of various species of *Acipenser* or sturgeon prepared, in several qualities, as an article of food. The word is common to most European languages and supposed to be of Turk or Tatar origin, but the Turk word *khavyar* is probably derived from the Italian *caviala;* the word does not appear in Russian.

The best caviar, which can only be made in winter and is difficult to preserve, is the loosely granulated, almost liquid kind, known in the U.S.S.R. as ikra. It is prepared by beating the ovaries and straining through a sieve to clear the eggs of the membranes, fibres and fatty matter; it is then salted with from 4% to 6% of salt. The difficulty of preparation and of transport made it a table delicacy in western Europe, where it has been known since the 16th century, as is evidenced by Hamlet's "His play . . . pleased not the million, 'twas caviare to the general."

Caviar is eaten either as an hors d'oeuvre, particularly in the U.S.S.R. and northern Europe, with kümmel or other liqueurs, or as a savoury, or as a flavouring to other dishes. The coarser quality, in the U.S.S.R. known as *pajusnaya* (from *pajus*, the adherent skin of the ovaries), is more strongly salted in brine and is pressed into a more solid form than the ikra; it is then packed in small barrels or hermetically sealed tins. This forms a staple article of food in eastern Europe and the U.S.S.R., where the best forms of caviar are made. The greater quantity of the coarser kinds are exported from Astrakhan, the centre of the trade. Large amounts are made each year for export in America and also in Germany, Norway and Sweden. The roe of tunny and mullet pickled in brine and vinegar is used, under the name of botargo, along the Mediterranean littoral and in the Levant.

CAVITE, a city and province on the island of Luzon, Republic of the Philippines. The city is located on a forked tongue of land in Manila bay, southwest of Manila (pop. [1960] 54,882). Chartered in 1940, it is a compact residential city, with many people commuting daily to work in Manila. At the outer edge of the city is a naval base, which was captured by Commodore George Dewey, of the United States navy, May 1, 1898. From 1898 until 1941 the Sangley Point naval base was the chief Asian base and fueling station for the U.S. navy, which continues to maintain a naval air station there.

Cavite province was long a revolutionary centre against the Spanish, and the home province of Emilio Aguinaldo, the insurrection leader against both Spain and the United States.

The northern part of the province is a wide strip of lowland devoted to rice cultivation. Along the coast, pond raising of fish, saltmaking and coastal fishing are important. People of many coastal towns work in Manila. The southern upland district has richer soils and better climatic conditions, producing bananas, pineapples, papayas and other fruits and a wide variety of fresh vegetables and flowers, which are delivered to the Manila markets by daily trucking services. Many tourists visit Tagaytay, a resort city chartered in 1938 (pop. [1960] 7,100). Located on the southern volcanic crater rim of the upland at about 2,000 ft. elevation, it is somewhat cooler than Manila. Tagaytay overlooks Taal lake, located below the rim in the core of an exploded volcano which occasionally shows mild activity. The city of Trece Martires (pop. [1960] 4,304), in the lowland, was chartered in 1954 and replaced the city of Cavite as the provincial capital.

(J. E. Sr.)

CAVOUR, CAMILLO BENSO, Conte di (1810–1861), Piedmontese statesman, the conservative whose exploitation of international rivalries and of revolutionary movements brought about the unification of Italy under the house of Savoy, with himself as the first prime minister of the new kingdom, was born at Turin on Aug. 10, 1810, the son of the marchese Michele Benso di Cavour. His mother (née Adèle de Sellon) was Swiss and a Calvinist, and this may help to explain the liberal and anticlerical tendencies which soon made Cavour lose favour under the reactionary government of King Charles Albert (*q.v.*) of Sardinia-Piedmont. After being dismissed from his post as page to the king, he became an army officer in the engineers. As the second son in an aristocratic family he had to earn his own living, and it was his strongly mathematical bent which made him prefer the engineers. The July revolution of 1830 in France moderated his radicalism and taught him that a traditional monarchy could also be liberal and avoid the extremes of revolution and reaction. Thus his political doctrine of the *juste milieu* ("happy mean") was learned from the France of Louis Philippe. That example further encouraged opposition to Charles Albert, and he resigned from the army in 1831.

As a political career seemed impossible for a liberal in contemporary Turin, Cavour turned to the management of his father's estate at Leri. There he proved highly successful, introducing new agricultural methods, new crops, new breeds of animals. He traveled widely to study foreign techniques of agriculture. He popularized the use of artificial manures in Piedmont as well as

English experiments with subsoil drainage. Agriculture always remained his chief hobby, and Leri his favourite residence. A growing interest in finance once led him to gamble away a large part of his father's money on the Paris stock exchange. But in the end he became very rich. He was a pioneer in developing banks and was one of the first to see the possibilities of railway transport in Italy and of a consequent industrial revolution. In 1842 he helped to found a famous agricultural society at Turin. This soon became an undercover institution for political discussions too, and it stressed the need for having an all-Italian and not merely a Piedmontese membership.

Revolution and Reform, 1848–49.—During his travels Cavour renewed his political interests by making a close study at first hand of the British and French constitutions. He also published serious analyses of the English poor-law system and the Irish problem. As a friend of Cesare Balbo and Vincenzo Gioberti (*qq.v.*) he shared the interest which all progressives at Turin nourished in the possibility of ending the predominant Austrian influence in the Italian peninsula. In 1847 Charles Albert yielded to contemporary trends sufficiently to grant some press freedom in Piedmont, and Cavour took advantage of this to found a newspaper bearing the significant title of *Il Risorgimento*. At once he began advocating the *juste milieu* of constitutional monarchy as the only way of avoiding the more radical revolution which Giuseppe Mazzini (*q.v.*) wanted. The victory of Mazzini would have meant the end of the monarchy, the end of aristocratic predominance at Turin and the end of Piedmontese hopes to conquer and absorb the other provinces of Italy. When revolution broke out elsewhere in Italy, Cavour took a leading part in asking Charles Albert to forestall worse dangers by granting liberal reforms. The king was reluctantly induced to grant a parliamentary constitution (March 4, 1848), albeit a conservative document which hardly allowed much power to the representatives.

Cavour showed great skill as a journalist, even though his own language was French and his articles had to be written in Italian. Without doubt he carried weight both with public opinion and with the king. In March 1848, when the Milanese rose in a popular rebellion against Austrian rule in Lombardy, Cavour at once advocated war, seeing this as a chance not only to undermine Austrian influence but also to extend the frontiers of Piedmont and to prevent the threatening victory of republicanism in Milan and Venice. Charles Albert declared war on April 5, but unfortunately military incompetence was made even more disastrous by regional and political differences between the conservative Piedmontese and the more radical Milanese. After defeat by the Austrians, an armistice was declared.

Meanwhile, in Piedmont, parliament had met under the new constitution. Cavour stood for election. His influence was not strong enough for him to succeed in April 1848, but he was returned at a later election in the following June and showed his political colours by sitting on the right among the conservatives. He spoke Italian with great hesitation, his voice was poor and he completely lacked rhetorical skill, but his intellectual power and clarity of mind were remarkable, and his good common sense and experience of parliamentary government in other countries were shortly to make him an expert in this unfamiliar method of politics. For the moment, however, he was regarded with some distrust, and in the elections of Jan. 1849 he was not elected. But he shared with many other people the desire to fight Austria once again in order to regain the influence which Piedmont had lost. War was declared again, but after a campaign which lasted only a few days the Piedmontese were totally defeated at Novara on March 23, 1849. Charles Albert saved the dynasty from disaster by a prompt abdication, and his son Victor Emmanuel II (*q.v.*) succeeded him. Peace was declared and forced on to an unwilling parliament. Cavour lamented the incompetence which had brought these two defeats and was now determined to make a career in politics. He had at last discovered his own abilities and was determined to try to use them in securing the independence of Italy. He was returned to parliament again in June 1849, and by Oct. 1850 he was minister of agriculture, industry and commerce in the government of Massimo d'Azeglio (*q.v.*).

Internal and Foreign Policy, 1850–58.—For the next ten years until his death, Cavour dominated Piedmontese politics. Almost at once he altered the pattern of trade by bringing duties down, having learned from Richard Cobden the advantages of free trade. As minister of finance in 1851 he reorganized the kingdom's finances and persuaded European banking houses to invest heavily in this little country. Then he undermined the position of his colleagues in the cabinet and tried to force D'Azeglio to resign and give place to him. Foiled in this, he made a secret "marriage" (*connubio*) with Urbano Rattazzi (*q.v.*) and the moderate left; then resigned for a few months when D'Azeglio heard about it; and by Nov. 1852 had succeeded in becoming prime minister himself. In this slightly disreputable maneuver he already showed the qualities for which he became famous: an enormous self-confidence, an impatience with any junior position, a lack of scruple and a tremendous flair for diplomacy and for sensing the movement of public opinion.

Finance and foreign policy were Cavour's particular fields. His policy for what he called "the aggrandisement of Piedmont" was going to cost money, and his severe taxation won him much unpopularity, while his loans built up a huge national debt. His first challenge to Austria came in 1853 when, after a Mazzinian outbreak in Milan, the Austrians confiscated the estates of certain Lombards who had become naturalized Piedmontese. Cavour broke off diplomatic relations in order to show that Piedmont was now the champion of Italian independence. In Jan. 1855 he joined the Anglo-French alliance against Russia (*see* CRIMEAN WAR), dragooned into this action by the king against his own instincts and against the vote of his cabinet. General A. La Marmora was sent to the Crimea with 15,000 troops but to Cavour's dismay the war was over before these soldiers had time to distinguish themselves, and many people at home naturally objected to this apparent waste of national resources in a motiveless war so far from Italy. Cavour attended the peace congress at Paris, hoping to secure as compensation the permission to annex Parma or Modena. All he won was the apparent acceptance of his country as the leading state of Italy. The British foreign secretary, Lord Clarendon, however, publicly raised the question of Italy and censored the harsh government of Pius IX in the papal states and Ferdinand II in the kingdom of the Two Sicilies. Here was matter for future exploitation.

Incidentally, at Paris, Cavour learned how he might play on the French emperor Napoleon III's ambition and compromise him in the Italian question. He also began the process of persuading Daniele Manin and other ex-Mazzinian revolutionaries to support the Piedmontese monarchy as their best hope of winning a resurgence of Italy.

Cavour's next step was to try to provoke a European war against Austria from which Piedmont might emerge with enlarged frontiers. At first he hoped for British support in such a war and traveled to London to arrange it. He soon saw his mistake and switched to France. Napoleon III at heart remained a revolutionary who hoped to gain popularity at home by winning glory abroad, and in return for his help the kingdom of Sardinia could give him Savoy and Nice. Napoleon's sympathies were temporarily cooled by Felice Orsini's attempt on his life in Jan. 1858; but Cavour pacified him by passing the restrictive De Foresta press law in April at French insistence and also gave up his alliance with Rattazzi and the moderate left. Napoleon then summoned Cavour secretly to Plombières (Vosges) in July, where they agreed on a plan. Piedmont was to organize an insurrection in central Italy against Austria, and this was to be made the pretext for war. A North Italian state was to be formed in which Piedmont should annex Lombardy, Venetia and central Italy down to Ancona (thus including part of the papal states). France would receive Savoy and possibly Nice, with the further satisfaction of a marriage between Prince Napoléon Joseph ("Plon-Plon"; *see* BONAPARTE) and Victor Emmanuel's daughter Clotilda.

The War of 1859.—At last in 1859 Cavour was on the verge of success. While insisting that his own intentions were peaceful, he openly arraigned Austria as a warmonger. In fact, however, he was bending all his resources to engineering war against a reluctant

Austria. He employed the radical Società Nazionale to organize conspiracy in Austrian Italy. Lombard citizens were welcomed as volunteers in the Piedmontese army. Garibaldi was made a general and employed to organize a corps of volunteers. On Jan. 10, 1859, the king, in orders suggested to him by Napoleon, spoke of the "cry of pain" (*grido di dolore*) that was reaching him from all parts of Italy. In this and other ways Cavour succeeded in making Austria send more troops to Italy as a safety measure, and these troop movements were then made to appear as an act of provocation which justified Piedmontese countermeasures. On Jan. 30 the king's 15-year-old daughter was married to Napoleon's disreputable middle-aged cousin, as arranged, and Napoleon thus won for his dynasty more status among other crowned heads of Europe. A secret military convention was also signed in Jan. 1859 (and backdated to 1858), by which Piedmont promised Savoy and Nice to France in return for the expulsion of the Austrians from Italy.

Cavour was single-minded enough about war, but Napoleon was in two minds, having to reckon with a pacifist public opinion in France and a powerful Catholic element in the population which was bound to dislike any dismemberment of the papal states. The French army was also unwilling to fight, especially after talks with their Piedmontese colleagues. So Napoleon suddenly backed down and supported the idea of a European congress instead. Cavour was beside himself. He threatened to fight Austria alone, to fight Great Britain too, to bring the United States in against Great Britain and to implicate Napoleon by publishing their private correspondence. Napoleon tried to calm him and gave him to understand that he would only have to put off his war for 12 months. Cavour eventually had to submit when, on April 18, 1859, an ultimatum arrived from France virtually ordering him to disarm and accept the congress as a means of settling the Piedmontese grievances against Austria. This was in fact a triumph for British diplomacy, which was sympathetic to Piedmont but strongly averse to Cavour's policy of engineering a war and upsetting the whole fabric of Europe for selfish interests of his own. Cavour gave in. So complete was his apparent failure that he threatened suicide. The very next day, however, the military party in Vienna persuaded the Austrian emperor to send Cavour an ultimatum of their own, threatening to fight if Piedmont did not disarm at once. Cavour brilliantly recovered his poise and gave the sort of polite answer that forced the Austrians to put themselves in the wrong by declaring war. France was bound by treaty to defend Piedmont from aggression, and British sympathies at once veered strongly round against Austria for so disturbing the peace.

When war broke out (*see* ITALY: *History*), the French and Piedmontese defeated the Austrians in several encounters, while insurgents in Parma, Modena, Florence and Bologna expelled the various ducal families and the papal legate and set up provisional governments of their own. Cavour saw here a chance of increasing his acquisitions in the war even over and above what he had agreed with Napoleon, and therefore sent special commissioners to these central provinces to take charge in the name of King Victor Emmanuel. This naturally alarmed Napoleon, who already was meeting growing hostility from Prussia and did not want to have to contend with papal censure as well. So on July 8, 1859, he concluded an armistice with Austria at Villafranca in Lombardy, not even bothering to tell Cavour in advance. Cavour's position had in any case been weakened by the war, for the military had taken over and the king paid little attention to his prime minister. The king had already quarreled several times with Cavour, over the Crimean War, over Cavour's insistence on dissolving the Piedmontese monasteries in 1855 and over his daughter Clotilda's marriage; Victor Emmanuel did not like playing the constitutional monarch in the limited way which Cavour wished. After Villafranca, Cavour at once went to see the king at Monzambano in eastern Lombardy and in highly disrespectful language tried to insist that the king should repudiate the armistice. The king, however, was there much more realistic than Cavour and preferred to accept the latter's resignation. It was arranged that Lombardy should belong to Piedmont, but that Venetia should remain Austrian. It was also resolved that the deposed princes should be reinstated in central Italy and that the pope should be made president of an Italian confederation.

For six months Cavour was out of office. A Rattazzi-La Marmora coalition signed peace at Zürich in Nov. 1859. Cavour still remained the most important political figure in the country and soon he was able to see Villafranca in a more favourable light: Savoy and Nice had not been surrendered; freedom of action had been won from the slightly compromising association with Napoleon; and this apparent split from Napoleonic France won the more active support of Great Britain. Lord Palmerston now informed France and Austria that he would never tolerate their armed intervention in favour of the despots of central Italy. This doctrine of nonintervention was to prove of great use in 1860, because Cavour had now made Piedmont unquestionably the strongest and most liberal state in Italy, with greatly increased chances of hegemony there if only other states could be kept from intervening.

The Treaty of Turin (1860).—Cavour's name now carried so much prestige at Turin that the king, with no great pleasure, was forced to reinstate him in power (Jan. 1860). Napoleon was still reluctant to allow Piedmont to grow too strong and would not agree to Piedmontese annexation of the central duchies. Cavour, however, now brought up again the question of Savoy and Nice, the two provinces of the kingdom of Sardinia on the French side of the Alps. The result was that on March 24 a treaty was signed at Turin ceding these two provinces to France (confirmed by local plebiscites in April). In return for this, Napoleon withdrew his opposition to the annexation of central Italy. Plebiscites were organized to give the required verdicts, and on April 2, 1860, a parliament met at Turin representing not only Lombardy and Piedmont but also Parma, Modena, Tuscany and the papal Romagna. Cavour had a difficult moment in this parliament explaining why he had alienated national territory to France, but in the end he obtained a majority. One important person who broke with him over this was Garibaldi (*q.v.*).

The Annexation of the Two Sicilies.—The next stage in Italian unification opened when Garibaldi, furious with Cavour and the conservatives, moved over once more toward the Mazzinian belief that Italy must not be made as the piecemeal process of absorption into Piedmont, but rather as a collective creation of something altogether new. Garibaldi sailed with his famous Thousand from Quarto near Genoa, on May 15, 1860, landing at Marsala in Sicily and destroying the whole fabric of Bourbon government in Sicily and Naples. Cavour had been hoping that the south would stay quiet. In the prevalent state of public opinion he did not dare to stop Garibaldi, and he secretly continued negotiating with the Bourbon king Francis II at Naples to arrange a possible division of Italy between him and Victor Emmanuel. No sooner, however, had Garibaldi scored his first successes than Cavour also sent secret aid to this radical buccaneer, hoping to keep a foot in both camps and to gain whether Garibaldi was victorious or not. On the other hand, when Garibaldi conquered Sicily and showed signs of wanting to cross over to the mainland, Cavour became frightened. Piedmontese agents were ordered to take over Garibaldi's provisional government in Sicily, and others were sent to forestall him in Naples by winning over the Bourbon army. They failed in both cases and only served to push deeper the cleavage between radical nationalists and conservative nationalists.

Cavour now took his most courageous decision of all, deciding to annex all that was left of the papal states except Rome. This would not only acquire further provinces for Piedmont, but he could pretend that it was needed in order to prevent the radical Garibaldians from marching on Rome first (Napoleon still kept a garrison of French troops in Rome to defend the pope). So Cavour unscrupulously engineered an insurrection inside the papal states to give colour to the Piedmontese invasion. A battle was fought against the tiny papal army at Castelfidardo near Ancona, on Sept. 18, 1860, and as soon as possible the Piedmontese marched down into Neapolitan territory. For on Oct. 1, 1860, Garibaldi was meeting his first serious opposition, and it was necessary on the one hand to prevent his being defeated by the Bourbons and on the other to ensure that he handed his conquests of Naples and Sicily over to Cavour and the conservatives. Garibaldi had little option, but he gave in magnanimously. The parliament at Turin quickly approved the annexation of Sicily and Naples as well as of the papal states. The old subalpine parliament was then dissolved and another summoned to represent the various regions of the new Italy which had now been created. Before it could meet, Cavour took care to introduce as much as possible of the laws and administrative procedures of Piedmont into the new provinces, because he rightly saw how difficult it would be for the new deputies to agree on such problems. When the chamber met in March 1861, it showed a large majority in favour of Cavour. Victor Emmanuel was declared king of Italy, but he was to be styled Victor Emmanuel II because Cavour insisted (against the wishes of Mazzini and Garibaldi) that Italy was a continuation or projection of Sardinia-Piedmont.

The Roman Question in 1861.—The problems facing this newly created kingdom were enormous, and unfortunately Cavour had only three months left to live. He had just enough time to turn his attention to the question of Rome, and he defied Catholic feeling in Europe by confirming that this city would one day be annexed to and form the capital of Italy. At the same time he introduced the anticlerical legislation of Piedmont into the recently conquered papal provinces and the south, dissolving the monasteries and making bishops submit to certain state controls. Here he overestimated his strength. Mistakenly he thought that the Vatican would accept his policy of "a free church in a free state." Some negotiations did in fact take place with the Roman curia, but in the end the papacy refused even to recognize the new state's existence. Its rulers were excommunicated, and the friar who absolved Cavour on his deathbed was punished by his superiors. The radical cleavage thus created in Italian society lasted till 1929.

Death.—Another almost unbridgeable division in 1861 was that between Cavour and Garibaldi. Cavour tried not to seem too publicly ungrateful to the national hero, but he could not afford any concessions to him. Garibaldi was treated ungenerously, and so were the officers in Garibaldi's volunteer regiments. A dramatic fight in parliament took place between these two men in April 1861 and perhaps hastened Cavour's death. For some time Cavour had been unwell and irritable, and he had had to carry too much of the strain of these last few years. A fever took him and he was bled too severely by the doctors. He died on June 6, 1861, and was buried at Santena where his family had their country house, to the southeast of Turin. His early death, at the age of only 50, was a tragic blow to his country.

Character and Achievement.—Cavour was one of the cleverest and most successful statesmen in 19th-century Europe. His good sense, pugnacity and perseverance were notorious, as were his personal charm and likability. Not being a doctrinaire nationalist, he had tended, up to 1856 at least, to think of Italian unity as Mazzinian nonsense. Nevertheless, as a born opportunist, he exploited every situation as he found it, and in the last resort the need to contain the revolutionary Garibaldi forced him into certain actions which made him one of the most successful nationalist leaders of the age. Paradoxically it was Cavour who thus realized Mazzini's lifelong dream of Italian unity, even having to use the latter's favourite method of popular insurrection which Cavour himself had earlier so often condemned.

Cavour in his lifetime earned an unenviable reputation for duplicity. He had to depend on the deliberate and unscrupulous provocation of war, and this was bound to give him a thankless part to play in international life. When he died, Italy had still not developed a viable system of parliamentary politics; national sentiment was still far from unified; the budget had been catastrophically unbalanced. Perhaps if Cavour had been more willing to share his power, he could have trained other leaders to succeed him and apply his methods to such problems. Unfortunately his disappearance from politics served to show up the weakness of his country, as it also showed up how much the unification of Italy had been due to the skill of this one remarkable man.

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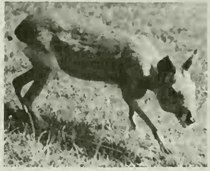
For biography *see* W. de la Rive, *Reminiscences of the Life and Character of Count Cavour* (1862), the work of an intimate friend; G. Massari, *Il Conte di Cavour* (1873); E. Artom, *L'Opera politica del senatore Isacco Artom nel Risorgimento italiano* (1905), a life of Cavour's devoted private secretary; W. R. Thayer, *Life and Times of Cavour* (1911); P. Matter, *Cavour et l'unité italienne* (1926); A. J. Whyte, *The Early Life and Letters of Cavour* (1925) and *The Political Life and Letters of Cavour* (1930); D. Mack Smith, *Cavour and Garibaldi, 1860* (1954). (D. M. SH.)

CAVY, any rodent of the family Caviidae of South America. The guinea pig (*Cavia porcellus*), which is widely used as a pet and for laboratory experiments, is a cavy native to Peru. It was domesticated for food by the Incas. True cavies (*Cavia*) are gray or brown, agouti-patterned, rat-sized, short-legged, terrestrial animals with small ears and no externally visible tail. They are diurnal and are one of the most frequently seen mammals of the mountains of Peru, Bolivia and western Argentina. One native name for the guinea pig is "cui," alluding to the cry made by the animal when captured. Less prolific than their domestic brethren, they breed in their first year of life and principally in spring months, producing a litter of one or two young. They live in burrows and are vegetarians. (*See* also GUINEA PIG.)


W SUSCHITZKY

PATAGONIAN CAVY OR MARA (DOLICHOTIS AUSTRALIS)

Other kinds of cavies also are herbivorous. Rock cavies (*Kerodon*) of eastern Brazil resemble large, gray guinea pigs. Mountain, marsh and pampas cavies (*Galea* and *Microcavia*) of the plains of Bolivia and central Argentina are like small gray or brown guinea pigs, but with shorter ears and legs. "Patagonian hares" (*Dolichotis*) and "woodland rabbits" (*Pediolagus*) are large, grayish, rabbit-like cavies with longer ears, legs and tail; they inhabit the plains and open woodlands of Argentina. (E. T. Ho.)

CAWDOR, a village and civil parish of Nairnshire, Scot. Pop. (1951) 823. The village is situated 6½ mi. S.S.W. of Nairn by road and 3 mi. from Gollanfield Junction railway station. In the vicinity is a large distillery. The castle was the scene, according to the tradition perpetuated by Shakespeare, of the murder of King Duncan by Macbeth, thane of Cawdor (or Calder), in 1040. Since the old central tower, the oldest part of the structure, dates from 1454, and seemingly had no predecessor, the tradition has no foundation in fact. The building stands on the rocky bank of Cawdor burn, a right-bank tributary of the Nairn. The massive keep with small turrets is the original portion of the castle, and to it were added, in the 17th century, the modern buildings forming two sides of a square. It is the seat of the earls of Cawdor.

Kilravock (pronounced Kilrawk) castle, 1½ mi. W. of Cawdor, commands the left bank of the Nairn. Its keep dates from 1460, and the later buildings belong to the 17th century. It has been continuously tenanted by the Rose family, who settled at Kilravock in 1293, after which date son succeeded father in direct descent. Queen Mary I was received at the castle in 1562, and Prince Charles Edward was entertained four days before the battle of Culloden.

CAWNPORE: *see* KANPUR.

CAXIAS, LUIZ ALVES DE LIMA E SILVA, DUQUE DE (1803–1880), Brazilian statesman and his country's greatest military hero, was born Aug. 25, 1803, in Rio de Janeiro. He received his schooling as a cadet at the royal military academy and saw his first combat in the war for independence in Bahia in 1823. Caxias distinguished himself in the Uruguayan campaign, 1825–28, and organized the forces that maintained order in Rio de Janeiro following the abdication of Dom Pedro I in 1831. Sent in 1837 as governor and military commander of the province of

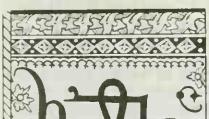
Maranhão, where a separatist revolt was in progress, he established his reputation as a brilliant military strategist and a generous victor. He was employed in a similar capacity to quell rebellions in Minas Gerais, São Paulo and Rio Grande do Sul between 1841 and 1845. Caxias led the Brazilian forces in the war against Argentine dictator Juan Manuel de Rosas, 1851–52, and, at the age of 64, was called upon to turn the tide of the war against the Paraguayan dictator, Francisco Solano López. For his exploits he was rewarded successively with the titles of baron, count, marquis, and, after his capture of Asunción in 1869, duke of the empire. A senator and prominent leader of the conservative party, he served for many years as minister of war and for two terms was president of the council of ministers of the empire, 1866, 1875–78. He died at Rio de Janeiro on May 7, 1880. (R. E. P.)

CAXTON, WILLIAM (*c.* 1422–1491), the first English printer, was born in the weald of Kent. In 1438 he was apprenticed to Robert Large, a rich mercer, who in the following year became lord mayor of London. Large died in 1441 and Caxton moved to Bruges, the centre of the European wool trade: during the next 30 years he became an increasingly prosperous and influential member of the English trading community in the Low Countries. In 1453 he was admitted to the livery of the Mercers' company, and in 1463 took up the duties of "Governor of the English Nation of Merchant Adventurers" in the Low Countries—a post of great authority over his fellow merchants. He exercised this office with energy and distinction, and was several times employed as ambassador to negotiate commercial treaties. Some time in 1470 he ceased to be governor and entered the service of Margaret, duchess of Burgundy, sister of Edward IV, where Caxton was certainly established by March 1471, possibly as her financial adviser. He continued to be employed on occasion as the king's agent in commercial affairs until 1475.

But his interests were turning to literature. In March 1469 he had begun to translate *The Recuyell of the Historyes of Troye,* but losing confidence, he laid it aside. However, the duchess Margaret commanded him to finish it, which he did on Sept. 19, 1471, in Cologne. It was in Cologne, where he lived from 1470 to the end of 1472, that he learned about printing. In the epilogue to Book III of the *Recuyell* he tells how his "pen became worn, his hand weary, his eye dimmed" with copying the book; so he "practised and learnt" at great personal cost how to print it. He bought a press and two fonts of type, reproducing contemporary book hand, probably from John Veldener of Louvain, and had the help of Colard Mansion, a well-known scrivener and illuminator of Bruges. He set up a press about 1474 and the *Recuyell,* the first book printed in English, was published at Bruges in 1475. In the same year he translated from the French another book in English, *The Game and Playe of the Chesse* (in which chess is treated as an allegory of life), which appeared with the publication date 1476.

Two or three other works were printed in Bruges in French, but toward the end of 1476 Caxton returned to England and established his press at the Almonry in the city of Westminster at the sign of the Red Pale. From then on he devoted himself entirely to writing and printing. His first-known piece of printing is an *Indulgence* issued by Abbot Sant on Dec. 13, 1476. By the time of his death in 1491, Caxton had published about 100 items of various kinds. His wife died in 1490 and a daughter survived him.

As the pioneer of printing in England, Caxton showed no great typographical originality, and produced no books of remarkable beauty, but he filled the hungry with many good things. The new interest in Latin and Greek, insofar as it existed in England, was already catered for by the continental presses, but Caxton served English culture perhaps better than he knew by concentrating on satisfying what was still the essentially late-medieval taste of readers of the vernacular. He did not aim only at one level of society. Some of his books were produced primarily for noble readers; thus the first dated book printed in England, *Dictes and Sayenges of the Phylosophers,* was a translation made by the Earl Rivers and published by his request. It appeared on Nov. 18, 1477 (only one copy, in the John Rylands library, Manchester, survives with the colophon, in which this date is given). Three editions were, however, published in Caxton's lifetime, suggesting that its appeal was in no way limited. Kings, nobles and rich merchants among his friends were Caxton's patrons and sometimes commissioned special books. His varied output of books of chivalric romance, conduct, morality, history and philosophy, including the encyclopaedia, *The Myrrour of the World* (1481), the first English illustrated book, shows that he catered also for a general public made up of the gentry, "clerks," and indeed almost all who could read. The large number of service books and devotional works which Caxton published were the staple reading of most literate persons and may well have represented the firm commercial basis of his enterprise. Caxton also printed practically all the English literature available to him in his time; for example, Chaucer's *Canterbury Tales* (1478? and 1484) and other poems by Chaucer; John Gower's *Confessio Amantis* (1483); Sir Thomas Malory's *Morte d'Arthur* (1485); and much of John Lydgate. The chief exception is Langland's *Piers Plowman.* The high standard of accuracy and clarity for which he constantly strove is illustrated by his reprinting *The Canterbury Tales* from a better manuscript when he was told how bad was the text of his first edition. A number of his books bear his initials, W. C., with his device. This has been fancifully interpreted, but it is probably no more than a clean-line representation of his own seal, representing "an eagle's head erased." It was adopted with minor alterations by his successor Wynkyn de Worde.



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CAXTON'S DEVICE, CONSISTING OF HIS INITIALS AND TRADE-MARK, FOUND IN 11 OF HIS BOOKS AND BROADSIDES

Caxton translated 24 books, some of them immensely long. Besides these and his editorial labours and his own prologues and epilogues, he added an eighth book of his own to John of Trevisa's translation of Ralph Higden's history, the *Polychronicon,* though it is of little worth. His editing of Malory was shown by E. Vinaver, *The Works of Sir Thomas Malory* (1947), to be much more extensive than had been suspected, and apart from his curious chapter-divisions Caxton's alterations are nearly always improvements. He translated from French, Latin and Dutch, working at great speed. He is fairly accurate but his style is usually clumsy, though in translation as in his original writings he improved with practice. In his prologues and epilogues he makes interesting and valuable remarks on his problems of translation and on the use of English at the time, as in the prologue to the *Eneydos* (1490); and he sometimes comments on books and life with considerable shrewdness and judgment, as in the prologue to the *Morte d'Arthur.* Occasionally he rises to a well-told anecdote.

For an account of Caxton's place in the history of printing, *see* PRINTING.

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CAYAPA, a tribe of South American Indians, belonging to the Barbacoan linguistic stock or substock. Their habitat is the lower Cayapas river and adjacent coasts in northern Ecuador. Traditionally they formerly lived in the upland region around Quito, moving to the coast a short time before the first appearance of Europeans.

They became much mixed with Negroes, and relatively little of their original culture survived. The basic social and economic unit is the one-family household. The main occupation is agriculture, but the Cayapa are also good hunters and fishermen, as well as skilful canoe-builders.

See S. A. Barrett, "The Cayapa Indians of Ecuador," Museum of the American Indian, *Indian Notes and Monographs,* no. 40 (1925).

CAYENNE, capital of French Guiana, is a port standing at the northwestern end of the Île de Cayenne formed by the estuaries of the Cayenne and the Mahoury rivers. Pop. (1954) 11,458. It was founded by the French in 1643 and was long the centre of French penal settlement in Guiana. Its streets, built on a rectangular pattern, are lined by brick or wooden houses of one or two floors. The Church of the Holy Saviour and the Jesuits' house are of some antiquity; and there are other interesting buildings, including the préfecture, around the Place d'Armes. To the west, Mont Cépérou and Fort Saint-Michel dominate the harbour. The sea wind mitigates the heat, and the climate, though humid, is healthful. Fever is kept down by draining the marshes and by spraying with insecticides.

The harbour is poor, so large ships unload at Larivot (a few kilometres distant) or at the Îles du Salut. Three times a month a ship goes between Cayenne and Fort-de-France, Martinique; and four international airlines maintain services. Timber, rosewood essence, rum and gold are exported in small quantities.

An avenue running along the sea front joins Cayenne to the suburbs of Chaton and Montabo, where are located the buildings of the Institut Français d'Amérique Tropicale, the Institut Pasteur and a hotel.

See also GUIANA: *French Guiana.* (HU. DE.)

CAYENNE PEPPER (GUINEA PEPPER, SPANISH PEPPER, CHILLI), a preparation of finely ground, dried, mature fruits of variously highly pungent or "hot" forms of *Capsicum frutescens.* The large, sweet garden peppers (including Pimiento) are horticultural varieties of the same species, belonging to the family Solanaceae. The true or black pepper belongs to the family Piperaceae (*see* PEPPER).

Capsicum frutescens, native to the American tropics, is widely grown in both temperate and tropical zones. The plants are herbaceous or semiwoody, frost-tender, many-branched perennials one and one-half feet to five feet tall; they are usually cultivated as annuals. The leaves are alternate, ovate and pointed; the flowers have five white petals sometimes tinged with green, yellow or purple. The fruits are two- to four-lobed, fleshy, thin-walled, nondehiscent, containing many yellowish, disk-shaped seeds attached to a spongy central placenta. The fruits of most very "hot" varieties are slender, from one to ten inches long, and red, yellow or purplish when ripe.

Commercial cayenne pepper in the United States is made from the fruits, minus the stems, of any of several highly pungent varieties produced in the southern and western states and in other countries. It is used principally as a condiment but small amounts are used in medicine as a counterirritant. In the U.S., 8,000 to 9,000 ac. of all kinds of "hot" peppers, including the Cayenne variety, are grown annually. No data are available on the Cayenne variety alone, but the commercial crop probably is from 2,000 to 3,000 ac. *See* CAPSICUM. (V. R. B.)

CAYEY is an interior town in the central part of Puerto Rico, with a population of 19,755 in 1960. Founded in 1774, the town derives its name from an Indian term for "a place of water." The Spanish military highway which connects San Juan on the Atlantic coast with Ponce on the south Caribbean coast goes through Cayey. The altitude of the town is 1,300 ft., and through the valley in which it is located runs the La Plata river. The principal product of the agricultural area is tobacco, and the hills around the town are dotted with drying sheds and warehouses. The climate of Cayey was so agreeable, the average temperature being 71°, that Spaniards, followed by Americans, established a military post in the town. The road from Cayey to Guayama is perhaps one of the most scenic on the island. (T. G. Ms.)

CAYLEY, ARTHUR (1821–1895), English mathematician, who for his range, analytical power and originality ranks high among 19th-century mathematicians, was born at Richmond, Surrey, on Aug. 16, 1821. He was educated at Trinity college, Cambridge, where, after being senior wrangler and first Smith's prizeman, he was awarded a fellowship (1842–45); but his reluctance to take religious orders prevented his continuance at Cambridge. In 1846 he entered at Lincoln's Inn; while practising law he met J. J. Sylvester, and the two spent much time discussing mathematics, in particular the new theory of algebraic invariants in which they were pioneers. Cayley was called to the bar in 1849 and practised at the same time as he was publishing his brilliant mathematical papers. In 1863, the year of his marriage, he was elected to the newly established Sadlerian chair of pure mathematics at Cambridge, which he occupied, with great distinction, until his death at Cambridge on Jan. 26, 1895.

Cayley's 900-odd mathematical notes and papers, published at Cambridge in 13 large quarto volumes (1889–98), treat of nearly every subject of pure mathematics, as well as theoretical dynamics and astronomy. His major contribution is the series of ten memoirs on algebraic forms, or quantics, in which he developed the theory of algebraic invariants and allied topics (1854–78). Other notable works deal with the theory of matrices, group theory, the geometry of n dimensions, the concept of the "absolute" in geometry, which links projective geometry to non-Euclidean geometry and which, with the work of F. Klein (*q.v.*) on the subject, is of great historical importance; researches on singularities of curves and surfaces, enumerative geometry, rational transformation and correspondences between curves, the configuration of the 27 lines on a cubic surface; and in analysis, the theory of elliptic functions, conformal transformation and the attraction of ellipsoids. He also produced two British association reports (1857, 1862) on theoretical dynamics and the moon's mean motion.

Cayley's lectures at Cambridge attracted very few students; among them, however, was A. R. Forsyth, who succeeded him in the Sadlerian chair. It was Forsyth who introduced into England the new theory of functions which had been making great progress in France and Germany, and who thus brought English mathematics back into the main stream, from which it had diverged after Newton's time. Thus, indirectly, Cayley played a great part in founding the modern British school of pure mathematics.

See also references under "Cayley, Arthur" in the Index volume.

See Eric T. Bell, *Men of Mathematics* (1937). (L. R.)

CAYLEY, SIR GEORGE (1773–1857), British scientist, founder of the science of aerodynamics and widely recognized as the originator of the modern airplane, was born at Scarborough, Yorkshire, Dec. 27, 1773. Absorbed from childhood by problems of flight, he discarded the ornithopter idea of flapping wings and devoted himself to the problems of the fixed-wing airplane, the helicopter and the airship. By 1799 he had established the basic configuration of the modern airplane, with fixed wings, fuselage and tail unit with a combined elevator and rudder. In 1804 he flew the first of his successful model gliders, and in 1809–10 published his first researches, which form the basis of modern aerodynamics. He devoted much of his life to aeronautical research and writing, including—for the first time in history—streamlining; longitudinal and lateral stability; the movement of the centre of pressure; the region of low pressure (and resulting lift) on the upper surface of wings; rudder and elevator action; and superposed wings (triplanes, etc.). The culmination of his aeronautical work came in 1849 and 1853, when he built two full-size gliders, the second of which, with his unwilling coachman on board, made the first man-carrying glider flight in history.

Cayley also invented the light-tension wheel (forerunner of the cycle wheel), the expansion air engine (hot air engine) about 1805, and the crawler-type tractor (1825); he founded the Regent Street Polytechnic institution in London (1839). Among other fields in which he did research were scientific education, land reclamation, acoustics, railway equipment, lifeboats, ballistics, optics and electricity. He was also, for a short period, the Whig member of parliament for Scarborough. He died at Brompton hall, Yorkshire, on Dec. 15, 1857.

See J. L. Pritchard, *Sir George Cayley* (1961); C. H. Gibbs-Smith, *Sir George Cayley's Aeronautics* (1962). (C. H. G.-S.)

ÇAYLUS, ANNE CLAUDE PHILIPPE DE TUBIÈRES, COMTE DE (1692–1765), French archaeologist, engraver and man of letters. Born at Paris on Oct. 31, 1692, he was the only son of the Marquise de Caylus, the celebrated memoirist and cousin of Madame de Maintenon. After a brilliant career in the army during the war of the Spanish succession, he resigned his commission and traveled widely in Europe and the middle east, where he acquired a lasting interest in archaeology. On his return to Paris he devoted himself to engraving and later became an active member of the Academies of Painting and Sculpture and of Inscriptions.

He wrote a seven-volume *Recueil d'antiquités égyptiennes, étrusques, grecques, romaines et gauloises* (1752–67), several books for artists and various minor works, published under the collective title *Oeuvres badines* (1787). Although he was a benefactor of the School of Fine Arts, where he founded three prizes, his artistic patronage was capricious and brought him into disrepute. Gaiety and the absence of moral restraint characterized the circles in which his private life was passed. He died at Paris on Sept. 5, 1765. (P. Ly.)

CAYMAN (Caiman), the name applied to several broad-snouted crocodilians of South America. The black cayman (*Melanosuchus niger*) of the Amazon is a large species, reaching 16 ft. in length. The smaller spectacled caymans (*Caiman* species) are extremely abundant in tropical America. *See* Crocodilia.

CAYMAN ISLANDS, a British colony in The West Indies, including Grand Cayman, Little Cayman and Cayman Brac, low-lying coral islands in the Caribbean. They have a total area of 100 sq.mi., and a population (1960) of 7,616, of which four-fifths live on Grand Cayman. This island lies 190 mi. W.N.W. of Jamaica and has two towns, Georgetown (the capital) and Bodden Town. Grand Cayman is 22 mi. long and 4–8 mi. broad. The lesser Caymans lie between 60 and 90 mi. E.N.E. of Grand Cayman; Cayman Brac is distinguished by a massive central limestone bluff. Coasts are reefed and rocky; there are no rivers.

The Caymans, previously a dependency of Jamaica, became self-governing in July 1959. The governor of Jamaica governs with the advice and consent of the elected assembly, and is bound to visit once a year; he is otherwise represented by an administrator. Primary education is free and compulsory.

Turtles provide the main livelihood of the islands, and the chief exports are turtle products; the manufacture of thatch rope from the thatch palm is a declining industry. Trade is mainly with the United States and Jamaica. Tourism is increasing because of improved accommodations and communications. There are regular airplane flights from Kingston, Miami, San José and Panama City to Owen Roberts airfield, Grand Cayman; and there is an airstrip on Cayman Brac.

The islands were discovered in 1503 by Christopher Columbus who named them Tortugas from the abundance of turtles. They were not occupied by the Spaniards but were colonized in the 18th century from Jamaica by the British.

See *Colonial Office List* (H.M.S.O., annually). (R. To.)

CAYUGA, a tribe of North American Indians of Iroquoian speech, being one of the Five Nations of the Iroquois league, who originally inhabited the region bordering Cayuga lake in central New York state. When first visited by the French Jesuit Father René Ménard in 1656 their three towns occupied the land east of the lake above the marshes south of the Seneca river. *Goi-o-gouen,* "where boats were taken out," corrupted from the name of their main town and the country, was the seat of the mission of St. Joseph; *Thiohero,* "amid the rushes" (St. Stephen), stood to the north; and *Onontaré* (St. René), named for a hill opposite on the same river, was farther north. They numbered about 1,500, with 300 warriors and about 100 houses. As the "fourth fire" of the Iroquois longhouse, they were considered "offspring" or "nephews" of the Onondaga to the east and the Seneca to the west, and together with the Oneida were called "younger brothers." In council parlance, the ten chiefs who represented them in the league were designated "the people of the Great Pipe."

Ancient Cayuga had abundant fish, game and water fowl, and boasted of hunters even more famous than their women were for corn production; when their storage pits were depleted in the 1750s, they borrowed from the Onondaga. Throughout history they have been a composite people. When they had a refuge settlement north of Lake Ontario, they took in Huron and Erie captives to replace war losses, and after the 1675 defeat of the Andaste (Susquehanna), they made satellites of broken Algonkian (Conoy and Nanticoke) tribes from the tidewater country, Siouan-speaking bands (Tutelo and Saponi) from the Piedmont, and various central Algonkians. They claim Logan the Mingo (*see* Logan, James John) as one of their own. Fishcarrier led their war parties out of Niagara during the American Revolution, after which they sold their New York lands and moved as loyalists to Grand River, Canada, where today on Six Nations reserve about 1,500 descendants perpetuate the language and maintain a rich ceremonial life. About 200 live among the Seneca nation in western New York, and perhaps 100 in Oklahoma. *See* also Iroquois.

(W. N. F.)

CAYUSE, an Indian tribe (of the Waiilatpuan linguistic family [*see* Sahaptin]) that formerly inhabited northeastern Oregon and part of Washington and was noted for its horses and warlike character. They were closely allied with the Wallawalla and Nez Percé tribes, and there was a great deal of intermarriage, particularly with the latter tribe. The Cayuse signed the treaty of 1855 establishing the Umatilla reservation, where they then lived. The tribe's population was officially given as 404 in 1904, but no Cayuse of pure blood was found on the reservation at the beginning of the 20th century.

Marcus Whitman (*q.v.*), who had established a mission near the present city of Walla Walla, Wash., in 1838, his wife and 12 others were massacred in an attack by the Cayuse in 1847. The Indians blamed Whitman, who was a doctor, for the large number of deaths caused by disease. Volunteer troops carried on a prolonged, indecisive campaign against the tribe until five Indians, who confessed to the murders, were voluntarily surrendered in 1850.

In the western states of the United States the term cayuse refers to an Indian pony. In *Three Thousand Miles Through the Rocky Mountains* (1869), A. K. McClure used the word in this sense in his remark that "Twice our kiyuse broke nearly out of the harnass. . . . The kiyuse is never perfectly tamed."

CAZEMBE, the name of a former powerful African kingdom on the Luapula river in Northern Rhodesia. The kingdom was created in the 17th century when the supreme Lunda chief, Mwata Yamvwa, sent Cazembe, one of his lieutenants, on an expedition to eastern Katanga in order to reconquer dispersed Lunda groups. Cazembe became the hereditary title of the ruler of the kingdom. In the course of this expansion various smaller Cazembe chiefdoms were created in Katanga, but all were subordinate to that of the Cazembe on the Luapula, who himself remained a vassal of the Mwata Yamvwa. About 1875 Cazembe was conquered by Msiri, an east African adventurer of the Nyamwezi tribe, and after his death the kingdom disintegrated. The country was first visited toward the close of the 18th century by the Portuguese Manoel Caetano Pereira and F. J. M. de Lacerda, and David Livingstone went there in 1868. The successor of the Cazembe title remained paramount over a large part of the Luapula valley.

See J. Slaski, *Peoples of the Lower Luapula Valley* (1951).

(D. P. Bi.)

CAZIN, JEAN CHARLES (1841–1901), French painter, etcher and ceramic artist, known for his idealistic landscapes in the general tradition of Millet and Corot, and for his historical paintings, was born at Samer, Pas-de-Calais, on May 25, 1841. Early in his career he accompanied Alphonse Legros to England where he made designs for the Fulham pottery, and came under the stylistic influence of the Pre-Raphaelites, as is evidenced in his religious pictures of that period.

His attempt to revive the art of encaustic painting attracted some attention. He won many important awards in Paris, and was decorated by the French government. He died at Le Lavandou, Var, on March 27, 1901.

CEANOTHUS, a showy genus of North American shrubs and woody vines of the buckthorn family (Rhamnaceae; *q.v.*), comprising more than 50 species found chiefly in the Pacific coast region, 30 of which are native to California. The small white or blue flowers are borne in handsome dense panicles or umbels. Several are grown as garden plants. Only two species occur east of the Rocky mountains—the New Jersey tea (*C. americanus*), so called because its leaves were used as tea during the American Revolution, and *C. ovatus*. The genus attains its maximum development in the foothills and mountains of California, often constituting a considerable part of the chaparral. Noteworthy representatives are the California lilac and the Oregon tea-tree (*qq.v.*).

CEARÁ, a northern state of Brazil, bounded north by the Atlantic, east by the Atlantic and the states of Rio Grande do Norte and Paraíba, south by the state of Pernambuco and west by the state of Piauí; and having an area of 57,102 sq.mi. Only a very small percentage of the population, which numbered 3,337,856 (1960), is of European origin, the large majority being *mestiços*. There are few Negroes.

The state lies partly upon the northeast slope of the great Brazilian plateau and partly upon the sandy coastal plain. Its surface is a succession of great terraces, facing north and northeast, formed by the denudation of the ancient sandstone plateau which once covered this part of the continent; the terraces are seamed by watercourses, and their valleys broken by hills and ranges of highlands, usually described as mountain ranges, but in fact only the remains of the ancient plateau, capped with horizontal strata of sandstone and having a remarkably uniform altitude of 2,000 to 2,400 ft. The flat top of such a range is called a *chapada* or *tabuleiro*, and its width in places is from 32 to 56 mi.

The boundary line with Piauí follows one of these ranges, the Serra Ibiapaba, which unites with another range on the southern boundary of the state known as the Serra do Araripe. Another range, or escarpment, crosses the state from east to west, but is broken into two principal divisions, each having several local names. These ranges are not continuous, the breaking down of the ancient plateau having been irregular and uneven. The higher ranges intercept considerable moisture from the southeast trade winds, and their flanks and valleys are covered with forest, but the plateaus are either thinly wooded or open campo. These upland forests are of a scrubby character and are called caatingas.

The sandy coastal plain, with a width of 12 to 18 mi., is nearly bare of vegetation; behind it there is a more elevated region with broken surfaces and sandy soil which is amenable to cultivation and produces fruit, cotton and most tropical products where conditions are favourable. The rivers of the state are small and, with one or two exceptions, become completely dry in the dry season. The largest is the Jaguaribe, which flows entirely across the state in a northeasterly direction with a length varying from 210 mi. to an estimated 465 mi. The year is divided into a rainy and a dry season, the rains generally beginning in October and lasting until December. The soil of the interior is thin and porous and does not retain moisture; consequently the long dry season turns this part of the country into a barren waste (*sertão*), relieved only by vegetation along the river courses and mountain ranges and by the hardy, widely distributed carnauba palm (*Copernicia cerifera*), which in places forms groves of considerable extent. Sometimes the rains fail altogether, and then a drought (*sêca*) ensues, causing famine and pestilence throughout the entire region. The most destructive droughts recorded were those of 1711, 1723, 1777–78, 1790, 1825, 1844–45 and 1877–79, the last-mentioned destroying nearly all the livestock in the state and causing through starvation and pestilence the deaths of nearly 500,000 persons—more than half the population—while thousands more were obliged to emigrate to other states. However, the calamity of drought is only in part a natural calamity. The long history of destructive land use, during which the cover of natural vegetation has been repeatedly stripped away, has destroyed whatever capacity to retain moisture the soil originally may have had.

There are two railroads running inland from the coast: the Baturité line from Fortaleza to Crato in the southern part of the state, and to Patos in the state of Paraíba; and the Sobral line from Camocim to Crateús, about 210 mi. The railways were built by the national government after the drought of 1877–79 to give work to the starving refugees. Great dams are also being constructed and extensive irrigation systems laid out.

The state of Ceará became a bishopric of the Roman Catholic Church in 1853, the bishop having his residence at Fortaleza. The state is represented in the national congress by 3 senators and 17 deputies. The capital, Fortaleza (*q.v.*), sometimes called Ceará, is the principal commercial centre and shipping port. The principal towns are Juàzeiro do Norte, Aracati, Baturité, Acaraú, Crato, Maranguape and Sobral.

The territory of Ceará included three of the *capitanias* originally granted by the Portuguese crown in 1534. The first attempts to settle the territory failed, and the earliest Portuguese settlement was made near the mouth of the Rio Camocim in 1604. The French were already established on the coast, with their headquarters at São Luis (Maranhão). Ceará was occupied by the Dutch from 1637 to 1654, and became a dependency of Pernambuco in 1680; this relationship lasted until 1799, when the *capitania* of Ceará was made independent. The *capitania* became a province in 1822 under Dom Pedro I. A revolution followed in 1824, the president of the province was deposed 15 days after his arrival, and a republic was proclaimed. Internal dissensions broke out, the new president was assassinated, and after a brief reign of terror the province resumed its allegiance to the empire. Ceará was one of the first provinces of Brazil to abolish slavery.

(R. D'E.; X.)

CEAWLIN (d. 593), king of the West Saxons from 560 to 592, was included by Bede in his list of kings who held an imperium over all lands south of the Humber, and hence was entered among the Bretwaldas in the Anglo-Saxon Chronicle. Before he became king he helped his father Cynric to defeat the Britons at Barbury in 556. He and his brother Cutha defeated King Aethelberht of Kent in 568. He won an important victory against the Britons at Dyrham in 577, killing three kings and winning the cities of Gloucester, Cirencester and Bath. Thus he opened the valley of the lower Severn to Saxon colonists and divided the Britons of Devon and Cornwall from those of Wales. He fought at Fethanleag (probably the Fethelée in Stoke Lyne, Oxfordshire, mentioned in a 12th-century charter) in 584, but in spite of an initial success, he returned home angry. A king called Ceol obtained at least part of the West Saxon kingdom in 591, and Ceawlin was driven out in 592 after a battle at Woden's Barrow (now Adam's Grave), Wiltshire, and was killed in 593.

BIBLIOGRAPHY.—Anglo-Saxon Chronicle, under the years 566–593, 827; Bede, *Historia Ecclesiastica*, book ii, ch. 5; F. M. Stenton, *Anglo-Saxon England*, 2nd ed. (1947). (D. WH.)

CEBU, an island province (Visayan SUGBU) of the central Philippines, includes the main island of Cebu (1,703 sq.mi.), the Camotes group to the northeast, Mactan Island (*q.v.*) on the east and Bantayan Island to the northwest, totaling 1,880 sq.mi. It is the most densely populated of the larger Philippine provinces (pop. [1948] 1,123,107; [1960] 1,340,439, or 717 per square mile). The native-born Cebuanos have been migrating to Mindanao for more than 200 years to relieve the population pressure. The province is divided into 26 municipalities, plus the central urban district of Cebu city, which is the provincial capital.

The island of Cebu has a range of low mountains running down its centre. The main island is of sedimentary rocks, overlain by coral limestone. It has only narrow coastal plains except for the Bogo plain in the far north, and has few harbours. Its climate is rather dry, and the coral and limestone soils do not yield good rice crops. The Bogo plain is mainly a commercial sugar-cane area, but small farms cultivate maize, coconut, yams, agave (sisal) and tobacco. The island does not feed itself, and maize, rice and other foodstuffs are imported. Coal, copper and limestone for cement are mined in the central hill country.

Important towns and municipalities on the east coast (north to south) are Bogo, a port and market town; Danao, a poor port and a trade and pottery-making centre near coal mines; Liloan, a local market town; Mandaue, just north of Cebu city and an important port; Opon, on the west side of Mactan Island across a narrow channel from Cebu city, important for its oil port installations; Naga, south of Cebu city, near coal and limestone mines and the centre of cement manufacture; Sibonga, a trade centre and local port; Argao, a port, cotton textile and pottery-making centre; and Dalaguete, a local trade centre on the southeastern coast. On the west coast in the north are Tubaran, a large trade and transport centre; Toledo, opposite Cebu city, a local port and transport centre; and Dumanjug on the southwestern coast, a transport and trade centre. (J. E. Sr.)

CEBU, CITY OF, chartered in 1936, is one of the largest Philippine cities (pop. [1960] 259,194) and capital of the island province of Cebu. Its location on the east coast, sheltered by Mactan Island, makes it an excellent port.

Cebu is one of the most historic spots in the Philippines. An important native port occupied the site when Ferdinand Magellan, commander of the first circumnavigatory expedition, landed there on April 7, 1521. It was on Mactan Island that he met the native chief Sicatuan (Humabon) and sealed a blood compact, only to lose his life later in a battle with another chief, Lapulapu, who has become a modern Filipino hero. The image of the Santo Niño (the Holy Child), now housed in San Augustin church, is said to date from this period, and what is reputed to be Magellan's wooden cross still stands in the city plaza. Miguel López de Legazpi and Friar Urdaneta arrived in Cebu on April 27, 1565, to found the first Spanish settlement and the first Catholic mission; and for the six years until Legazpi's removal to Manila, Cebu was the Spanish colonial capital. Cebu continued to be an important Spanish centre of control in the south. Cebuanos took a prominent part in the insurrection against both Spain and the United States.

A coastal railway operated north and south of the city prior to World War II, but was abandoned in 1948. The city proper was almost completely destroyed by the Japanese in May 1942 in reprisal for guerrilla operations. American liberation occurred on March 27, 1945, with the port intact, and later rebuilding greatly improved and enlarged the city. Cebu is a Roman Catholic see. Good highways encircle the island and cross the central mountain range near the city, making it easily accessible from all parts of the island.

The Spanish banned foreign trade with Cebu until by royal decree of 1860 it was declared open. Located among the Visayan Islands, Cebu has become the chief coconut products exporter, and exports also large amounts of abacá (Manila hemp), sugar and timber. It imports little foreign goods, running a poor second to Manila in foreign trade. As an interisland trade centre, however, Cebu stands out, leading Manila in freight and passengers. It is a key station on the domestic airline network, and many industrial and commercial companies maintain branches there. In the late 1950s manufacturing plants began to locate in Cebu, and industry began to augment the commercial trade on which the city formerly depended. (J. E. Sr.)

CEBUANO (Sugbuhanon) is the major dialect of Bisayan (*q.v.*), the language with the largest number of first speakers in the Philippines. It is the mother tongue of about 5,000,000 Filipinos, of more than half of all speakers of Bisayan and of about one-fourth of the Philippine population.

The difference between Cebuano and other Bisayan dialects is quite large, almost as great as that between different languages. Nevertheless, there is a certain amount of mutual intelligibility between it and these others, as exemplified in Sagay in northern Negros, where both Hiligaynon and Cebuano are spoken. Like Hiligaynon, Cebuano is an *l*-dialect as against Samaran (Samar-Leyte), an *r*-dialect; *e.g.*, Cebuano, Hiligaynon *ulan*, Samaran *uran*, "rain." On the other hand, Cebuano differs in many ways from Hiligaynon; *e.g.*, Cebuano *aːkoq*, Hiligaynon *aːkon*, "mine."

Cebuano speakers are distributed over eastern Negros, Cebu, Bohol, western Leyte, Camotes and the northern and western coast of Mindanao, including the entire Surigao peninsula. It is still spreading along the northern coast of Mindanao as a consequence of Bisayan expansion there and has become the lingua franca used by the pagan and Moro peoples of the area to communicate with the settlers. Except for this region, however, there is little tendency to acquire Cebuano as a second language. Cebuano speakers thus constitute the largest single cultural-linguistic unit in the Philippines.

Despite the relatively large number of its speakers, literary publication in Cebuano has been nearly nonexistent; even disregarding Tagalog, the national language, there is more literary publication in some of the Luzon languages with far fewer speakers. This unusual circumstance is attributable to the distance of the Cebuano area from Manila, the cultural centre of the Philippines. Because of its overwhelming dominance in its own areas, however, Cebuano is used in local publications. Two dailies published in Cebu city are in Cebuano and English. A number of weeklies are published either in Cebuano or in Cebuano and English. Although most of the weeklies are published in the Cebuano-speaking area, *Bisaya*, the Cebuano weekly with by far the largest circulation, is published in Manila. Cebuano films likewise make up a large part of the Filipino films produced in the vernacular because of the large prospective audience for such entertainment. (I. Dx.)

CECCHETTI, ENRICO (1850–1928), Italian ballet dancer and teacher, was noted for his part in training many distinguished artists, including Anna Pavlova, Alicia Markova, Cia Fornaroli, Leonide Massine and Serge Lifar.

Both of Cecchetti's parents were dancers, and he was born on June 21, 1850, in a dressing room at the Tordinona theatre, Rome. A pupil of Giovanni Lepri, he became a brilliant technician, noted for his dazzling pirouettes. Popular throughout Europe, he appeared with outstanding success in Manzotti's ballet *Excelsior* at La Scala, Milan, and in London. At the Mariinsky theatre, St. Petersburg, he created the roles of the Bluebird and Carabosse in Tchaikovsky's *The Sleeping Beauty*.

Cecchetti taught many dancers of the Russian Imperial ballet and, later, the Diaghilev Ballet Russe. From 1925 he directed the ballet school at La Scala. He continued to teach until stricken during a lesson the day before he died, Nov. 13, 1928. The Cecchetti method of ballet training is widely used in the United States and Great Britain. (Ln. Me.)

CECCO D'ASCOLI (popular name of Francesco degli Stabili) (1267–1327), Italian astrologer and poet, whose heretical opinions made him fatal enemies, and whose links with Dante helped to ensure his fame, was born in or near Ascoli Piceno. Professor of astrology in Bologna, he was condemned as a heretic in 1324 and went to Florence, where he became astrologer to Duke Charles of Calabria. Having aroused the suspicion of the church and the enmity of a leading physician, Dino del Garbo, he was tried again there and burned at the stake in the autumn of 1327.

His Latin works (commentaries on the astronomical work of Joannes de Sacrobosco and the astrological work of Alcabizio) are merely compilations, as is his more famous encyclopaedic vernacular poem, *L'Acerba*. (The meaning of the title is not clear; perhaps it indicates the sourness of his doctrine and of his style.) Cecco's polemics are particularly directed against Dante, whose astrological theories he did not accept. Artistically rough, the *Acerba* would be scarcely remembered but for its attack on Dante and its author's tragic end.

See *L'Acerba*, ed. by A. Crespi (1927); A. Beccaria, "I biografi di Cecco d'Ascoli e le fonti per la sua storia," etc., in *Memorie della R. Accad. di Scienze di Torino, S. II*, lviii (1908). (G. A.)

CECIL, the name of one of England's most famous and politically influential families, which is represented by two branches, holding the marquessates of Exeter and Salisbury, both descended from William Cecil, Lord Burghley, Elizabeth I's lord treasurer. Burghley's many inquiries concerning the origins of his family created for them more than one splendid and improbable genealogy, but they in fact began as small gentry at Alltyrynys in Walterstone, a Herefordshire parish on the Welsh border. The first recorded Sitsilt, Syssell or Seisill (the name was variously spelled until Burghley established the form Cecil) was a Thomas, whose son Philip had two sons, Richard, the elder, who made his will in 1508, and David (d. *c.* 1537). The elder line remained, undistinguished, at Alltyrynys until Richard's great-great-grandson Matthew died childless in 1598, leaving the estate, considerably encumbered, to Sir Robert Cecil (*see* below). David, however, moved out, after the manner of younger sons. In the train of his mother's relation, Sir David Philips, he probably joined Henry VII at the battle of Bosworth (1485) and certainly became afterward a yeoman of his guard. Philips was steward of a manor, near Stamford in Lincolnshire, belonging to the king's mother, the Lady Margaret Beaufort, and in 1494 David Cecil became a freeman of Stamford. There he prospered. He was three times mayor, represented the town in parliament and in 1532–33 was sheriff of Northampton. Under Henry VIII he became yeoman of the chamber and sergeant at arms, besides receiving several profitable leases, keeperships and other favours. His son RICHARD (d. 1553) became a page in the king's chamber in 1517, was present at the Field of Cloth of Gold (1520) and rose to be yeoman of the wardrobe. He had some share in the distribution of monastic lands, and left, by his wife, Jane Heckington (d. 1588), the son WILLIAM who, as Lord Burghley and Elizabeth I's principal minister, was to be the founder of the family fortunes (*see* BURGHLEY, WILLIAM CECIL).

Burghley's elder son, THOMAS, was created earl of Exeter by James I, and his descendant, the 10th earl, was raised to a marquessate in 1801 (*see* EXETER, EARLS, MARQUESSES AND DUKES OF). This elder line has remained seated at Burghley, the great mansion built by their ancestor, the 1st Lord Burghley. Burghley's second son, ROBERT, principal secretary to Elizabeth from 1596, was created earl of Salisbury by James I in 1605 (*see* SALISBURY, ROBERT CECIL). He was forced to exchange his house, Theobolds, with the king for Hatfield, where he built, but did not live to inhabit, the new Hatfield house whose library contains the famous collection of state papers retained by his father and himself.

His descendant, JAMES (1748–1823), 7th earl, was lord chamberlain to George III and was raised to a marquessate in 1789. The 3rd marquess was the 19th-century prime minister (*see* SALISBURY, ROBERT ARTHUR TALBOT GASCOYNE-CECIL), three of whose sons took an active part in politics (*see* SALISBURY, JAMES EDWARD HUBERT GASCOYNE-CECIL; CECIL OF CHELWOOD, EDGAR ALGERNON ROBERT CECIL). Their brother, LORD WILLIAM GASCOYNE-CECIL, was bishop of Exeter from 1916 until his death in 1936.

ROBERT ARTHUR JAMES (1893–), 5th marquess of Salisbury, was born on Aug. 27, 1893, and succeeded his father, the 4th marquess, in 1947. During World War II he held various major political offices. He was twice leader of the house of lords (1942–45 and 1951–57) and was lord president of the council from 1952 to 1957. In 1957, on the resignation of the prime minister, Sir Anthony Eden, he was one of the elder statesmen who advised the queen on the appointment of a successor. In 1957, disapproving of the government's policy over Cyprus, he resigned his offices. His brother LORD DAVID CECIL (1902–) was born on April 9, 1902. The author of several well-known historical and literary biographies and works of criticism, he was appointed Goldsmith's professor of English literature at Oxford university in 1948.

See A. L. Rowse, "Alltyrynys and the Cecils," *English Historical Review*, vol. lxxv (1960). (R. B. WM.)

CECILIA, SAINT (2nd or 3rd century), one of the most famous Roman martyrs of the early church and historically one of the most discussed. According to the legend, which dates from the late 5th century, she was a noble Roman virgin who had vowed her virginity to God as a child. When she was married against her will to Valerian, a pagan, she told him that an angel of God wished her to remain a virgin. He promised to respect this wish if he were allowed to see the angel. She replied that he would do so if he were baptized. On his return from baptism he found Cecilia talking to the angel. She then converted his brother Tiburtius, who also saw the angel. Both men were martyred before her. She herself distributed all her possessions to the poor, which enraged the avaricious prefect Almachius, who ordered her to be burned in the bath. But the flames refused to touch her, and so she was finally beheaded. She was buried in the catacomb of St. Callistus. At the beginning of the 9th century Pope Paschal I discovered her relics in the catacomb of Praetextatus and had them moved to a church in Rome which was then called Sta. Cecilia in Trastevere. As the legend mentioned her interest in music, she became the patroness of church music and is often represented in art playing the organ. Her feast day is Nov. 22.

See *Butler's Lives of the Saints*, ed. by H. Thurston and D. Attwater, 4:402–405 (1956). (H. C. G.)

CECIL OF CHELWOOD, EDGAR ALGERNON ROBERT CECIL, 1ST VISCOUNT (1864–1958), British statesman, who played a major part in the creation and work of the League of Nations, known before his elevation to the peerage as Lord Robert Cecil, third son of the 3rd marquess of Salisbury, was born in London on Sept. 14, 1864. He was educated at Eton and University college, Oxford, and was called to the bar by the Inner Temple in 1887.

In 1906 he entered parliament as Conservative member for East Marylebone, but although he opposed the Liberals' education bill, on many questions he took a heterodox position. Thus his opposition to the tariff reform policy of Joseph Chamberlain cost him his seat between 1910 and 1911, when he was returned at a by-election for Hitchin, retaining this seat until 1923. He opposed the disestablishment of the church in Wales, but supported the women suffragists, though he did not palliate their offenses against law and order. In 1918 he had the satisfaction of carrying a resolution "to amend the law with respect to the capacity of women to sit in Parliament."

During World War I, Lord Robert was in office from May 1915 until the Armistice. As undersecretary for foreign affairs, then as minister of blockade and lastly as assistant secretary of state for foreign affairs, he was mainly concerned with the vital question of blockade. He resigned at the general election of 1918 because he could not agree to treat Welsh disestablishment as a *fait accompli*. Though no longer a minister of the crown, he nevertheless went over to Paris in 1919 where he served as chairman of the Supreme Economic council, and played a principal part in drafting the covenant of the League of Nations. After the peace he advocated increasingly full co-operation in the work of the League. In 1920 he attended the first assembly of the League in Geneva as a representative of South Africa. In parliament he steadily drifted into opposition to the coalition ministry, and in 1923 he joined Stanley Baldwin's first cabinet as lord privy seal. He was raised to the peerage in Dec. 1923. In Nov. 1924 he became chancellor of the duchy of Lancaster. On several occasions he represented Great Britain on the council of the League of Nations. As the principal British representative on the disarmament commission at Geneva in 1926–27 he found that his instructions necessitated a policy not in complete accordance with his convictions, and in 1927 he resigned from the Baldwin administration. President (1923–45) of the League of Nations union, Lord Cecil remained uncompromisingly loyal to the League covenant. He was a principal promoter of the "Peace Ballot" in 1934 and he was one of the few parliamentarians to vote against the Munich settlement in 1938. In 1937 he was awarded the Nobel peace prize. He published an account of the inception of the League and his own work for it in *A Great Experiment* (1941). A largely autobiographical study, *All the Way*, appeared in 1949. He died at Tunbridge Wells on Nov. 24, 1958. (H. G. N.)

CECROPIA, in botany, a genus of trees (family Moraceae, *q.v.*), native to tropical America. They are of rapid growth, yielding a light wood used for making floats. *C. peltata* is the trumpet tree, so-called from the use of its hollow stems by the Uaupé Indians as a musical instrument. It is a tree reaching about 50 ft. in height, with a large spreading head and deeply lobed leaves 12 in. or more in diameter. The hollows of the stems and branches are inhabited by ants, which, it has been claimed, in return for the shelter thus afforded and food in the form of succulent growths on the base of the leaf stalks, repel the attacks of leaf-cutting ants that would otherwise strip the tree of its leaves. This is an instance of myrmecophily; *i.e.*, a living together for mutual benefit, or symbiosis, of ants and a plant.

For cecropia moth *see* SATURNIID MOTH; BUTTERFLY AND MOTH.

CECROPS, traditionally the first king of Attica in ancient Greece. He was said to have divided the inhabitants into 12 communities and to have instituted the laws of marriage and property and a new form of worship. The introduction of bloodless sacrifice, the burial of the dead and the invention of writing were also attributed to him. He is said to have acted as umpire during the dispute of Poseidon and Athena for the possession of Attica. As one of the autochthons of Attica, Cecrops is represented as human in the upper part of his body, while the lower part is shaped like a dragon. This was rationalized by supposing that he invented marriage; *i.e.*, joined the unlike natures of man and woman.

CEDAR, the name applied to a variety of trees, both gymnosperms and angiosperms (*qq.v.*), most of which are evergreen and have aromatic, often red or red-tinged, wood which in many cases is decay-resistant and insect-repellent. In a technical sense the word is used only for trees of the coniferous genus *Cedrus,* which differs in many respects from the popular conception of cedars. It has been estimated that perhaps 70 different kinds of wood bearing the name cedar in one form or another are in the trade.

The true cedars (*Cedrus* species) are related to the larches and pines and are placed with them in the pine family (Pinaceae). Most authorities recognize at least three species in the genus, but the distinctions between them are slight, and they may represent geographic races of one species; the species are so variable, especially in their horticultural forms, that they overlap extensively. Native to North Africa and Asia, they are easily grown in warm, equable regions. In the U.S. most are at home in California and some of the southern states; a few—a variety of *Cedrus libani* and *Cedrus atlantica*—may be grown as far north as southern New England. Cedars are cultivated in warmer portions of Europe, especially in England, as ornamentals. All have rather short, sharp needles arranged in a close spiral on spurlike branches. The pollen is produced in narrow, erect cones up to several inches in length; and the seeds are borne in similar but larger cones, several inches in diameter and up to six inches in length at maturity. When the reddish-brown seed cones are ripe (in about two or three years), the cone scales separate and fall away from the central axis, which remains on the bough.

The deodar or god tree, *Cedrus deodara,* forms forests in the mountains from Afghanistan to the northwest Himalayas at elevations of from 5,500 to 12,000 ft. It has a close-grained, long-fibred, scented and highly resinous wood; the timber, which is resistant to the action of water, is used in a variety of ways. The leaves—long, slender, dark bluish-green needles—give an over-all pale-green foliage effect. The tree, with its great drooping branches and branchlets, makes a handsome and picturesque sight, for which reason it is much cultivated as an ornamental. Its rapid growth and eventual great size make it unsuitable for all but the larger gardens, however. Several leaf-colour and growth-form variants are available.

The Atlas cedar, *Cedrus atlantica,* occurs in the Atlas mountains of North Africa from elevations of 4,000 to 6,000 ft., usually in scattered groves. It has shorter and denser foliage than the deodar, usually with a grayish cast or, in other varieties, a silvery-white, bluish-gray or yellowish cast. Form variants—narrow-pyramidal, branchlets drooping, etc.—are also cultivated. *Cedrus atlantica* var. *glauca,* with foliage a striking bluish-gray, is widely grown in California and in England.

The cedar of Lebanon, *Cedrus libani,* is the best known of the cedars because of its frequent appearance in art and literature, especially in the Scriptures, as a symbol of power and longevity. The tree grows, chiefly in groves which may include over a thousand individual trees, at elevations of about 6,000 ft. in the Mount Lebanon province of Lebanon and on the higher slopes of the Taurus and Anti-Taurus mountains in Turkey.

The cedar of Lebanon, a fairly rapid grower, reaches a height of from 60 to 100 ft. and usually develops several erect leading branches, which by their ramification produce a very broad flat crown. The side branches often extend horizontally for considerable distances from the trunk and, with their numerous spreading branchlets, give the tree its distinctive tiered appearance. Old trees are gnarled and majestic, and the aspect of a dense grove truly awe-inspiring.

While the tips of the leaders droop as in the deodar, the branchlets of *C. libani* are not pendent, and the leaves are much shorter than in that species. *Cedrus libani* is very similar to *C. atlantica* in the size and shape of its needles, but the latter usually has but a single leader and does not have a tiered appearance.

The wood of the cedar of Lebanon is reddish-brown, fragrant and light. Because of its coarse grain, spongy texture and tendency to shrink, it finds less use than that of other species. *Cedrus libani* and its varieties are possibly the least hardy of the genus.

A variety of *C. libani,* having shorter leaves and cones, is largely restricted to the island of Cyprus.

Among the angiosperms, the mahogany family (Meliaceae) has the largest number of so-called cedars, especially in the genus *Cedrela.* Several species of *Cedrela* have fine durable wood used for timber and, among other things, cigar boxes, chests and closets. *Cedrela odorata* (Jamaican red cedar) and *C. toona* (*Toona ciliata,* Australian red cedar) are the most important. Other woods called cedar are found in this family and the following families: Ulmaceae, Cunoniaceae, Leguminosae, Rutaceae, Simaroubaceae, Euphorbiaceae, Anacardiaceae, Celastraceae, Sterculiaceae, Araliaceae, Boraginaceae, Bignoniaceae and Rubiaceae.

The great majority of so-called cedars, however, are conifers. The eastern red cedar of America is a juniper (*Juniperus virginiana*) and is much used in cabinetmaking, for posts and in the manufacture of pencils. The Bermuda cedar is *J. bermudiana,* and the Spanish cedar is *J. thurifera* (although the name also is applied to *Cedrela odorata*). In the western United States, *Libocedrus decurrens* is known as incense cedar, and *Chamaecyparis lawsoniana* as Port Orford cedar. The Japanese redwood or cedar is *Cryptomeria japonica.* Other genera of gymnosperms which are often called cedar are: *Torreya, Cupressus, Thuja, Callitris, Athrotaxis, Podocarpus, Pinus* and *Widdringtonia.*

See also CONIFERS. (R. W. H.)

CEDARBIRD (CEDAR WAXWING): *see* WAXWING.

CEDAR RAPIDS, a city of east central Iowa, U.S., the seat of Linn county, is on the Cedar river in an agricultural region that emphasizes corn production and livestock feeding. Pop. (1960) city, 92,035; standard metropolitan statistical area (including all of Linn county) 136,899. The Sauk and Fox Indians relinquished title to the region in the 1830s and the power possibilities of the river soon attracted pioneers to the site of Cedar Rapids. A town charter was obtained in 1849 and a city charter in 1856. Major periods of city growth occurred between 1870 and 1890, during World War I and after 1940. Many early settlers came from the Ohio valley and mid-Atlantic states.

By 1900, however, 39% of the county population was of foreign birth or descent and included 3,198 Bohemians and 1,100 Germans. Czechoslovak culture still marks urban life there. The most important manufacturing plants produce radio and electronic equipment, cereals, corn products, meat products and road building and mining machinery.

Coe college, a liberal arts college supervised by the Presbyterian Church, obtained its charter in 1881 although its history began with the founding of Cedar Rapids Collegiate institute in 1851.

Iowa Masonic library contains one of the oldest and largest Masonic collections in the U.S. The city has a symphony orchestra and a community and children's theatre. Palisades-Kepler State park lies to the southeast. (A. G. Bo.)

CEDAR RIVER, a nonnavigable stream in Minnesota and Iowa, named after the stands of red cedar along its lower course. From its source in southern Minnesota it flows southeasterly across Iowa to within ten miles of the Mississippi river and then swings abruptly southwestward to join the Iowa river instead. Over its course of 329 mi., the river drops about 740 ft. The stream is young geologically, and only in places where the glacial material has been removed is the underlying bedrock exposed. (*See* STRATIGRAPHY.) In the Palisades-Kepler State park near Cedar Rapids, Ia., wooded rocky cliffs rise from 30 to 75 ft. above the valley floor.

Hydroelectric power is developed at seven small dams, whose total capacity is under 5,000 kw. The drainage basin comprises 7,819 sq.mi., most of which is fertile agricultural land. Major cities along the river include Austin, Minn., and Charles City, Cedar Falls, Waterloo and Cedar Rapids, Ia. The Cedar river's principal tributaries are the Little Cedar and Shell Rock rivers. (E. HG.)

CEDRINUS, GEORGE (fl. 11th century A.D.), compiled a world history (*Synopsis historiarum*) from the creation to 1057. The earlier part is based on the so-called pseudo-Symeon, an anonymous chronicle which draws on Theophanes (*q.v.*). After Theophanes ends, Cedrinus borrows heavily from John Scylitzes (*q.v.*). He has therefore little independent value, but is important for textual and source problems, and provides the only published version of the Greek text of Scylitzes. Practically nothing is known of his life; he may have been a monk.

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CEFALÙ, a town, port and road junction of northern Sicily, in the province of Palermo, lies 68 km. (42 mi.) E. of Palermo at the foot of a 1,233-ft.-high promontory. Pop. (1957 est.) 12,775 (commune). An episcopal see and formerly capital of the surrounding district, it is an important junction on the railroad line between Palermo and Messina. On the promontory, site of the ancient city, stands the so-called Temple of Diana, a pre-Hellenic sanctuary of megalithic construction (9th or 8th century B.C.). Near the Porta Garibaldi and the Porta Guidecca are the remains of a megalithic wall dating from the 6th century B.C. The external part of the Norman cathedral is well preserved and is finely decorated on the outside with interwoven spiral arches. On each side of the façade is a massive four-story tower, and the portal is beautiful though somewhat damaged. The interior was considerably restored in the 16th and 17th centuries. The arches and their abutments with arabesque molding rest on granite columns with figures carved on the capitals, possibly the work of local artists. The mosaics in the apse and in the first spaces between the arches of the choir (1148) are among the most beautiful in Sicily. The Osterio Magno is an interesting medieval building. The Museo Mandralisca contains a collection of ancient vases and coins and the portrait of "Ignoto" by Antonello da Messina. Cefalù is a tourist centre. Grapes, olives and citrus fruits are cultivated. Fishing is important and there is a canning industry.

The ancient Cephaloedium first appeared in history on the occasion of its alliance with Himilco (*see* SICILY: *Carthaginian Wars*) in 395 B.C. Valued for its strategic natural position, it was in turn conquered by Dionysius, Agathocles and the Carthaginians, from whom the Romans seized it in 254. The new town was founded at the foot of the coastal mountains by Roger II in A.D. 1131, the year in which the cathedral was begun. (G. A. DI R.)

CEGLÉD, a characteristic town of the Alföld or Great Hungarian plain, is located in Hungary, 64 km. (about 40 mi.) S.E. of Budapest, between the Danube and the Tisza. Pop. (1960) 37,943 (mun.). At Cegléd the main railroad line from Budapest divides, one section continuing southeast to Szeged and the other northeast to Debrecen. The principal road from Budapest through eastern Hungary also passes through the town. Cegléd is a well-established market for agricultural products with a traditional export of corn, poultry and fruit. The fruit market and nursery gardens for young trees are well known. Cegléd shared the Calvinist traditions which were widespread in that part of Hungary. (H. G. S.)

CEILING, the overhead surface or surfaces covering a room; the underside of a floor or a roof. It is often used to hide the floor and roof construction. The term is also employed, technically, for any finished boarding or sheathing and especially for a type of narrow, thin board, tongued and grooved, with a molding on the edge.

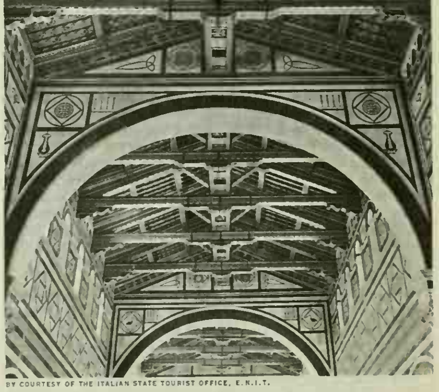
Ceilings have been favourite places for decoration from the earliest times: by painting the flat surface, as in the case of Egyptian tombs; by emphasizing the structural members of roof or floor, as in the beamed ceilings of the period of Francis I in France or the ceilings of Italian medieval churches (*e.g.*, S. Miniato at Florence); by treating it as a field for an over-all pattern of relief (*e.g.*, the earlier rooms of Hampton Court palace near London).

Of Greek ceilings little is known, except for some of marble over temple porticoes, decorated with small, sunk panels or coffers, with molded edges, and the field further decorated in polychrome. Roman ceilings were rich with relief and painting, as is evidenced by the vault soffits of Pompeian baths. Italian Renaissance architects found in similar examples inspiration for much of their most charming painted and relief decoration in stucco, and Robert Adam's 18th-century designs for ceilings ornamented with ovals, fans, hanging garlands, delicate scrolls and little painted panels have the same origin. The general Gothic tendency to use structural elements decoratively led to the rich development of the beamed ceiling, in which large cross girders support smaller floor beams at right angles to them, beams and girders being richly chamfered and molded and often painted in bright colours (the Palazzo Davanzati in Florence contains numerous late 14th-century examples).

In the Renaissance, ceiling design was developed to its highest pitch of originality and variety. Three types were elaborated. The first was the coffered ceiling, in the complex design of which the Italian Renaissance architects far outdid their Roman prototypes. Circular, square, octagonal and L-shaped coffers, with their edges richly carved and the field of each coffer decorated with a rosette, abounded. Occasionally pendants were placed at the intersections (the Hall of the Two Hundred in the Palazzo Vecchio at Florence and various rooms of the ducal palace at Mantua are good examples). The second type consisted of ceilings wholly or partly vaulted, often with arched intersections, with painted bands bringing out the architectural design and with pictures filling the remainder of the space, as in the loggia of the Farnesina villa in Rome, decorated by Raphael and Giulio Romano. In the baroque period, fantastic figures in heavy relief, scrolls, cartouches and garlands were also used to decorate ceilings of this type; *e.g.*, the Pitti palace, Florence; many French ceilings of the Louis XIV style are similar.

In the third type, particularly characteristic of Venice (*e.g.*, the doge's palace), the ceiling became one large framed picture. (*See* RENAISSANCE ARCHITECTURE; BAROQUE AND POST-BAROQUE ARCHITECTURE.) (T. F. H.)

In contemporary architecture ceilings may be divided into two major classes—the hung ceiling and the exposed ceiling. With



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BEAMED CEILING, BASILICA OF S. MINIATO AL MONTE, FLORENCE, ITALY; 11TH CENTURY ceilings hung at some distance below the structural members some architects have sought to conceal great amounts of mechanical and electrical equipment, such as electrical conduits, air-conditioning ducts, water pipes, sewage lines and lighting fixtures. The ceiling may be smooth plaster applied to metal lath (*e.g.* Rockefeller centre, N.Y.), translucent plastic, or aluminum egg crating (*e.g.* Manufacturer's Trust Co., N.Y.). Other architects, emphasizing the aesthetic of the exposed structural system, delight in revealing the mechanical and electrical equipment. In response to this desire many structural systems have been developed that have an expressive power in themselves and make admirable ceilings (*e.g.* Johnson Wax offices, Racine, Wis., by Frank Lloyd Wright, 1939, and the Exposition hall in Turin, Italy, by P. L. Nervi, 1947). *See* INTERIOR DECORATION. (H. MN.)

CELAENAE, an ancient fortress city of Phrygia, at the site of the modern town of Dinar, in the Afyonkarahisar *il* of Turkey. It was the starting point of the march of Cyrus (401 B.C.) with the 10,000 against Artaxerxes. Its acropolis long held out against Alexander the Great in 333. In Seleucid times, in order that it should benefit from the growing commerce on the great eastern trade route, Antiochus Soter refounded it on a more open site as Apamea (*q.v.*). West of the acropolis were the palace of Xerxes and the agora, in or near which is the cavern whence the Marsyas, one of the sources of the Buyukmenderes (Maeander), issues. (WM. C. B.)

CELANDINE (*Chelidonium majus*), a member of the poppy family (Papaveraceae), an erect branched herb from one to two feet high. It has yellow sap, much-divided leaves and yellow flowers, nearly an inch across, succeeded by narrow, thin pods, each opening by a pair of fine valves, separating upward.

The plant grows in waste places and hedgerows, and is probably an escape from cultivation. It is common in Britain and has become widely naturalized in eastern North America, in open grounds, roadsides and in woods from Maine to Ontario and Illinois southward to North Carolina. The lesser celandine is a species of *Ranunculus* (*R. Ficaria*), a small low-growing herb with smooth heart-shaped leaves and bright yellow flowers about an inch across, borne each on a stout stalk springing from a leaf-axil.

JOHN MARKHAM

CELANDINE (CHELIDONIUM MAJUS)

CELASTRACEAE, the staff tree family of about 45 genera and 500 species of trees and shrubs, often twining, with simple, mostly deciduous leaves, widely distributed. A few of the genera containing species that are cultivated for ornament are *Celastrus*, *Euonymus*, *Maytenus* and *Pachistema*. *See* CLIMBING BITTERSWEET; EUONYMUS. (J. M. BL.)

CELEBES (SULAWESI) is one of the four Greater Sunda Islands in Indonesia. Pop. (1956 est.) 6,404,516. Area (including adjacent islands) 72,986 sq.mi. The island extends from 1° 45′ N. to 5° 37′ S. and from 118° 49′ E. to 125° 5′ E.

Physical Geography.—From the backbone of the island, which runs north and south, three long peninsulas project northeast, east and southeast, respectively, the first being the longest. These peninsulas form great gulfs on the eastern side—from north to south, the gulfs of Tomini or Gorontalo, Tolo and Bone, the first being the largest. Thus the island is a curious shape and its length, 637 mi., and coast line, 3,536 mi., are quite disproportionate to its breadth, which averages between 36 and 120 mi. and at one point narrows to 9 mi. No place in Celebes is as far as 70 mi. from the sea. Celebes is situated in a very deep sea, between Borneo on the west, which is in a shallow sea on a shelf off the continent of Asia, and New Guinea to the east, also in a shallow sea, on a shelf projecting from Australia. The coast is dangerously fringed by drying coral reefs with many shoals and banks.

The whole island is mountainous. Two parallel ranges run from north to south in the main central mass, and a northern extension of this traverses the entire northern arm of Celebes to Manado. From these ranges a single range projects northeastward to the extreme end of the eastern arm of the island, and two parallel ranges run, in a southwesterly direction, throughout the greater part of the southeastern arm. The great central ranges (with Kambuno, 9,678 ft., and Baliase, 9,896 ft., in the centre, and Rantekombola or Mario, 11,320 ft., and Lompobatang or the peak of Bonthain, 9,514 ft., in the southern arm) throw out large spurs, which dominate the central and western parts of Celebes. In the extreme northeast (Mt. Klabat, 6,634 ft.) and south the mountains are volcanic, some in the former region being active, while *solfataras* and hot springs are found in Minahasa. Wide rift valleys between the mountain ranges contain several lakes—in the north, Tondano, 1,968 ft. above sea level, 8 mi. long and $3\frac{1}{2}$ mi. wide, Limboto, Batudako and Bolanosau; in the central nucleus, Lake Lindu; farther south, Tempe and Sidenreng (monsoon lakes); and east of these, extending into the southeastern arm, the principal lakes of the island, Poso, Matana and Towuti. These three are very deep, Matana having been sounded to 1,936 ft. and Poso to 1,673 ft.

SHELL

FISHING CRAFT IN THE HARBOUR AT MAKASAR, CELEBES

The rivers of Celebes are short and unimportant. Waterfalls and rapids are frequent, the mouths are obstructed by bars and there is very little coastal plain, save at the head of the Gulf of Bone and near Makasar (Macassar) and among mangrove swamps of the north coast of the Gulf of Tomini. The Djenemedja, which flows into the Gulf of Bone, is wide and navigable for some distance from its mouth. The Poso, which enters the Gulf of Tomini, is also wide and navigable, for very small craft, to Paluasi. The Sadang, entering the Gulf of Mandar on the southwest coast, has many affluents and is navigable by sampans. The La Solo, southeast, admits steamers for 16 mi. from its mouth. The rivers of Gorontalo are very small. The best natural harbours are Manado bay, Amurang bay, Kuandang bay and Dondo bay on the north coast; Tambu bay, Parepare bay and Palu bay (Donggala) on the west coast; Gorontalo and Poso in the Gulf of Tomini, with the Gulf of Poh, which penetrates eastward for 22 mi.; the bays of Tomori, Kendari and Staring in the Gulf of Tolo; and the bays of Mekongga, Palopo, Usu (Luwu) and Sopang in the Gulf of Bone. Off the west coast is the Spermonde (Sangkarang) archipelago, a number of low islands surrounded by coral reefs; off the south coast, Salajar or Kabis. At the end of the southeastern peninsula are several islands, of which the most important are Kabaena, Muna, Wowoni and Butung. They are separated from the peninsula by the straits of Tioro and Wowoni, both dangerous. The

Banggai and Peleng islands lie off the eastern extremity of Celebes and geographically resemble it, but the Banggai group is administratively a part of the Moluccas.

In the Gulf of Tomini are the Schildpad or Togian Islands, extending for nearly 80 mi. east and west, the chief of them Talatakoh, Togian and Batudaka. The Sangihe (Sangi) Islands (*q.v.*) form the northeast extension of Celebes toward Mindanao in the Philippines, which is continued by the Talaud group, northeast of these. They belong administratively to Celebes.

Geology.—The situation of Celebes between the two shelves of the Asian and Australian continents makes its geology especially interesting. The broad central block is a complex of igneous rocks, with granite, gneiss, diorite and amphilbolite characters, pierced in places by later eruptives, mostly Tertiary. This block is enclosed around its base by Cretaceous rocks, overlaid by Tertiaries and Recent alluvial deposits toward the coasts. In the southeast corner of the block there is a broad band of pre-Tertiary tuffs, fringed occasionally by coral limestone. The northern part of the Gulf of Bone is widely bordered by Pleistocene and alluvial deposits, resting in the northeast upon Late Tertiaries. A band of old igneous rocks stretches from near Palopo across the Gulf of Bone and the southeast peninsula to the Gulf of Tolo.

The meridional ridge of Celebes has an axis of crystalline schist, tourmaline quartzite and glaucophane schist, penetrated and overlaid by andesite and basalt, flanked by tuffs and overlaid by Late Tertiary *Orbitoides* limestone. The southern extension from the central block shows Late Tertiary limestone, raised in parts to a height of more than 3,000 ft., where portions of the Archaean foundation are revealed. East of the central block is a faulted and depressed area of crystalline schists and metamorphosed shales, with gneiss and metamorphic limestones. The southeastern and eastern peninsulas are, in the main, a broken crustal block with igneous rocks. Metamorphics run southward along the Gulf of Bone inland. A series of Pleistocene to Recent rocks passes near to the north of Muna Island, with no Tertiaries except a small patch on Butung Island. Around Mekongga bay is a fringe of coral limestone which borders Kabaena, covers more than two-thirds of Muna, all except the centre of Butung and all of Wowoni and the small islands north of it. There are indications of Jurassic rocks south of Lake Matana and metamorphics reappear in Peleng Island. The northeastern peninsula has northern and southern belts. The northern belt consists mostly of sedimentary rocks, Cretaceous or Tertiary, some altered by metamorphism. This belt runs parallel with the coast and is separated by a parallel fault line from the southern belt, which consists of granites, gneisses, schists and intrusives, with Archaean schists and altered rocks, caught in faults; the valleys are filled with Recent deposits. Older rocks, Cretaceous and Tertiary, are preserved in occasional east and west bands, and in places near the south coast there are fringes of coral limestone. Minahasa is volcanic and differs structurally from any other portion of Celebes.

Climate.—The climate of Celebes is hot but is tempered by sea winds, which reach every part of it. Mean temperature ranges between 86° and 72°, with absolute extremes of 94° and 66°; it falls to below 50° at high altitudes on the mountains. There is rain in all months, though relatively little in the east monsoon, June to October. Makasar has an annual total of 115 in., Manado 109, but in the mountains it is much higher (Rantepao, in the southwest central section, has 160 in.). Rift valleys on the west side tend to be very dry (Palu has 21 in.). The number of rainy days varies from 194 at Rantepao to 81 at Palu, and is about 150 in Makasar and Manado.

Animal Life.—Celebes has the poorest fauna in the archipelago in number of species; yet among these it has animal forms with close allies nowhere else in the world except in the three neighbouring islands of Batjan, Buru and Jolo. Most interesting are the babirusa or pig deer, so named by the Malays from its long, slender legs and curved tusks, resembling horns; the black-crested baboon (*Cynopithecus nigrescens*), akin to the African baboon; and the anoa, or dwarf buffalo, hunted extensively for its flesh. There are peculiar varieties of other indigenous animals, including five squirrels, a pig, a deer, two wood rats and two marsupials. Celebes has a number of peculiar species of parrots, woodpeckers, hawks, cuckoos, hornbills, starlings, flycatchers and pigeons; the brush turkey is found there. Crocodiles are common. There are snakes of various kinds, and many peculiar species of beetles and butterflies. There is a distinct cleavage between the fresh-water fishes of Borneo and Celebes.

Although it has species which belong neither to the one nor to the other, the fauna of Celebes is more Asian than Australian and the island is established as a transitional region between the oriental and Australian zoological regions. It is one of the oldest parts of the archipelago.

Vegetation.—Much of Celebes is still covered with forest, especially around the Gulf of Tolo where it is almost primeval and practically without tracks or clearings. The vegetation grows on the sides of precipitous and almost vertical mountain slopes, and the scenery is exceedingly varied and picturesque. The rift valleys are extremely fertile, and there are extensive plateaus at varying heights where there is rich pastureland. The flora, which shows many resemblances to that of the Philippines, is more Asian in character in the west of the island and more Australian in the east. While the trees of the lower mountain slopes differ strongly from those of Java and are smaller, the alpine flora is very similar. There are many kinds of palms—fanleaf, rattan, sago and *Arenga sacchorifera*, which gives fibre for ropes, juice for sugar and a beverage known as sagwire. Bamboo, breadfruit, tamarind and coconut trees flourish.

People.—There are at least six quite different peoples of Celebes—the Toala, Toradja, Bugis, Makasars, Minahassen and Gorontalese. The Toala are found scattered all over the island, sometimes living in communities among other peoples as a result of having been enslaved by them. It is thought that they represent the true aborigines of Celebes. They are short and dark and have wavy or curly hair, a broad, flat nose, prominent mouth and receding chin. They are undeveloped and uncivilized, partly nomadic, shy jungle dwellers, quiet and good-tempered, with a distinct language of their own.

The Toradja are a collection of tribes in central, southeast and east Celebes. Living in isolated groups, in a very thinly populated country, they differ considerably in development. Of Malayo-Polynesian stock, they are divided into highland and lowland people. In some parts they intermingled with the Toala; in others they came under a Bugis and Makasarese civilizing influence. Mostly pagan (with increasing Muslim and Christian elements, however), they gradually began to give up their inaccessible fortified villages for neat little settlements of houses standing each in its own garden, and to become reconciled to the government prohibition of head-hunting and divination by spear throwing. Courteous and good-tempered when their confidence has been gained, they are agriculturists with only a few industries such as plaiting, pottery, wood carving and ironworking. Bark clothing is worn in remote districts; Malayan-style cotton garments where there is contact with more advanced cultures. Many ornaments are worn and teeth are filed. Society is organized on the family basis, and the tribe is an extension of the family, a man choosing a wife from another branch of his own family. There are no social distinctions or tribal chiefs and women have, comparatively, a high position, being able to choose their own husbands. The Toradja collect forest produce and grow rice, possess their own language, with many dialects, and Christian schools have been well received by them.

The Bugis and Makasars, probably of Toradja descent, came into touch with Hindu culture in southern Celebes, their home, and later were converted to Islam. They are now all Muslims, but with traces of Hinduism and paganism. Well built, fairly light skinned and energetic, they are keen traders, proud, passionate and vindictive, devoted to feasting, gambling and cockfighting. As shipbuilders and seafarers they are unsurpassed in the archipelago; their excellent proas are to be found everywhere in Malayan seas. Society is both endogamic and exogamic, with survivals of a matriarchate, but Islamic law and customs tend to displace all others. Both peoples are abstemious, feed chiefly on rice, maize and fish, eating buffalo flesh on festive occasions only;

clothing is Malayan in style. They are extremely industrious, but their industries are not in a high state of development. Weaving is one of the chief, cotton sarongs of fine material being exported in large numbers from Mandar. Plaited goods of superior quality are made in Bone, gold- and silversmiths are mostly in Makasar, Gowa, Mandar and Bone, ironworkers in Luwuk, Laiwui and Mandar, while shipbuilders flourish in Pambauwang, around Bira and elsewhere. A peculiar written alphabet, shared by Bugis and Makasar, is used also by some of the tribes of northern Celebes and by people of Sumbawa. The Makasar language and Bugis, to which it is nearly allied, belong to the Malayo-Javanese group. Arabic letters are used for religious literature and books in Arabic are read. There is a slight native literature, historical, legal, epistolary and poetic. The Bugis and Makasars, like other groups in Celebes and throughout the archipelago, began to adopt Malay as a lingua franca and then began to learn standard Indonesian.

The Minahassen are quite distinct from the other inhabitants of Celebes; they are closely related to the people of the islands of Siau and Sangihe, and are probably descended from a partly Caucasian immigrant race from the north which settled there and in the Philippines. They have a very light skin (some of the women have red cheeks and lips), lighter than any other race in the archipelago, high nose, prominent lips, widely separated eyes, stiff, short, black hair and pleasant features, and they are tall and strong. In the early 19th century they were a savage, warlike race, constantly engaged in raids and head-hunting. Protestant missions, starting in 1827, converted them and the Minahassen came to be among the most westernized people in the archipelago. They live in European style (each village has its church and school), are clean, sober and industrious. Many formerly served in the Dutch colonial army and police, and they compete successfully with Amboinese and Eurasians as clerks, teachers and the like. Their native tongue was largely superseded by Dutch, which in turn was replaced officially by Indonesian. Their territory is in the extreme northern tip of the island and their number is about 500,000.

The Gorontalese, who live in the west and south of the northeastern peninsula, are of the Toradja family, not related to the Minahassen, and largely Muslim, a short, smooth-haired, and rather light-skinned people. There is a marked difference between the people of the coast and inland. (J. O. M. B.)

Archaeology.—The earliest evidence of human habitation in Celebes is afforded by the stone implements of the Toalian culture of the southwestern part of the island. This is regarded as Mesolithic and is characterized by stone flakes and blades and, in its later stages, by arrowheads. Human remains associated with it are of small people with small teeth, very distinct from the usually large-toothed people of Melanesian type whose remains accompany the Hoabinhian Mesolithic of Indochina and Malaya. The Toalian culture was discovered near the beginning of the 20th century by the cousins Sarasin and was intensively studied by H. R. van Heekeren.

A Neolithic site near Galumpang in western central Celebes was excavated by Van Stein Callenfels. Some hand axes of Mesolithic type were found, together with typical Neolithic tools including quadrangular adzes, tanged adzes, arrowheads and curious violin-shaped stone tools resembling a type found in the Neolithic of Japan. The tanged adzes resemble those of Indochina and Hong Kong, and the assemblage seems to indicate that the Neolithic of Celebes had its origin in the region north and east of the island.

No indigenous early metal age culture is known from Celebes, the few celts and other bronze objects that have been found being probably importations. (M. W. F. T.)

History.—The general theme of the history of Celebes is one of contrast and conflict between coastal and interior peoples, the former consisting of seafaring and trading colonists, the latter of indigenous tribes. In the century preceding the coming of the Europeans, Muslim sultanates of coastal Malays had established themselves firmly in southern Celebes.

The Portuguese appear to have discovered and established some influence in Celebes in 1512 when they were monopolizing the spice trade of the Moluccas. The sultan of Makasar, as head of the state of Gowa (southwestern Celebes), favoured the Portuguese and the English, who later attempted to get a footing in Celebes. This annoyed the Dutch, who defeated the sultan early in the 17th century despite help given to him by the Portuguese. In 1607 a Dutch settlement at Makasar began to establish a firm trade footing in southern Celebes. The Dutch then used the sultan to check the power of Ternate in the Moluccas, and with their friendship he was able to subdue Bone, a rival state in southeast Celebes, and to hold Luwu. He grew too powerful, however, and the Dutch (1654) conquered the island of Tidore in spite of a Makasarese fleet. War with Gowa, interrupted only by indecisive treaties, lasted till 1667, when the Dutch admiral Speelman crushed Gowa and the Makasarese, with help from Bone, and imposed the Bongay treaty. Gowa abandoned all claims to supremacy, surrendered lands to the Dutch East India company to which it left its trade monopoly, and fell into decay. Bone's growth in power led the Dutch later to protect the independence of Gowa but the Dutch used their Bugis allies of Bone in the early wars in Java, and during the British occupation of Java Stamford Raffles had to send an expedition to Celebes against the unruly Bugis. When Dutch power in Java was restored, a Dutch expedition had to be sent to Bone; but it was not until 1848 that Bone submitted to the Bongay treaty in a revised form. Later conflicts led to complete loss of independence for Bone (1905) and Gowa (1911). The state of Luwu had signed the Bongay treaty in 1667, but it was not until after the Bone War, in 1861, that the Dutch succeeded in establishing any real influence there. Manado, on the northern coast, was first colonized by the Spaniards, and settlers were attracted from neighbouring islands. The sultan of Ternate also claimed suzerainty over it, and fairly early in the 17th century the Dutch entered into relations with the inhabitants to protect them from both Spaniards and Ternate. In 1657 the capital and fort were built at Manado and a trade agreement was signed for the delivery of a certain amount of ironwood annually. In 1677 the Sangihe and Talaud islands and, later, certain small kingdoms on the north coast were placed under the rule of the Dutch governor of Ternate, and from that time onward Dutch influence expanded until the conquest of the East Indies by the Japanese during World War II. In 1949 Sulawesi became part of the Republic of Indonesia. Thereafter there were a number of political disturbances and open rebellions in the island. The central government, however, maintained control over the port towns and surrounding areas.

Administration and Economy.—Celebes and the adjacent islands are divided into two provinces: Sulawesi Tenggara-Selatan (Southeast and South) and Sulawesi Utara-Tengah (North and Central), with populations, respectively, of about two-thirds and one-third of the whole. Southeast and South Sulawesi is divided into nine districts: Kota (city) Makasar, Makasar, Bonthain, Bone, Parepare, Mandar, Torea, Luwuk and Southeast Sulawesi. North and Central Sulawesi is divided into Sangihe and Talaud (Islands), Minahasa, Kota (city) Manado, Bolaang-mongondow, Sulawesi Utara, Donggala and Poso.

The economically most advanced parts, with a fairly dense population, are the south arm and the tip of the northeast arm. The coastal plains of Makasar and Bonthain produce dry-land crops (*e.g.*, maize [corn], cassava, yam, beans) and wet rice where adequate water is available. Virginia-type tobacco is cultivated on the phosphorous sandy soils of Bonthain. Salt is produced along the coast. The granary of Celebes is the wide alluvial plain—a former sea strait—with a northwest-southeast axis, centring on Tempe and Sidenreng lakes. Maize is grown on the lake bottoms and swamplands that dry out in the east monsoon. The catch of lake fish is a secondary source of income. Rice cultivation, which is also important, is dependent either on rainfall or on irrigation works, as near Watampone (Bone) and especially in the Sadang river area northeast of Parepare. The Sadang project, initiated in the 1930s and completed after World War II under Dutch administration, serves over 150,000 ac. of sawah (paddy fields). A dam and hydroelectric station on the Sawito river (east of Parepare) provide power for pumping the water to higher ground. Much of the rice and maize surplus is exported via Parepare.

Palima, the outlet on the east coast, is seriously impaired by silting. The higher grounds beyond the coastal plains are a sparsely populated savanna landscape, with lontar palms and groves of teak, especially on the dry east side. A fairly good road runs along the coasts of the south arm with connecting branches through its interior. The chief port and trade centre as well as the capital of Southeast and South Celebes is Makasar, with a population of about 250,000. It is the main entrepôt for southern Celebes and also for much of eastern Indonesia.

The other economically advanced area is in the northeast, centring on Minahasa. There the mainstay of the economy is copra, the dried meat of the coconut, largely produced by small holders on the fertile volcanic soils. Dry field crops and rice (especially around Lake Tondano) are grown, but there is a food deficit. The less populated districts to the west of Minahasa and the Sangihe and Talaud islands to the north are also important copra producers. Forest products, including timber, rattan, copal and dammar, are exported. There is also some sulfur production. The main port is Manado (est. pop. 65,000) on the west side of the island's north tip, on a mountain slope overlooking a beautiful bay. Rough seas during the northwest monsoon endanger shipping from November to March. Manado was formerly known as a very clean and neat town of parklike appearance with, as the capital of northern Celebes, many government buildings and regional offices. It was severely bombed in World War II and rehabilitation was slow. Roads lead across the peninsula past Tomohon, a pretty mountain town and mission centre, and Tondano, on the lake of that name, to Kema, a small port on the south coast, frequently used instead of Manado in the northwest monsoon season. Westward a road leads from Manado along the coast to Amurang, another port on a broad bay. Outside the towns the population of Minahasa lives in villages strung out along the roads. West of Minahasa the main port is Gorontalo. There is much fishing in the seas surrounding northern Celebes, including that of tuna, centring on the port of Aertembaga.

The east and southeast arms of Celebes are hardly touched by modern civilization. The population is sparse; subsistence agriculture is practised on temporary fields and there is some export of copra and forest products. There are few roads, and government control over the interior is loose. Kendari is the administrative centre of southeast Celebes, and Poso of the north central and eastern section. Roads lead from both towns across the interior to the opposite coasts. There are nickel deposits in southeast Celebes, some of which are exploited, near Kolaka and Malili. An interesting area is the Toradja highlands, opened to western civilization early in the 20th century by governmental and missionary activity. A road leads from the lake plain in central south Celebes northward through the rugged, fantastically shaped, limestone mountains to Rantepao on the headwaters of the Sadang and down again like a corkscrew to Palopo on the coast. Wet rice cultivation was introduced in 1907, and the hardy, energetic Toradjas practise it on a wide scale, also growing some coffee. However, shifting cultivation and burning for game hunting have destroyed much of the forest cover, resulting in serious soil erosion and, in the plains, silting of rivers. (J. O. M. B.)

CELEBES SEA, enclosed by the island chains of Indonesia and the Philippines, measures about 420 mi. from north to south and 520 mi. east to west, and is 165,000 sq.mi. in area. It is bounded on the north by the Sulu archipelago and Mindanao, on the east by the Sangihe Island chain, on the south by Celebes (Sulawesi) and on the west by Indonesian Borneo (Kalimantan) and British North Borneo. Main access is from the south via the Makasar straits.

The Celebes sea occupies a large downfaulted block. More than half the sea is over 2,000 fathoms deep, the greatest recorded depth being 3,400 fathoms. The edges of this enclosed basin are seen in the line of volcanic cones in northern Celebes and Sangihe Islands as well as the mountains of the Sulu archipelago and Mindanao.

Fishing is important and there is much coastwise and interisland trade in marine produce, copra, coffee, timber and forest products. Although the Dutch seized parts of Celebes and the Sangihe group early in the 17th century, the Celebes sea itself was long dominated by traders and pirates from Borneo, Celebes and the Sulu archipelago, and did not come under colonial control until late in the 19th century. (L. A. P. G.)

CELERY (*Apium graveolens*), a succulent, hardy biennial plant of the family Umbelliferae (*q.v.*). Celery is native to the near east and eastern Mediterranean area. It was known to the ancient Greeks and Romans but apparently not much earlier, since names for it in very ancient languages are lacking. It was used until the 17th century only as a flavouring or for its supposed medicinal qualities; the first record of its use as food was in France in 1623. The ancient forms were similar to, if not the same as, smallage, an herb still grown for flavouring. Celery with large, fleshy, succulent, upright petioles appeared after the late 1700s.

In the first season of growth celery normally produces only a dense, erect rosette of leaves having very large, overlapping, long, thick, succulent petioles and compound leaves. After a period of rest imposed by temperature near freezing, a large, branched flower stalk grows three to five feet. Small white flowers are borne in somewhat open compound umbels. The "seeds" are halves of tiny two-parted fruits called schizocarps, and are among the smallest seeds of cultivated plants. Both yellow and green varieties are popular; the finest quality is found among the modern green varieties of the Utah and Pascal types. The "hilling" of soil high up on celery plants to blanch the stalks and make them mild in flavour became much less common with the introduction of varieties free of objectionably strong flavour. In the United States celery is grown chiefly in California, Florida, Michigan and New York.

Celeriac (*Apium graveolens*, var. *rapaceum*) or turnip-rooted celery is a form having a large edible root instead of large petioles. (V. R. B.)

CELESTA, an instrument of percussion resembling in shape a small piano, usually heard in a large orchestra. Patented about 1886 by Auguste Mustel, it consists of a series of small metal bars that are set in vibration by hammers operated by a pianoforte action and keyboard. Each metal bar is resonated by a wooden box or similar chamber, the fundamental thus being reinforced. The bars are sustained and controlled by a foot pedal. Pressure on the pedal lifts a felt pad from the bars, permitting the use of short or sustained notes. It has normally a chromatic range of four octaves. The celesta is frequently used in the standard repertoire of the modern orchestra, Tchaikovsky, in his *Nutcracker Suite* (1891–92), being one of the first composers to write for it. It should not be confused with the dulcitone (or typophone), an instrument equipped with graduated steel tuning forks instead of metal bars. (J. Bl.)

CELESTIAL MECHANICS is the branch of astronomy that deals with the mathematical theory of the motions of celestial bodies. The foundation was laid by Sir Isaac Newton by the publication in 1687 of his *Philosophiae Naturalis Principia Mathematica,* usually referred to as the *Principia*. Here he published the three laws of motion which express the principles of mechanics, consolidating progress begun with the pioneer work of Galileo Galilei earlier in the 17th century.

Newton also formulated the universal law of gravitation, which states that any two particles of mass in the universe attract each other with a force that varies directly as the product of the masses and inversely as the square of the distance between them. These foundations permit the statement of a problem in celestial mechanics in the form of a set of equations of motion, ordinary differential equations of the second order. A proper understanding of the subject requires knowledge of this branch of mathematics.

An important triumph of Newton's was that Kepler's three laws of planetary motion, which had been derived empirically by Johann Kepler, were obtained as a consequence of the law of gravitation in conjunction with the laws of motion, applied to the problem of two bodies (*see* ORBIT, in which basic technical terms used in this article are defined).

The next in order of difficulty is the case in which three bodies are considered, the famous problem of three bodies. The solar system, consisting of the sun and nine known principal planets, all but three surrounded by one or more satellites, constitutes a problem of many bodies.

The significant circumstance that the mass of the sun is about 1,000 times that of the most massive planet, Jupiter, makes the sun's gravitational attraction far outweigh the mutual attractions of the planets. This suggests a process of successive approximations that has become the standard procedure in the mathematical theory of planetary motion, the deviations from elliptic motion being called the perturbations. In the case of the moon's motion the earth produces the principal attraction. Notwithstanding the very great mass of the sun, the effect of the sun's attraction is a small fraction of that of the earth owing to the close proximity of the latter. However, in the case of some satellites the perturbations produced by the sun's attraction may reach very sizable amounts. The mutual attractions of the component stars in triple and quadruple systems of stars suggest other interesting problems in celestial mechanics.

During the 18th century powerful analytical methods, made possible by the development of differential and integral calculus, were applied to the problems of celestial mechanics. These methods were generally successful in accounting for the observed motions of bodies in the solar system.

The moon's motion was an apparent exception until this problem was finally solved during the second quarter of the 20th century (*see* MOON). The observed deviations between observations and theory were shown to be caused not by defects in the theory but by lack of uniformity of the earth's rotation. This led, in 1950, to the introduction of "ephemeris time," which is independent of the earth's rotation, but based on the observed motions of the moon and the sun. Ephemeris time may thus be regarded to be the independent variable of Newtonian mechanics.

Relativity Effects.—It is now recognized that the Newtonian laws of motion and law of gravitation are approximations to the true laws governing the motions of celestial bodies (*see* RELATIVITY).

In the motion of the perihelion of the innermost planet, Mercury, and in a very few other cases, relativity effects are large enough to be revealed by the most precise observations. A comparison between observations and theory, in which the perturbations are properly taken into account, confirms the excess of the motion of the perihelion in the amount of 43 seconds of arc per century, as required by the theory of relativity. This is one of the most convincing observational proofs of that theory.

The effect diminishes rapidly for planets at a greater distance from the sun. In the case of the earth the relativity advance of the perihelion is about four seconds of arc per century, just large enough to be confirmed by observations. Because of the smallness of the relativity effects in problems in celestial mechanics the justified procedure is to continue the use of the equations of motion following from the classical theory, and to apply the small relativity corrections, if at all necessary, in a minor adjustment of the results.

Gravitational Attraction of Finite Bodies.—The Newtonian law of gravitation is stated for particles, not for bodies of finite extent. It was shown by Newton that bodies the masses of which are arranged with perfect spherical symmetry attract each other in accordance with the law of gravitation as if the masses were concentrated in the centres of the respective spheres. It is found that the effect of nonsphericity diminishes rapidly with the distance between the bodies. Hence in the solar system in which the principal bodies are all nearly spherical and the distances, as a rule, large compared with the dimensions of the bodies, it is in many cases permissible to treat the planets and satellites as point masses.

Interesting exceptions are exhibited by the orbits of the inner satellites of outer planets and of artificial earth satellites. The gravitational attraction exerted by a rotationally flattened planet on a nearby satellite differs appreciably from that exerted by a spherical body with the same mass. The principal observable effects are a backward motion of the node and a motion of the line of apsides. The rates of these motions depend primarily on the radius of the orbit, on the inclination of the orbital plane to the planetary equator and on the degree of concentration of mass in the interior of the planet. Observed data may therefore reveal significant information concerning the distribution of mass within the planet. The most important applications have been made for Jupiter and Saturn from their inner satellites and for the earth from artificial satellites.

Other Branches of the Subject.—A related branch of celestial mechanics is the gravitational theory of rotating liquid or gaseous masses with applications to the earth and the other larger planets. Astrophysical applications to close double stars have become increasingly important (*see* GEODESY and PRECESSION OF THE EQUINOXES). Newton explained the ocean tides as caused by the gravitational attraction of the moon and the sun. Sir George Howard Darwin, in addition to developing modern methods of tidal analysis and tidal prediction, also treated the cosmogonic aspect of tidal theory in his work on the development of the earth-moon system (*see* TIDES).

The various subjects described are recognized branches of celestial mechanics, which may be understood to embrace all of gravitational astronomy.

Planetary Theory.—An important method for the treatment of planetary perturbations was introduced by Joseph Louis Lagrange (1736–1813). In an elliptic orbit the six orbital elements have constant values, completely determined by the three co-ordinates and the three components of the velocity at any time. Since the attractions by other planets cause a planet to follow a path differing from a fixed ellipse, the elements of its orbit so determined will necessarily vary with the time. Hence one may describe the "perturbed" orbit of a planet by giving the elements as functions of the time. Lagrange's method provides a process for deriving analytical expressions for the derivatives of the varying elements. These expressions are rigorous, but their integration requires the introduction of a process of successive approximations. The ordinary procedure gives rise to the presence of terms proportional to the time, in addition to periodic terms, in the final expressions for the elements. The terms proportional to the time, t, are called secular terms. Their presence raises such questions as whether the eccentricity of a planetary orbit may increase indefinitely, endangering the stability of the planetary system. Such a conclusion would be very superficial. The terms obtained in further approximations, having higher powers of t as factor, will modify the terms obtained in the earlier approximations in a manner that cannot be foreseen without appropriate mathematical analysis.

The integration of the periodic terms introduces divisors of the form $kn + k'n'$, in which n, n' are the mean motions of the two planets, and k, k' integers, both positive and negative. In the mean longitude the squares of these divisors occur. Whatever the mean motions, there will always be linear combinations $kn + k'n'$, small compared with either of the mean motions, n or n'. Such small divisors cause large coefficients in long-period terms, with the principal effect in the mean longitude. The motions of the planets Jupiter and Saturn furnish one of the most interesting illustrations of the effects of small divisors. The annual motions of the two planets are very nearly in ratio 5 to 2, which produces a long-period term with period of about 900 years. The amplitude of the perturbation in the mean longitude is 1,196 seconds of arc in Jupiter and 2,908 seconds of arc in Saturn. These are "the great inequalities" in the motions of these planets the cause of which was discovered by Laplace in 1786. The small divisors in celestial mechanics are related to the more general problem of resonance in mechanical systems.

A more direct approach to the solution of the perturbation problem is that in which the perturbations in the co-ordinates are obtained directly. Among the methods of this type that were employed with success may be mentioned those of Pierre Simon de Laplace and of Simon Newcomb. The apparent advantages are largely cancelled, however, in cases of planetary motion in which large perturbations due to small divisors are an important feature. In such cases a method in which the mean longitude is obtained has decided advantages. By an ingenious procedure, P. A.

Hansen succeeded in deriving a method that combines the advantages of the two solutions of the perturbation problem. This method has been tested in numerous applications, and was chosen by G. W. Hill for his theory of Jupiter and Saturn, the most difficult problem among the principal planets.

An accomplishment that demonstrated strikingly the power of the theory of planetary motions was the discovery of the planet Neptune in 1846. Its presence and location in the sky had been predicted with astonishing accuracy by J. C. Adams and by U. J. J. Leverrier from deviations in the motion of the planet Uranus (*see* NEPTUNE). Attempts were made to discover planets beyond Neptune by a similar procedure, but the discovery of Pluto at the Lowell observatory in 1930 must be ascribed to perseverance in systematic search rather than accuracy of prediction by mathematical theory.

Secular Variations.—Planetary theories of the types described are entirely satisfactory for the immediate purposes of astronomy: the construction of tables that represent the motion of a planet for a limited time, say, a few thousand years. For questions concerning the stability of the solar system or, generally, its configuration in the very distant past and future such representations of planetary motion are insufficient. The question arose whether the secular terms occurring in planetary theories could be avoided. Lagrange obtained a solution in which he ignored the periodic terms. Retaining only the terms of the lowest power in the elements he obtained for the variation of the elements two sets of linear differential equations with constant coefficients, the eccentricity and perihelion appearing in one set, the inclination and node in the other. For the principal planets of the solar system, excluding Pluto, these equations have been solved in closed trigonometric form. In a solution of this type one obtains for the eccentricity and perihelion of each planet expressions containing eight trigonometric terms, the separate terms constituting oscillations with periods ranging from 57,000 years to 2,100,000 years.

Similar expressions are obtained for the elements defining the positions of the orbital planes in space. These results give at least some indication of the long-period fluctuations in the elements of the planetary orbits. They should, however, be applied with caution. Further approximations present the same difficulty of small divisors as is met in the case of the periodic perturbations of the ordinary planetary theory.

The asteroids or minor planets furnish a rich field of application of the processes of celestial mechanics. The existence of the gaps in the ring of asteroids leads to the difficult theory of resonance in planetary motion. The application of the theory of secular variations led K. Hirayama to the discovery of five families of minor planets. He concluded that the members of each family must be fragments of a larger parent body. (*See* ASTEROIDS.)

Satellite Motion.—A common feature of all satellite problems is that the motion proceeds at a much more rapid rate than among planetary orbits. In the moon's motion the line of apsides goes through a revolution in about 9 years, the node in 19 years. These periods should be compared with the periods of tens or hundreds of thousands of years that affect the motions of the perihelia and nodes of planetary orbits. Consequently, in a satellite theory one cannot permit the appearance of the time in the coefficients of perturbation terms in the manner in which they are tolerated in planetary theories. One must aim at expressions free from this defect.

The most complete solution of a satellite problem is the lunar theory. Elaborate investigations have also been devoted to the satellite systems of Jupiter and Saturn. These systems present cases of resonance that are among the more interesting problems of celestial mechanics.

Modern Methods.—From the time of Lagrange until the present, mathematical astronomers have made attempts to introduce the more perfect methods used in the lunar theory into the problem of planetary motion. A method similar to that used by Charles Eugène Delaunay in the lunar theory has been applied to planetary problems, but its application to the entire system of principal planets would be exceedingly laborious.

G. W. Hill opened up a new approach to problems in celestial mechanics by his use of a periodic orbit as a first approximation to the lunar theory. This subject was very fully investigated by H. Poincaré, whose work has led to a clearer understanding of the mathematical questions involved.

The analytical difficulty of many problems in celestial mechanics led to the introduction of the method of numerical integration: a step-by-step numerical solution of the differential equations. The method was formerly used on a modest scale for calculating the motions of asteroids and comets, and also in mathematical researches in the problem of three bodies. Undertakings of wider scope have become possible with the introduction of high-speed calculators. An example is the calculation of the co-ordinates of the five outer planets over an interval of 400 years with an accuracy that leaves little to be desired (see *Bibliography*); this would formerly have been a hopelessly laborious undertaking. Numerical integration with high-speed computers has also been used extensively for the calculation of the paths of artificial satellites, especially if allowance must be made for atmospheric drag, and of rockets to the moon and nearby planets.

The General Problem of Three Bodies.—This problem possesses ten known integrals, all of an algebraic character. Such an integral is a function of the co-ordinates and momenta of the three bodies that remains constant throughout the motion. The original equations of the problem form a system of the 18th order, nine differential equations of the 2nd order. With the aid of the ten integrals, the "elimination of the nodes" and the elimination of the time, the system may be reduced to one of the sixth order. This reduction was actually made by Lagrange and improved by later authors by the use of the canonical form of the equations. The reduction of the problem of three bodies with the aid of known integrals suggested that, if additional integrals were discovered, the problem might be further reduced and even completely solved. All such attempts failed; finally H. Bruns, in 1887, proved that no further algebraic integrals of the three-body problem exist. Soon afterward Poincaré proved that no further integrals uniform with respect to the elliptic elements exist. This result is of the greatest importance since it proves that the developments in trigonometric series used in the astronomical methods cannot converge for all values of the constants within a finite range. It does not exclude such a representation in the case of particular orbits; obvious examples are furnished by the periodic solutions and by the particular solutions which were first studied by Lagrange (*see* TROJAN PLANETS).

The simplified problem in which one of the three bodies has negligible mass and moves in the orbital plane of the two massive bodies, which are supposed to move in circular orbits, is the so-called restricted problem. The system of equations is one of the fourth order with one known integral, the Jacobian integral. Let $1 - m$ and m be the masses of the finite bodies; r, r_1, r_2, the distances of the infinitesimal mass from the centre of the mass and the two bodies respectively, and V the velocity of the infinitesimal mass in a co-ordinate system the origin of which is at the centre of mass, and which rotates uniformly with the period of revolution of the finite masses. The Jacobian integral, if the units of time and distance are conveniently chosen, is then

$$r^2 + \frac{2(1-m)}{r_1} + \frac{2m}{r_2} = V^2 + C,$$

C being an arbitrary constant. By putting $V^2 = 0$ one obtains a single family of curves with C as parameter. These "curves of zero velocity" may be looked upon as barriers in the sense that an orbit for which the constant of the Jacobian integral equals C' can never cross any of these curves of zero velocity for which C' exceeds C. The curves of zero velocity were first introduced by Hill with application to the moon's motion and have figured prominently in more recent studies of the restricted problem.

A totally different approach to the solution of the problem of three bodies was made by using developments in powers of a variable related to the time. If applied to the original equations the method fails owing to the singularities of the differential equations that correspond to collisions. These singularities may be removed by suitable changes of variables, a procedure known as regularization. The first significant step in this direction was made by P. Painlevé. In 1912 K. F. Sundmann obtained a solution for the general problem of three bodies that can be expanded as power series which are convergent, but not uniformly so, for all values of the time. This result is of great theoretical interest.

In the restricted problem, the use of the Jacobian integral permits the elimination of one of the velocity components. Hence the motion can be represented completely by a trajectory in a three-dimensional phase space comparable with a streamline in a noncompressible fluid. This approach permits an attack upon problems that were not accessible by other methods. The earlier developments are due to Poincaré; important advances were made by G. D. Birkhoff, especially on questions concerning the probability that a trajectory returns to the same small region in space.

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CELESTIAL NAVIGATION: *see* Navigation.

CELESTIAL SPHERE, the apparent surface of the heavens, on which the stars might seem to be fixed like jewels. Greek scholars attributed the rising and setting of the stars to the daily westward rotation of the sphere around an axis thrust through a globular earth. Copernicus taught that the supposed rotation of the sphere is the motion of the celestial scenery caused by the earth's daily rotation from west to east. The earth's axis is directed northward to the north celestial pole, marked roughly by Polaris, the pole star, at the end of the Little Dipper's handle. *See* Astronomy: *The Celestial Sphere*. (R. H. Br.)

CELESTINA, LA, is the title by which one of the most celebrated Spanish works of prose fiction—the *Comedia* (or *Tragicomedia*) *de Calisto y Melibea*—has been popularly known since soon after it was first published (Burgos?, 1499). The popular title is taken from the chief character, the formidable bawd whose deeply explored personality dominates the tale of two young lovers who, in achieving the consummation of their inordinate passion, bring disaster on themselves and the other major characters. *La Celestina* is written entirely in dialogue, and exists in two forms, one of 16 and the other of 21 "acts." It was not intended for stage performance. The originality and vitality of the work owe much to the way in which the author contrives to disclose his characters as complex, autonomous beings existing in their own right, and in a convincingly everyday environment which is, however, not fixed geographically or temporally. Even the Celestina, despite her corrosive contempt for those who attempt to suggest that there is anything in life more powerful than the sexual urges, is, like all the other characters, treated with understanding and some compassion. Ironic humour, sometimes decidedly coarse, is not excluded; nevertheless, the book, which makes no attempt to impose Christian solutions to the problems it presents, is pervaded by a sense that fate is an undiscriminatingly hostile force against which human efforts are vain. *La Celestina* reflects, to some extent, the stoical doctrines set out in Petrarch's Latin *Opera*. It also owes a debt to Latin 15th-century humanistic comedy.

La Celestina was reprinted in Spanish, sometimes with important textual modifications, well over 100 times between 1499 and 1634. It was also translated into all the principal European languages, including Latin and Hebrew. It was originally published anonymously, but it seems probable that the author of both the 16- and 21-act versions was Fernando de Rojas (d. 1541), a converted Jewish lawyer from Puebla de Montalbán. His assertion that he found the long first act of *La Celestina* already completed by an unidentified author has received some confirmation from a comparison of its sources, language and content with those of the rest of the book with which it is, however, astonishingly well integrated. The tone of the work is consistent with the emotional situation of the highly literate, but socially and psychologically insecure, community of Spaniards of Jewish descent whose persecution had been intensified toward the end of the 15th century.

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CELESTINE (Caelestinus), the name of five popes and one elected pope who did not reign.

St. Celestine I (d. 432), pope from 422 to 432, was a deacon in Rome when he was elected to succeed Boniface I on Sept. 10, 422. His restoration of the priest Apiarius was checked in 426 by African bishops, but the Gallic prelates deferred to his directives. To confute Pelagianism, the pope in 429 dispatched Germain of Auxerre to Britain. In 431 he sent Palladius as first bishop to the Irish. Celestine condemned the teaching of Nestorius in Aug. 430 and entrusted Cyril of Alexandria with the recantation. Upon receipt of the council of Ephesus' report, he gave papal approval to Nestorius' deposition. Celestine died on July 27, 432, and in the Roman martyrology he is commemorated on the anniversary; his feast is observed on April 6 in Ireland. (H. G. J. B.)

Celestine II (Teobaldo Buccapecus or Buccapecorini) was elected in Dec. 1124, after the death of Calixtus II, and assumed the name Celestine. He would have been Celestine II, but he resigned after a few days in favour of Honorius II and is therefore not counted in the official list of popes.

Celestine II (Guido di Città di Castello) (d. 1144), pope from 1143 to 1144, studied under Peter Abelard, with whom he remained on friendly terms even after the latter's condemnation at the council of Sens. He was made cardinal deacon in 1127 by Honorius II and cardinal priest around 1134 by Innocent II, whom he was elected to succeed on Sept. 26, 1143. As pope, Celestine removed Innocent II's interdict against King Louis VII of France. He died March 8, 1144.

Celestine III (Giacinto Bobo-Orsini) (*c.* 1106–1198), pope from 1191 to 1198, was a Roman, son of Petrus Bobonis, from whom also the Orsini family was descended. At his election on March 30, 1191, to succeed Clement III, he was about 85 years old and had been cardinal deacon of Sta. Maria in Cosmedin ever since the pontificate of Celestine II; like Celestine II he had been a student and friend of Abelard. Giacinto had carried out many important legations in Germany, Spain and Portugal; Thomas Becket considered him his most reliable friend at the Roman curia. It would seem that Celestine III's conciliatory and temporizing policy toward the young emperor Henry VI was caused not by senile weakness, as has been asserted, but rather by moderation and patience; his successor, Innocent III, was to reap the fruits of this policy. Celestine's pontificate, however, was overshadowed by the spectacular successes of Henry, who had succeeded his father Frederick Barbarossa in 1190, had been crowned emperor by Celestine himself, and through his wife Constance, the daughter of Roger II, had also become ruler of the kingdom of Sicily. Henry not only ignored the fact that Sicily had been a vassal of the papal see since Nicholas II (1059), but, contrary to a treaty between Frederick Barbarossa and Clement III, also failed to restore the full extent of the papal states to the pope. According to one contemporary source Henry offered Celestine a considerable part of the revenues of the German church in compensation for full renunciation of the papal states, but the pope did not accept, since possession of the papal states was then the papacy's only guarantee of independence. He also refused to make the imperial dignity hereditary. In spite of the anxiety that the emperor's ambitious projects caused the pope, he never excommunicated him, not even when Henry imprisoned the returning crusader king of England, Richard Lion-Heart. Yet Celestine gave only half-hearted support to Henry's own crusade, which would probably have led to a Latin conquest of the Byzantine empire a few years earlier than it actually occurred. But Henry died in 1197, at the age of 32, a few months before the nonagenarian pope, who died on Jan. 8, 1198.

Celestine IV (Goffredo Castiglioni) (*c.* 1187–1241), pope during 1241, a Milanese, nephew of Pope Urban III, had been made cardinal priest of St. Mark's in 1227 and cardinal bishop of Sabina in 1239 by his predecessor Gregory IX, whom he was elected to succeed on Oct. 25, 1241. He was the first pope to be elected in a conclave, which had been set up under most inhuman circumstances and shocking sanitary conditions by the senator of Rome, Matthew Rosso Orsini, who thus hoped to break the deadlock in the College of Cardinals. Celestine, an old and sick man, died on Nov. 10, less than a month after his election, and was succeeded by Innocent IV.

St. Celestine V (Peter of Morrone) (d. 1296), pope during 1294, was born *c.* 1209 or 1210 in the county of Molise in south Italy. He came from a poor family, probably of Isernia. In his youth he had been a Benedictine monk, but soon had become a hermit and lived in the high Abruzzi mountains, in the Maiella and on Monte Morrone near Sulmona. His extremely rigorous asceticism, comparable with that of the eastern desert fathers, attracted a number of followers, and Peter became the head of an eremitical congregation that was incorporated into the Benedictine order by Pope Urban IV. Peter himself, however, spent most of his life in natural caves or primitive cells in the mountain wilderness.

In his cell on Monte Morrone, situated about 3,000 ft. above Sulmona and still extant as the Chapel of S. Onofrio, the octogenarian hermit to his surprise and dismay was informed by an embassy from the College of Cardinals that he had been chosen pope on July 5, 1294. This election was due chiefly to two causes: first, the inability of the cardinals, dominated by the rival Roman families of the Orsini and Colonna, to agree on a pope from their own midst to succeed Nicholas IV, as a result of which the see of St. Peter was left vacant for over two years; second, the widespread belief, nurtured by the Franciscan Spirituals and other propagators of the prophecies of Joachim of Fiore, that the church should and would be reformed by a *papa angelicus*, an ascetic on the papal throne, who would bring back to the centre of Christendom the poor and humble way of life of the apostles. It was Cardinal Latino Malabranca who actually proposed Peter as pope; he found no real opposition and the election soon became unanimous. Having reluctantly accepted the papal dignity because of the perilous situation of the leaderless church, Celestine was crowned in his own congregation's church of Sta. Maria di Collemaggio in the Abruzzi town of Aquila, which he entered riding on an ass in a Christlike *adventus* ceremony.

It was all the more unfortunate that the new pope, though a holy man, lacked many of the qualities of great leadership and could in no way be compared to such reformers of medieval religious life as St. Bernard of Clairvaux or St. Francis of Assisi. He lacked education, experience of the world and judgment of men. His high office he saw chiefly as a distraction from his ascetic struggle for the salvation of his own soul. At the same time he distrusted the cardinals who had elected him. It was not surprising under these circumstances that he soon became utterly dependent on the clever political schemer who had been his temporal sovereign, Charles II of Anjou, the king of Naples. Soon after his coronation Celestine went to Naples and filled the curia with Neapolitan and French cardinals and in general with creatures of Charles II; he also greatly favoured his congregation of hermits, called after him the Celestines, and the Franciscan Spirituals to whom he permitted secession from the main part of their order (a solution that much later was to become permanent after a long struggle). Celestine granted benefices on all sides, some of them to more than one person at the same time. His exhortations to peace between Naples and Aragon, France and England, were weak and ineffectual.

It soon became clear that the unhappy man on the throne of St. Peter was not the expected angelic pope, that a great dream had not come true. Celestine himself realized that it was dangerous for the church as well as for his own soul if he continued as pope, and after consultation with the cardinals, he resigned on Dec. 13, 1294. There can be little doubt that Dante (*Inferno*, iii, 59 ff.) had Celestine in mind when he spoke of him *che fece per viltate il gran rifiuto*, thus rather unjustly calling a coward the man who had had the courage to terminate an impossible situation.

After Cardinal Benedict Caetani had become his successor as Boniface VIII, Celestine's resignation was called unlawful by some of his followers. Boniface and the majority of the cardinals therefore thought it wise to keep the former pope under supervision. He was not allowed to return peacefully to his native mountains. On the point of making good his escape across the Adriatic sea, the old hermit was captured by Neapolitan officials and extradited to Boniface VIII, who kept him interned in a small cell-like room of the castle of Fumone near Ferentino, where he died on May 19, 1296. He was canonized by Clement V in 1313, and his feast is celebrated on May 19.

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CELESTINES (Ordo Caelestinensis), an extinct order of hermits founded about 1260 by Peter of Morrone, later Pope Celestine V (*see* Celestine), in an attempt to unite the eremetical and cenobitical modes of life. The Benedictine rule was taken as the basis of the life, but was supplemented by regulations notably increasing the austerities practised. During the founder's lifetime the order spread rapidly from the mother abbey of Sulmona, Italy, and eventually there were 150 monasteries in Italy, France, Saxony, Bohemia and the Netherlands. During the French Revolution and its aftermath their houses were destroyed. *See* also Benedictines.

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CELESTITE, a mineral composed of strontium sulfate, is mined as a source of strontium for the preparation of various strontium salts used in sugar-beet refining and the manufacture of fireworks, fusees and other pyrotechnic products. It occurs chiefly in sedimentary rocks, particularly limestones and is found in many places throughout the world. It is commonly associated with relatively soluble minerals such as gypsum, anhydrite and rock salt. It occurs occasionally in vein deposits.

Celestite, with the formula $SrSO_4$, is similar to barite ($BaSO_4$). A complete range in the proportions of strontium to barium is possible (the property termed *solid solution; see* Mineralogy) so that all gradations in composition and physical properties exist between the celestite and barite (*q.v.*) end members of the range.

The name celestite is applied to those varieties in which the number of strontium atoms is greater than those of barium. Most specimens of celestite, however, contain only slight amounts of barium.

Celestite occurs in orthorhombic crystals, commonly with well-developed crystal faces. It ranges from colourless to white to pale blue in colour. Generally it has a specific gravity of approximately 3.9 and is heavy for a nonmetallic mineral. Celestite can be distinguished with certainty from barite only by careful determination of properties such as composition, specific gravity and refractive indexes. It is much less common than barite. (D. M. H.)

CELEUS, the legendary first king of Eleusis. When the goddess Demeter, wandering in search of her daughter Persephone, had reached Eleusis disguised as an old woman, Celeus made her the nurse of his infant son Demophon. When the mother surprised her in the act of burning his mortal parts so as to give him immortality, Demeter disclosed her divinity. She commissioned Celeus' son Triptolemus (*q.v.*) to distribute her gift of corn to mankind, and Celeus erected her first temple. Thus began the important shrine of Demeter at Eleusis. (H. W. Pa.)

CELIBACY, the state of being unmarried, which may be assumed for religious or nonreligious motives. This article deals with religious celibacy, primarily the celibacy of the Christian clergy.

Outside Buddhism, Jainism and Christianity, religious celibacy has been little practised. Traces of it are found among the early American Indians and in early Babylonia, the Romans had their vestal virgins, and Islam produced some who practised celibacy for mystical reasons. Buddhism enjoins celibacy on its clergy and monks. If a monk has been married, the marriage is dissolved on his entrance into the monastic life. The prohibition seems to have been strictly observed in early Buddhist monasticism. In Japan, however, Shinran (1173–1262), founder of the True Pure Land sect, tried to abolish the celibacy of priests, monks and nuns, for reasons very like those of Martin Luther; but the stricter practice survived among some. In the 15th century Tsoṅ-k'a-pa introduced monastic celibacy into Tibet, where it had lapsed, and while it is still practised there today, its status is said to be somewhat precarious. Jainism resembles Buddhism in its attitude to celibacy.

The link between Christianity and Judaism, and the acceptance of the Old Testament by the Christian church, tended to perpetuate in the early church the esteem the Hebrews had for marriage and numerous children. The New Testament does not impose celibacy on the ministers of the Gospel; although it does require that a "bishop" be married only once (Tit. i, 5 ff.); apparently this is a prohibition not of bigamy but of second marriage for the clergy. Jesus proposes celibacy as an example of superior virtue (Matt. xix, 12), and St. Paul recommends it (I Cor. vii, 8–10; 32 ff.) without imposing it.

Celibacy of the clergy does not appear to have been obligatory during the first Christian centuries. The opinion formerly held by some, that celibacy was of apostolic origin, has been largely abandoned. Freedom of choice was the norm. The writings of Tertullian, Clement of Alexandria, Origen, Eusebius of Caesarea, Cyril of Jerusalem, Jerome and Epiphanius make it clear, however, that many Christian clergymen did in fact practise celibacy, and in both east and west celibacy always has been enjoined on monks and nuns.

In the 4th century the discipline of celibacy for the clergy tended to take a fixed form in ecclesiastical legislation, but the development in the east differed from that of the west. In the east married men were ordained and allowed to live in wedlock, though marriage after ordination was not permitted. Such was the decision of the councils of Ancyra (314), Nicaea (325), Gangra (*c.* 350) and the Trullan council of 692. Only bishops were required to leave their wives, who had to enter a monastery. The legal position of the eastern churches has remained the same, though since the 17th century the marriage of subdeacons after ordination has been tolerated in some places. Since the 9th century, bishops usually have been chosen from among the celibate monks. The Copts, Jacobites and Armenians tolerate the marriage of deacons; the Nestorians and Ethiopians permit priests to marry, and the Nestorians for a long time permitted bishops to live in wedlock.

The eastern churches united to Rome follow the decrees of the early eastern councils in this matter. The St. Thomas Christians of Malabar, however, adopted celibacy for the clergy in the 19th century, and the Syrian and Coptic churches united with Rome also have moved in the direction of a celibate clergy. In 1929 the Holy See reserved to priests living in celibacy the right to minister to the faithful of eastern rites living in the Americas.

In the west the council of Elvira in Spain (*c.* 306) decreed that "it be entirely forbidden bishops, priests, deacons and all clergy placed in the ministry to live with their wives and beget sons. Whoever does this, let him be deprived of the distinction of the clergy." A decretal of Pope Siricius in 386 ordered celibacy for "priests and levites." This decree was renewed by Innocent I (pope 401–417), and at the beginning of the 5th century Leo I (Epistle xiv) explained it so as to include subdeacons explicitly.

This law has remained in force ever since, though during the early middle ages it was violated frequently. St. Boniface, St. Chrodegang of Metz and Charlemagne did what they could to revive its observance, and enforcement of celibacy was one of the principal aims of the reform of the clergy under St. Gregory VII (pope 1073–85). The first (1123) and second (1139) Lateran councils declared the marriages of priests invalid, and Alexander III in 1180 extended this impediment to deacons and subdeacons.

The reforming Council of Trent (1545–63) retained the earlier laws, including the Lateran decree, and the law of Trent was incorporated in the *Codex juris canonici* of 1917. During the Reformation, Pius IV (pope 1559–65), under pressure from the emperors Ferdinand I and Maximilian II, thought of exempting Germany from the law, but his successor, St. Pius V, definitely abandoned the project. During the French Revolution many priests and some bishops married without the approval of Rome. The Old Catholics when they broke with Rome permitted bishops and priests to marry. The schismatic Czechoslovak church also abolished celibacy in the 1920s. According to the press, Pius XII allowed some former Protestant ministers who had joined the Roman Catholic Church to live with their wives, but in the absence of the official documents it is impossible to give the conditions attached to the concession. John XXIII, following the example of Gregory XVI, Pius IX and Pius XI, was firm and peremptory in rejecting suggestions that the law might be reconsidered.

The early Protestants rejected obligatory celibacy as something beyond any human power to impose, as contrary to the practice of the early church and as a source of scandal. Martin Luther characterized celibacy as a papal invention against the eternal word of God; John Calvin denounced the prohibition of marriage as contrary to the word of God and to all justice. In more recent times this attitude has been considerably softened by a number of Protestant leaders.

Critics have maintained that the Roman Catholic Church through the law of celibacy sought power by isolating the secular clergy from the laity. The church, however, maintains that its legislation is spiritually motivated. The priest is the mediator between God and man, and celibacy facilitates the accomplishment of this function. Unmarried priests can be concerned about the things of God; the married priest would have to care for a family and consider the rights of his wife. Much of his time and energy would necessarily be given to nonreligious preoccupations. Furthermore the laity would find it more difficult to show to a married priest the confidence that is required for the successful direction of souls.

See H. Thurston, "Celibacy of the Clergy," in the *Catholic Encyclopedia*, vol. iii, pp. 481–488; J. Viollet *et al.*, in *Catholicisme*, vol. ii, col. 754–769. (E. A. R.)

CELJE (Ger. and Ital. Cilli), a town of Slovenia, Yugos., is situated in mountainous country on the Savinja river, 75 km. (47 mi.) E.N.E. of Ljubljana by road. Pop. (1961) 16,487. The picturesque town is notable for its old houses and churches and remains of walls and castles, as well as for its many factories. It is one of the most industrialized towns in Yugoslavia. Celje is on the railway from Maribor to Zidani Most where it joins the main Zagreb-Ljubljana line. Antimony and zinc are mined nearby and enameled iron utensils are manufactured.

The Romans captured Celje, probably a Celtic settlement, in 15 B.C. Claudius made it a Roman municipium in A.D. 50, calling it Claudia Celeia. Its temple of Mars was famous. The Roman sewerage system, rediscovered in the second half of the 19th century, is in use. Incorporated with Aquileia under Constantine, Celje was destroyed by the Slavs at the end of the 6th century. From 1350 to 1455 it was ruled by the powerful counts of Cilli, who had their castle on a hill southeast of the town. Later the town became subject to the Habsburgs. A part of Yugoslavia after 1918, it was annexed by Germany in 1941 during World War II, and set free in April 1945. (V. De.)

CELL, in biology, the basic structural living unit forming the bulk of the tissues of animals and plants of visible dimensions. Although cells vary somewhat in size, each type in a particular tissue and in a particular species is fairly uniform. Bacterial cells are among the smallest, being seen at the limits of visibility of the ordinary compound microscope (*q.v.*); yolks of birds' eggs are among the largest cells. For voltaic, dry and concentration cells *see* BATTERY; for gas cell *see* HYDROGEN IONS; for standard cell *see* INSTRUMENTS, ELECTRICAL MEASURING.

The precise meaning of the term cell in biological literature is set forth in the article CYTOLOGY (*q.v.*). When the term came into usage in biology, it referred to the smallest units of structure that the microscope could reveal in the animal or plant body. First used by Robert Hooke (1665) for the minute cavities of cork, a tissue which he described as made up of "little boxes or cells," it is a survival from the microscopic descriptions of plant structure made by 17th-century botanists, and as such is really a misnomer, for tissues of animals rarely display the honeycomb-like appearance of pith, cork, etc., when examined microscopically.

Today the cell is recognized to be a complex, consisting of a number of well-defined structures (nucleus, mitochondria, etc., each concerned with particular cell functions), so that it is no longer possible to define the cell as the ultimate structural unit of living matter. On the other hand, it is a physiological unit, the "working area" for those microscopic bodies within. It is the delimitation of this characteristic complex of microscopically visible units by a boundary, the cell membrane, which possesses the physical property of differential permeability to different kinds of molecules that characterizes the individual cell, which has thus come to be regarded as a unit of physiological activity of a certain order.

The fact that the respective contributions of the maternal and paternal parents to the physical constitution of the offspring are derived in each case from a single cell of the parent body has revolutionized the study of heredity and has stimulated a considerable body of research which makes it possible to envisage the structural basis of hereditary transmission and the determination of sex.

Thus the cell doctrine, *i.e.*, the recognition of the cell originally as the structural unit of the body and later as a unit of physiological activity, has exerted its influence on every department of biological thought since the doctrine was formulated by M. J. Schleiden and Theodor Schwann in 1839.

See BIOLOGY; PLANTS AND PLANT SCIENCE; ZOOLOGY.

(L. T. H.; X.)

CELLA, in architecture, the Latin name corresponding to the Greek *naos*, used for the enclosed room or sanctuary of a Greek or Roman temple or any building of similar plan. *See* GREEK ARCHITECTURE; ROMAN ARCHITECTURE; TEMPLE ARCHITECTURE.

CELLE, a town of Germany which after partition of the nation following World War II was included in the *Land* (state) of Lower Saxony in the Federal Republic of Germany. It is situated on the southern edge of Lüneburger Heide and on the Aller river at the highest point of navigation, 38 km. (24 mi.) N.E. of Hanover by road, on the main railway line from Hanover to Hamburg. Pop. (1959 est.) 56,429. The old part of the town has a large number of half-timbered houses dating from the 16th to the 18th century, among them the Hoppenerhaus (1532) and the grammar school (1603). The parish church (1308–1675) contains the tombs of the dukes of Celle and a vault where Princess Sophia Dorothea, divorced wife of George Louis of Hanover, later George I of England, and Queen Caroline Matilda of Denmark are buried. In the ducal palace (1292) is the oldest theatre in Germany still in use (1674–75). The suburb of West Celle has many houses of the nobility in the French baroque style and the Bomann-Museum, specializing in exhibits from Lower Saxony.

Celle has several technical colleges. Industries include candles, dyes, biscuits, insulators, mining equipment, petroleum, potash and gravel. Spinning is carried on and there are extensive tree nurseries.

Celle was founded in 1292, the old town, Altencelle, having been founded about 1248. It was the residence of the dukes of Brunswick and Lüneburg from 1378 to 1705. On April 25, 1858, the first boring for raw petroleum ever made took place at Wietze, a short distance northwest of Celle. In World War II Celle was occupied by Allied forces in April 1945. (Ju. R.)

CELLINI, BENVENUTO (1500–1571), Italian goldsmith and sculptor, author of a celebrated autobiography, was born in Florence on Nov. 3, 1500. Resisting the efforts of his father to train him as a musician, he was apprenticed as a metalworker in the studio of the Florentine goldsmith Andrea di Sandò Marcone. Banished to Siena as a result of a brawl in 1516, he was back in Florence during 1517–19 and then moved to Rome. Prosecuted for fighting in Florence in 1523 and condemned to death, he fled again to Rome, where he worked for the bishop of Salamanca, Sigismondo Chigi and Pope Clement VII. Cellini participated in the defense of Rome in 1527, when, by his own account, he shot the constable of Bourbon and the prince of Orange.

After the sack of Rome he returned to Florence, and in 1528 worked in Mantua, making a seal for Ercole Cardinal Gonzaga. Moving back to Rome in 1529, he was appointed *maestro delle stampe* at the papal mint, and in 1530–31 executed a celebrated morse (clasp for a cope) for Clement VII. Like so many of Cellini's works in precious metals, this was melted down, but its design is recorded in three 18th-century drawings in the British museum, London. The only survivors of the many works he prepared for the pope are two medals made in 1534.

Guilty of killing a rival goldsmith, Cellini was absolved by Pope Paul III, but in the following year, having wounded a notary, he fled from Rome and settled in Florence, where he executed a number of coins for Alessandro de' Medici. After a further year in Rome, he paid a brief visit to France, where he was received by Francis I, a portrait medal of whom is the sole relic of the journey. On his return to Rome in 1537, he was accused of peculation and imprisoned. He escaped, was once more imprisoned and was finally released in 1539 at the instance of Ippolito Cardinal d'Este of Ferrara, for whom he executed a seal (original lost; lead impression in the museum at Lyons). Again invited to France by Francis I, he arrived at Fontainebleau in 1540, carrying with him an unfinished saltcellar which he completed in gold for the king in 1543. This, Cellini's only fully authenticated work in precious metal (now in the Kunsthistorisches Museum, Vienna), is the supreme example of Renaissance goldsmith's work. In 1542 Cellini was granted letters of naturalization by the king, and in 1544 received a royal commission for 12 silver candlesticks decorated with figures from mythology. The scheme of one of these, representing Juno, is recorded in a drawing in the Louvre, Paris. Also in 1543–44 he modeled and cast a large bronze lunette of the Nymph of Fontainebleau for the entrance to the palace (now in the Louvre). For a projected fountain at Fontainebleau he prepared a model for a colossal figure of Mars (lost).

In 1545 Cellini left Paris precipitately and returned to Florence, where he was welcomed by Cosimo I de' Medici and entrusted with the commissions for his best-known sculpture, the bronze Perseus in the Loggia dei Lanzi, and for a colossal bust of the grand duke (now in the Museo Nazionale, Florence). Flying to Venice in 1546 to escape charges of immorality, Cellini completed the bust by 1548. In the same period he restored an antique torso from Palestrina as a Ganymede and carved marble figures of Apollo and Hyacinth, and of Narcissus: all three works are now in the Museo Nazionale, as is a small relief of a greyhound made as a trial cast for the Perseus (1545). A bronze bust of Bindo Altoviti (Gardner museum, Boston) was executed by Cellini in Florence, probably in 1550. After the unveiling of the Perseus (1554), he began work on a marble crucifix destined for his own tomb in SS. Annunziata; this is now in the church of the Escorial. Two designs for the seal of the Academy of Florence (British museum and Graphische Sammlung, Munich) date from 1563. His autobiography was begun in 1558 and completed in 1562, and in 1565 he began work on his important treatises of goldsmith's work and sculpture, the *Trattato dell'oreficeria* and the *Trattato della scultura*. Cellini died in Florence on Feb. 13, 1571.

As an artist Cellini was not only a craftsman of surpassing taste and skill, but a sculptor of great significance, enjoying a position of importance both in France and in Florence, where he executed all but one of his large-scale works. He declares in his *Treatise on Sculpture* that he "always had a desire to do some great works in marble," and the tone of frustration and disappointment that runs through his autobiography is due in the main to the failure of his contemporaries to supply scope for his transcendent gifts. His Perseus is perhaps the greatest statue produced in Florence by any member of the generation after Michelangelo's, and the scene of Perseus rescuing Andromeda originally let into its base (now in the Museo Nazionale) leaves no doubt of his talent as an artist in relief. The Escorial crucifix is greatly superior to the work of his rivals B. Ammanati and Bandinelli.

Cellini's fame, however, is mainly due to his record of his own life. First printed in Italy in 1728, the autobiography was translated into English (1771), German (1796) and French (1822) and, launched on the tide of the romantic movement, gained immediate popularity. Dictated to an amanuensis, it is composed in colloquial language with no literary artifice, and gives a first-hand account of the writer's experience in the Rome of Clement VII, the France of Francis I and the Florence of Cosimo de' Medici. Despite its manifest exaggerations and its often boastful tone, it is a human document of surprising frankness and incomparable authenticity, and thanks to it we know Cellini's character more intimately than that of any other figure of his time.

Bibliography.—The best Italian ed. of Cellini's autobiography is that of O. Bacci, *Vita di Benvenuto Cellini* (1901); the standard Eng. trans. is by J. A. Symonds (1887; reprinted with notes and bibliography as *The Life of Benvenuto Cellini Written by Himself*, 1949). On Cellini's works *see* E. Plon, *Benvenuto Cellini, orfèvre, médailleur, sculpteur* (1883); E. Camesasca, *Tutta l'opera del Cellini* (1955). For the *Trattati see* C. Milanesi, *I Trattati dell'oreficeria e della scultura di Benvenuto Cellini* (1857); C. R. Ashbee, *The Treatises of Benvenuto Cellini on Goldsmithing and Sculpture* (1898). (J. W. P.-H.)

CELLO: *see* Violin Family.

CELLOPHANE, a thin film of regenerated cellulose, usually clear and transparent, used primarily as a flexible packaging material. While the word "cellophane" is a trade-mark in England, France, Canada and many other countries, in the United States it became, by court decision, a generic term.

In 1892 the English chemists C. F. Cross and E. J. Bevan discovered viscose, a solution of cellulose treated with caustic soda (sodium hydroxide) and carbon disulfide. Six years later C. H. Stearn was granted a British patent for producing films from viscose. It was not until 1911, however, that J. E. Brandenberger, a Swiss, designed a machine for continuous production of a strong, transparent film. Brandenberger coined the term "cellophane" by combining parts of "cellulose" and "diaphane," the French word for "transparent."

World War I delayed large-scale development. In 1920 a French company, La Cellophane, was formed, and a cellophane plant was built at Bezons, near Paris. Three years later E. I. du Pont de Nemours & Co. acquired rights from La Cellophane to manufacture the product in the United States and produced the first U.S.-made cellophane at Buffalo, N.Y., in 1924.

Several factors contributed importantly to cellophane's growth. Moistureproof cellophane, invented in 1927 by W. H. Church and K. E. Prindle, gave the film new usefulness as a protective wrap for foods. By the early 1960s about 90% of the U.S. production was moistureproof, and about 70% of the total went to the food industry. More than 50 varieties of cellophane had been developed. Basically, the film is transparent, odour resistant, tough, greaseproof and gas impermeable. It can be made in various thicknesses and colours. By applying special coatings, it can be made moistureproof, partially moistureproof, and heat-sealing.

Cellophane manufacture starts with steeping of sheets of wood pulp in caustic soda to form alkali cellulose. After excess liquids are removed, the sheets are shredded, aged to control molecular weight, and discharged into steel drums known as barattes. Carbon disulfide is added to the slowly rotating barattes, forming sodium cellulose xanthate. The xanthate is dissolved in another caustic solution to form viscose. Carefully ripened viscose is piped to the casting machine, where it is extruded through a metal slit into an acid bath in which it coagulates to a film and is regenerated into cellulose. Driven rolls carry the film through a further series of baths where it is washed and bleached, and softening materials are added. The film then enters the dryer, passing over heated rolls and through circulating hot air. Finally, it is wound up in mill rolls, which may weigh as much as 950 lb. and contain up to 5 mi. of film. If the cellophane is to be coated, the film is led through a coating bath, over doctor knives or rolls to remove excess coating and to distribute the coating evenly, and then through drying and humidifying chambers.

Finished mill rolls are commonly slit to widths required for use on automatic packaging machinery, though some are unwound on large drums to be cut and trimmed to sheet form for use in hand-wrapping operations. (J. L. Bl.)

CELLULOID, the first synthetic plastic material, also known as xylonite or artificial ivory. The invention of Celluloid in 1870 in the U.S. is commonly ascribed to J. W. Hyatt and I. S. Hyatt, who first realized the necessity of working cellulose nitrate, camphor and alcohol under heat and pressure. Their efforts were based upon earlier investigations by A. Parkes and D. Spill in Great Britain. In the U.S., "Celluloid" is a trade name. Celluloid is a homogeneous colloidal dispersion of cellulose nitrate and camphor. Its commercial importance persists because of its good properties: resilience; high tensile strength (up to 12,000 lb. per square inch); toughness; a density of 1.40; high lustre; low cost; uniformity; resistance to water, oils and dilute acids; ready workability; and the great variety of colours, from transparent crystal and pastel shades through bizarre mottles and pearls, in which it can be fabricated.

Since it is based upon a nitrate ester of cellulose, a long-chain polymer, Celluloid is thermoplastic in character. It can be worked in molds at 200° to 220° F., and it becomes brittle at −70° F. At room temperatures it may be sawed, drilled, turned, planed, buffed and polished. Direct sunlight or storage above 120° F. will discolour it, and decomposition sets in above 365° F. The inflammability is best controlled by the use of it in articles of thick cross section, or as a sheath covering other materials that dissipates heat more rapidly.

Although less inflammable synthetic polymers have replaced Celluloid in such markets as safety glass and telephone mouthpieces (*see* Plastics: *Synthetic Resin Plastics*), it was still widely used in the early 1960s. Manufacture was carried out in Austria, Belgium, France, Germany, Great Britain, Japan, the U.S.S.R., Switzerland and the U.S.

CELLULOSE is the main ingredient of cell walls of higher plants and comprises at least one-third of all vegetable matter. It is a carbohydrate (*q.v.*) and the most abundant of naturally occurring organic compounds.

Cellulose has no function in human diet except as roughage, since it is resistant to digestive juices. Its availability as food for cows, horses and other herbivorous animals is due to the fact that their digestive tracts are able to retain it long enough for the digestive process to be accomplished by microorganisms. Termites and other destructive insects digest the cellulose content of wood by the action of amoeboid protozoa.

Cotton and wood, the principal sources of industrial cellulose are about 90% and 50% cellulose, respectively. Flax, hemp, cotton, hard wood, soft wood and other sources contain celluloses of different molecular weight and fibre structure, associated with varying amounts of natural bonding agents such as sap, lignin, resins and minerals. Though cellulose may be derived from many vegetable sources, the original cost, difficulties in collection and quality limitations of purified fibre have kept wood and cotton linters (hairs from cottonseed) the chief industrial sources.

USES OF CELLULOSE AND DERIVATIVES

The mere mention of such products as rayon, cellophane, plastics and lacquers suffices to recall the enormous development which took place after 1920 in industries based on cellulose and its derivatives. The principal industrial applications of cellulose and its derivatives are so numerous and varied that they can be only summarized here.

Purified Natural Cellulose Fibres.—*Textiles.*—Cotton is the natural fibre most widely used; flax and ramie are used to a much smaller extent.

Paper.—Purified fibres for papermaking are obtained from wood, grasses and straws, seed hairs (cotton rags and cotton linters) and bast fibres (flax).

Miscellaneous.—Vulcanized fibre, plastics fillers, filtering media and surgical cotton.

Regenerated Cellulose and Cellulose Derivatives.—*Lacquers.*—Nitrocellulose lacquers are used for spray-coating automobiles, airplanes and furniture; and for dip-coating hardware, brush handles and other mass-production items. Cellulose acetate propionate and cellulose acetate butyrate are used in clear metal finishes for outdoor use. Ethyl cellulose is used in coatings for ignition cables in automobile and airplane motors and other coatings requiring flexibility at low temperatures.

Plastics.—Nitrocellulose plastics (Celluloid) have the best combination of physical properties, apart from heat sensitivity and inflammability, of all the thermoplastic materials; large volume uses are eyeglass frames and sanitary supplies. Cellulose acetate is used widely in making plastics by injection molding and where flame resistance is important; *e.g.*, in motor housings and electric light ornaments. Cellulose acetate butyrate plastics are used where water resistance and dimensional stability are important; *e.g.*, in steering wheels and various types of piping. Ethyl cellulose plastics are tough over the widest range of temperature and are used in hammer heads and flashlights.

Rayon.—Viscose rayon, cellulose acetate rayon and cuprammonium rayon.

Films and Foils.—Nitrocellulose, long used for photographic films, has generally been replaced by the safer cellulose acetates. Cellulose acetate propionate and cellulose acetate butyrate films are used where high dimensional stability is required; *e.g.*, aerial mapping. Thin sheets of regenerated cellulose (cellophane), cellulose acetate and ethyl cellulose are used for merchandise packaging. Regenerated cellulose is made from nitrocellulose for the production of sausage casings.

Textiles.—Artificial leather is made by coating cotton fabrics with solutions containing nitrocellulose and other ingredients. Aircraft fabric coatings may contain nitrocellulose, high-substitution cellulose acetate, cellulose acetate butyrate or cellulose acetate propionate. Flexible finishes on garment and upholstery leathers are produced with nitrocellulose lacquer emulsions. Hydroxyethyl cellulose and sodium carboxymethyl cellulose are used in textile sizes. Sodium carboxymethyl cellulose is also used as a detergent aid in textile washing.

Coated Paper and Cellophane.—Lacquer coatings containing nitrocellulose or other cellulose derivatives improve the grease and oil resistance, washability and electrical properties of paper. The moistureproof coating on cellophane contains nitrocellulose and a small amount of wax. Paper disks coated with ethyl cellulose are used for sound recording in the home. Methyl cellulose is used to greaseproof paper. Sodium carboxymethyl cellulose is used in special papers because it improves fibre bonding.

Adhesives.—Cellulose derivatives are used in a wide variety of special adhesives.

Explosives.—Nitrocellulose is a minor ingredient in blasting gelatin and the major ingredient in smokeless powders, including rocket powder.

Thickening Agents.—Methyl cellulose and sodium carboxymethyl cellulose are used to increase the viscosity of certain food products (*e.g.*, ice cream), textile finishes, printing pastes, latex dispersions, paints, oil well drilling mud, and pharmaceuticals.

INDUSTRIAL PREPARATION

Cellulose (wood pulp) is prepared from wood by removal of the noncellulosic constituents. The following pulping processes are the ones most widely used: (1) the sulfite process, which employs a solution of calcium bisulfite and sulfur dioxide; (2) the soda process, in which a sodium hydroxide solution is used; and (3) the sulfate process, in which pulping is effected by a solution of sodium hydroxide and sodium sulfide; a modern modification of this process involves an acid hydrolysis of the wood prior to the conventional treatment. (The sulfate process was so named because sodium sulfate is the raw material used for the production of the sodium sulfide.) Most of the so-called dissolving wood pulps used in the manufacture of cellulose derivatives are prepared by the sulfite process. As ordinarily prepared, these sulfite pulps contain 88% to 90% alpha-cellulose; alkaline purification treatments are used to obtain pulps with higher alpha-cellulose contents. The alpha-cellulose content of a cellulose pulp, *i.e.*, the portion insoluble in 17.5% sodium hydroxide at 20° C., serves as a rough measure of its purity. Increasing amounts of dissolving wood pulp are also being made by the modified sulfate process mentioned above.

The tremendously increased demand for wood pulp, particularly for the paper industry, has focused attention on the need for high-yield pulping processes to conserve wood supplies. This has stimulated the industrial use of the semichemical pulping processes.

Cotton is the purest naturally occurring form of cellulose. Raw cotton contains, on an ovendry basis, less than 10% of noncellulosic impurities which include proteins, fats and waxes, pectic substances, carbohydrates and inorganic compounds. Chemical cotton for the manufacture of cellulose derivatives is prepared from cotton linters, which are the short fibres removed from cotton seeds after the long fibres have been taken off by ginning for use in textiles.

The cotton linters are purified by pressure digestion at 130° to 180° C. with a solution containing 2% to 5% sodium hydroxide and by a subsequent bleaching to remove colour bodies. Chemical cotton contains about 99% alpha-cellulose.

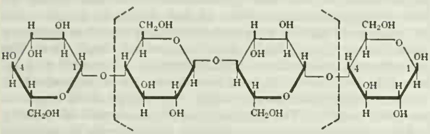
The viscosity of cellulose, or, more precisely, the viscosity of aqueous solutions of cuprammonium hydroxide and of cupriethylenediamine hydroxide and cellulose at some definite concentration, is an important property by which the product is characterized for industrial use.

The moisture content of cellulose, which has an important effect on its chemical behaviour and on its mechanical and electrical properties, rises or drops with increase or decrease in the relative humidity of the atmosphere. The moisture content reached on desorption is higher than that reached on adsorption and varies somewhat with the source and purity, and with the treatment. Thus, for a bleached surgical cotton, the moisture content varies from about 4.6% at 30% relative humidity to about 7.9% at 60% relative humidity; the corresponding figures for a bleached sulfite pulp are 5.6% and 9.5%. High-temperature drying reduces the ability of cellulose fibres to absorb moisture whereas mercerization causes a marked increase in moisture sorption.

CHEMISTRY OF CELLULOSE

Chemical Constitution.—Elementary analysis of the purest available form of cellulose, obtained by purification of cotton, shows that it is composed of 44.4% carbon, 6.2% hydrogen and 49.4% oxygen. These figures correspond to the theoretical composition of a hexose anhydride with the formula $C_6H_{10}O_5$. The hexose anhydride is identified as anhydroglucose (specifically anhydroglucopyranose) by the fact that hydrolysis of cellulose gives an almost quantitative yield (more than 95%) of glucose.

Each anhydroglucose unit contains three alcoholic hydroxyl groups, two secondary and one primary, which can be esterified or etherified. Considerable evidence is available to show that the molecular weight of cellulose is much greater than that of a single anhydroglucose unit. Controlled hydrolysis of cellulose has yielded cellobiose, cellotriaose, cellotetraose and cellopentaose, which contain two, three, four and five anhydroglucose units, respectively. These and other observations prove clearly that cellulose molecules are made up of many anhydroglucose units linked together by primary beta-glucosidic linkages as shown in the figure.



STRUCTURAL FORMULA OF CELLULOSE MOLECULE. THE CHEMICAL UNIT WITHIN BRACKETS IS REPEATED INDEFINITELY

In the formula, as shown in the figure, the glucose unit at the extreme right has a potential aldehyde group at position 1, whereas the other terminal glucose unit contains an extra free hydroxyl group at position 4. The potential aldehyde group cannot be detected readily in cellulose of high molecular weight; however, even cellulose whose molecular weight has been reduced somewhat by acid hydrolysis exhibits an aldehydric reducing action. In celluloses which have been treated with oxidizing agents, the aldehyde group has usually been converted to a carboxyl group.

Conclusive evidence has been accumulated to show not only that cellulose has an extremely high molecular weight but also that all the molecules in any sample of the substance are not of the same molecular weight. The evidence for this nonuniformity with respect to molecular weight includes the results of fractional solution and fractional precipitation experiments. Molecular-weight determinations on unfractionated samples of cellulose or its derivatives will, therefore, yield only average values. The usual cryoscopic and ebullioscopic methods are unsuitable for determining large molecular weights. The viscosity method is the simplest and most useful method of molecular-weight determination. It depends on the relation between the molecular weight of a sample of cellulose (or of a cellulose derivative) and the viscosity of a dilute solution of the material. The viscosity method is not an absolute one and must be standardized against the osmotic-pressure, light-scattering or ultracentrifuge method. Some typical molecular weights based on viscosity measurements are given in the accompanying table:

	Molecular weight (average)	Number of anhydroglucose units per molecule
Native cellulose	More than 570,000	More than 3,500
Chemical cotton	100,000–500,000	600–3,000
Wood pulps	100,000–210,000	600–1,300
Commercial regenerated celluloses	30,000– 90,000	200– 600
Commercial nitrocelluloses	45,000–875,000	175–3,500
Commercial cellulose acetates	45,000–100,000	175– 360

Fibre Structure.—Microscopic examination of the gross structure of native cellulose fibres reveals that, although they have diverse structural patterns, they also have some general structural similarities. The cotton fibre is composed of a primary wall, which is the thin outer sheath of the fibre and is the portion first formed during growth; a thick secondary wall formed by deposition of cellulose inside the primary wall; and a central canal or lumen. The thin primary wall contains wax and pectic materials in addition to cellulose. The secondary wall has a layered structure resulting from the deposition of daily growth rings, each of which contains one compact and one porous layer. Although woods contain a wide variety of cells, the tracheid fibres are of chief interest since they constitute most of the fibres in commercial wood pulps. In wood, the fibres are separated from each other by layers of an intercellular substance known as the middle lamella and consisting chiefly of lignin. The fibre proper contains a primary and a secondary wall (both composed largely of cellulose) and a lumen. Investigations with the electron microscope show that the cell walls of all native cellulose fibres are made up of small fibrous elements known as fibrils, whose width may be as small as 0.000001 in.

X-ray examination of cellulose fibres yields diffraction patterns which show that they are made up, to a large extent, of crystalline cellulose. At least two general types of crystal structure have been observed—native and hydrate. With the exception of the cellulose in the marine alga *Halicystis* which has the hydrate structure, all naturally occurring fibres have the native structure. The hydrate structure occurs in mercerized fibres and in cellulose regenerated from solution or from a derivative.

The X-ray diffraction patterns of native fibres indicate that their crystallinity is discontinuous and that each fibre is an aggregate of small crystalline areas (crystallites or micelles) and amorphous, intercrystalline areas. It is believed that cellulose chains crystallize in such a way that the crystalline regularity is interrupted by irregular regions which behave as amorphous matter toward X-rays and also toward the penetration of swelling and dispersing agents; there is probably a continuous transition between crystalline and amorphous areas of such nature that an individual cellulose chain may pass through several regions of complete order and complete disorder.

Cellulose Degradation.—In the degradation of cellulose, chemical changes occur which result in a reduction of the chain length of the cellulose molecules and, hence, in a weakening of the fibre structure. In the heterogeneous acid hydrolysis of cellulose, the reaction is nonuniform in that the amorphous areas are preferentially attacked so that the reaction appears to stop at a viscosity level which is a function of the size and the amount of crystalline cellulose present. In a true homogeneous hydrolysis, a quantitative recovery of glucose is not observed since there is a tendency for the glucose molecules to recombine and to reform a polymer which is not cellulose but is definitely a polysaccharide. In some cases, cellulose is deliberately degraded to bring about a desired reduction in the viscosity of the cellulose and of the derivatives made from it. In the hydrolytic degradation which is catalyzed by hydrogen ions (*i.e.*, aqueous solutions of acids), cleavage of 1:4 beta-glucosidic linkages between anhydroglucose units occurs with the formation of two new terminal glucose units. One of these is characterized by the presence of a reducing hemiacetal group, the other by an extra hydroxyl group. If the hydrolysis is carried to completion, the cellulose is converted almost quantitatively to glucose. If only partial hydrolysis takes place, degraded products are obtained to which the name hydrocellulose has been given. A wide variety of hydrocelluloses can be prepared. Their properties are determined by the conditions of the hydrolytic treatment. In general, degradation of cellulose by acids is accompanied by a decrease in viscosity and in tensile strength; by an increase in reducing power and in solubility in aqueous alkalies.

The oxidation of cellulose is, as a rule, heterogeneous in character. In those cases where a specific reaction is observed, as with periodate or lead tetracetate, the reagent system has the ability to swell and to penetrate the crystalline as well as the amorphous region, thus allowing a uniform attack. When such swelling is not possible, the amorphous regions are oxidized and reoxidized, producing a nonuniform product which rapidly loses all of its fibrous characteristics.

Cellulose can be degraded by oxidizing agents under a wide variety of conditions, and consequently oxycelluloses of widely varying properties can be obtained. Oxidation is of importance in certain commercial operations, such as bleaching, and the reaction of cellulose with oxygen in the presence of alkali in the preparation of viscose and cellulose ethers. In general, oxycelluloses of the reducing type are formed with neutral or acid oxidizing media, whereas alkaline media yield the acidic type of oxycellulose.

Cellulose is also subject to mechanical degradation which is quite comparable to hydrolysis or thermal decomposition in its severity. The extreme of such action is observed in a vibrating ball mill where the characteristic crystalline X-ray structure is lost and becomes that of the amorphous background and viscosity breakdown is extremely rapid and severe. Such effects, particularly the viscosity reduction, are also observed in the mechanical processing in the textile industry, but to a far lesser extent.

Degradation of cellulose takes place on heating, the extent of degradation depending on the temperature and duration of heating. In general, heating lowers the tensile strength of cotton and regenerated cellulose fibres. The degradation by heat is slower in the absence of oxygen. Drastic destruction occurs on heating at relatively high temperatures. Of the derivatives, cellulose acetate seems to possess the best heat stability and nitrocellulose the poorest. Cellulose suffers loss in fibre strength and viscosity on exposure to light. This degradation is accelerated by oxygen, certain metallic catalysts and some dyes; other dyes seem to exert an inhibiting effect. Degradation by light is influenced by temperature and moisture.

A variety of bacteria, fungi and protozoa causes decomposition of cellulose with the ultimate production of carbon dioxide and water. The ability of ruminants, horses and insects to digest cellulose is believed to be caused by the presence in their intestines of cellulose-decomposing bacteria and fungi.

DERIVATIVES

In the preparation of cellulose derivatives the hydroxyl groups are replaced by substituent groups. The degree of substitution is customarily designated by the average number of hydroxyl units replaced per anhydroglucose unit. Thus, a derivative in which all the hydroxyl groups have been substituted is said to have the maximum substitution of 3.0. If analysis shows that, on the average, 2.5 hydroxyl groups have reacted, the product has a substitution of 2.5. Each molecule contains hundreds of hydroxyl groups and practically all of these are replaced when fully substituted derivatives are prepared; *e.g.*, cellulose triacetate, trimethyl cellulose. However, most of the derivatives which have attained industrial importance are not fully substituted and contain appreciable amounts of free hydroxyl groups. The chance for reaction of any hydroxyl group is affected by its position in the anhydroglucose unit, by the presence of neighbouring hydroxyl groups and by the position in the fibre structure of the molecule to which it is attached. The rate of reaction of cellulose fibres is determined by the rate of diffusion of reagent to the individual hydroxyl groups. Diffusion is rapid in the amorphous areas of fibres and relatively slow in the crystalline areas. Swelling of the fibres will accelerate diffusion and, hence, the rate of reaction. If swelling takes place uniformly throughout each fibre, the reaction will proceed uniformly. These factors are usually of importance in the preparation of uniform derivatives with substitution less than 3.0.

Uniform substitution in all cellulose molecules is obtained directly when reaction takes place in solution, as in the case of etherification of cellulose dissolved in an aqueous solution of a quaternary ammonium base; any effect caused by fibre structure is eliminated and the distribution of ether groups along the molecule is determined by the relative reactivities of the hydroxyls and by chance. As would be expected in a homogeneous reaction of this type, the primary hydroxyls are more reactive than the secondary hydroxyls.

Nitration of cellulose is unique in that uniform reaction takes place even though fibre structure is retained throughout the reaction. This behaviour is caused by the fact that nitration is an equilibrium reaction which is apparently unaffected by fibre structure, and that the extent of nitration is determined by the composition of the nitrating acid. Cellulose formate is the only other common derivative whose preparation involves an equilibrium reaction; in this case, however, the product dissolves in the esterification reagent. The partially substituted organic acid esters which are of industrial importance (*e.g.*, cellulose acetate) are prepared by first esterifying completely in a medium in which the product dissolves and then uniformly removing some of the substituent groups by hydrolysis while the cellulose ester is in solution. It will be apparent from the foregoing discussion that derivatives with substitution less than 3.0 are not mixtures of cellulose and stoichiometric compounds having substitution of 1, 2 or 3. This view is supported by numerous fractionation experiments on commercial derivatives, in which it was found that the substitution of the individual fractions fell within a comparatively narrow range.

In the preparation of derivatives, substituent groups are introduced into the cellulose molecule; these produce marked changes in physical properties and thereby determine the industrial usefulness of the derivatives. This effect on properties is determined both by the nature of the substituent group and by the degree of substitution. The mechanical and other physical properties of cellulose and cellulose derivatives are affected by their average molecular weight. If their molecular weight is too low, they yield plastics with poor strength or lose their ability to form films or fibres. An increase in molecular weight above the lower limit causes a marked improvement in the strength of plastics, films and fibres. There is also an upper limit beyond which further increase in molecular weight causes only slight improvement in strength. The physical properties are also affected by molecular-weight distribution, that is, by the relative numbers and sizes of the molecules that make up the average value. In particular, the presence of relatively small molecules of cellulose or cellulose derivatives exerts a harmful effect on their strength properties.

In industrial operations, the viscosity of derivatives is used as a measure of molecular weight. The viscosity is controlled by selecting cellulose of a given viscosity for the starting material, by regulating the conditions of the reaction and, in some cases, by appropriate aftertreatment of the cellulose derivative. As in the case of cellulose itself, the viscosity of derivatives is determined on a solution of standard concentration by the capillary viscometer or falling-sphere methods.

Cellulose Esters.—Cellulose nitrate, which is usually referred to as nitrocellulose, is the only ester of cellulose and an inorganic acid which is produced commercially. It is prepared by nitrating cellulose with a mixture of nitric acid, sulfuric acid and water. After removal of most of the acid mixture, the fibrous nitrocellulose is given a series of washing treatments to remove last traces of acid and so obtain a product of good stability. The extent of nitration, which is usually designated by the nitrogen content, and the other properties of nitrocellulose are determined to a large extent by the composition of the nitration reagent and the other reaction conditions. For many purposes, the viscosity of nitrocellulose may be controlled by selecting cellulose of the proper viscosity and by regulating the reaction conditions. In the manufacture of low-viscosity nitrocelluloses for use in lacquers, the product is usually given a special treatment after nitration to reduce the viscosity to the desired level. In the best method for the reduction of viscosity, an aqueous suspension of nitrocellulose is heated under pressure in a continuous digester. Cellulose trinitrate (14.14% N) is not produced commercially because it is difficult to prepare and has limited solubility in common solvents. Nitrocelluloses containing 12.5% to 13.5% nitrogen (substitution 2.4–2.8) are used in explosives; those containing about 12% nitrogen (substitution 2.2) are used in lacquers, photographic film and cement, and Celluloid plastics and special lacquers are made with nitrocelluloses containing about 11% nitrogen (substitution 2.0). Cellulose sulfates have been made on a semicommercial scale. Cellulose phosphates have also been prepared but are of only academic interest. The use of sulfuric acid in the reagent mixtures used to nitrate and acetylate cellulose results in the introduction of a small amount of sulfate groups into nitrocellulose and cellulose acetate. Because these sulfate groups exert an adverse effect on the stability of these products, special treatments are used to eliminate sulfate groups and to counteract the effect of any traces that are not removed.

The esters of cellulose with organic acids may be prepared by treating cellulose with the appropriate acid, acid anhydride or acid chloride. Literally hundreds of such esters had been prepared by mid-20th century, but only a few of them had attained technical importance. Formic acid is the only organic acid which will effect appreciable esterification of celluluse by direct reaction with it. Cellulose formate has not been used commercially because of its poor resistance to hydrolysis. Cellulose acetate, the most important of the cellulose organic acid esters, is prepared by treating cellulose with more than three moles of acetic anhydride in a suitable solvent such as acetic acid or methylene chloride, in the presence of a catalyst such as sulfuric acid. The product of this reaction is primary cellulose acetate, which approximates cellulose triacetate in substitution (acetyl content, 44.8%). Cellulose triacetate, or products approaching that degree of substitution, are in a period of increasing interest both for textiles and for photographic and X-ray film. By adding to the homogeneous primary acetate reaction mixture an excess of water over that required to decompose unreacted acetic anhydride, the reaction is reversed and acetyl groups are uniformly removed by hydrolysis; the hydrolysis reaction is stopped at the desired point by the addition of a base to neutralize the catalyst. The cellulose acetate is precipitated from solution by the addition of water, and then given a series of washing treatments to remove last traces of acid and thereby ensure good stability. In this way products are obtained with acetyl contents ranging down to about 37% acetyl (substitution about 2.2) and which are soluble in acetone and other solvents. These cellulose acetates find wide use in the manufacture of rayon, plastics and photographic film. Mixed cellulose esters, such as cellulose acetate propionate and cellulose acetate butyrate, attained industrial importance because of their great moisture resistance and wider compatibility with plasticizers than ordinary cellulose acetates. These mixed esters are prepared by esterifying cellulose with mixtures of the appropriate acid anhydrides.

Cellulose xanthate is an important derivative of cellulose which has only a transitory existence in the process of preparing viscose rayon and cellulose film. In the first step in the process, cellulose is treated with a solution of 18% sodium hydroxide to form so-called alkali or soda cellulose. After removal of the excess sodium hydroxide solution, the alkali cellulose is allowed to stand in contact with air (aging) to reduce viscosity to a desired level. The alkali cellulose is then treated with carbon disulfide to form cellulose xanthate. In commercial practice, slightly more than one xanthate group is introduced for each two anhydroglucose units in the cellulose molecule. The cellulose xanthate is dissolved in 6% sodium hydroxide solution to yield the solution commonly known as viscose, which is then ripened to effect partial decomposition of the cellulose xanthate and to improve its coagulation properties. The ripened viscose is extruded continuously in the form of threads or films into an acid precipitating bath; the regenerated cellulose is then suitably washed and dried.

Cellulose Ethers.—The cellulose ethers which have attained industrial importance include ethyl cellulose, methyl cellulose, carboxymethyl cellulose, hydroxyethyl cellulose and benzyl cellulose. In most cases, these ethers are prepared commercially by the interaction of cellulose and the halide or sulfate of the appropriate alcohol in the presence of an alkali, usually sodium hydroxide. Presumably, alkali cellulose is formed as an intermediate product. The extent of etherification is determined by the reaction temperature and the relative proportions of cellulose, alkali, etherifying agent and water in the reaction mixture. Commercially, the methyl, carboxymethyl and hydroxyethyl ethers are produced only in the low-substitution types which are soluble in water or in dilute solutions of an alkali. The preparation of the hydroxyethyl ether is unique in that it may be carried out by treatment of alkali cellulose either with ethylene chlorohydrin or with ethylene oxide. Carboxymethyl cellulose is prepared by treating alkali cellulose with sodium chloroacetate. Carboxymethyl cellulose will dissolve completely in water if some or all of its carboxyl groups are neutralized by NaOH, KOH or NH_4OH. All of the ethyl and benzyl ethers of cellulose produced commercially are of the types which are soluble in organic solvents; *i.e.*, with substitution more than 2.0. Ethyl cellulose possesses good resistance to acids and alkalies, high flexibility at low temperature, good electrical properties, solubility in a wide range of solvents and ready compatibility with many resins and plasticizers. These properties have won for ethyl cellulose wide use in protective coatings and plastics. Benzyl cellulose has not attained wide use because of its poor stability on exposure to light or to the action of oxygen at elevated temperatures.

Cellulose Addition Compounds.—Cellulose has the ability to form addition compounds with a variety of reagents. Although some investigators believe that the formation of alkali cellulose is a physical process, others believe that the mode of reaction of alkali cellulose in etherification indicates that it is a compound of the alcoholate type. (A true alkoxide, sodium cellulosate, is formed when cellulose is treated with a solution of sodium or sodamide in liquid ammonia.) However, the most widely accepted view is that alkali cellulose is an addition compound of the type $(C_6H_{10}O_5)_x.(NaOH)_y$. The results of X-ray analysis indicate that cellulose may form several different addition compounds with alkali, the compositions of which are determined by the type of cellulose used, the alkali concentration and the temperature. Treatment with aqueous solutions of alkalies (usually sodium hydroxide) has two important practical applications: (1) the modification of the physical and chemical properties of fibres, as in mercerization; and (2) the preparation of alkali cellulose as an intermediate in the manufacture of viscose and cellulose ethers. The ability of aqueous solutions of cuprammonium hydroxide and of strong acids to dissolve cellulose seems to depend on the formation of addition compounds. So-called cuprammonium rayon is prepared by extruding a cuprammonium hydroxide solution of cellulose in the form of filaments into an acid precipitating bath where the cellulose is regenerated.

See CARBOHYDRATES: *Polysaccharides;* CYTOLOGY; FIBRE, MAN-MADE; PAPER MANUFACTURE; PLANTS AND PLANT SCIENCE; PLASTICS; *see* also references under "Cellulose" in the Index.

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CELOSIA, a fairly large genus of tropical herbs or shrubs of the amaranth (*q.v.*) family, the cultivated members being herbaceous annuals. Their stems and branches are terminated by dense chaffy spikes of minute flowers that are enlarged, flattened, crested or otherwise modified and often brilliantly coloured. *See* COCKSCOMB. (J. M. BL.)

CELSIUS, ANDERS (1701–1744), Swedish astronomer and inventor of the centigrade thermometer, was born on Nov. 27, 1701, in Uppsala, where he was professor of astronomy (1730–44). At Nürnberg he published in 1733 a collection of 316 observations of the aurora borealis made by himself and others from 1716 to 1732. In Paris he advocated the measurement of an arc of the meridian in Lapland, and took part, in 1736, in the expedition organized for the purpose by the French academy. Six years later he described the centigrade thermometer in a paper read before the Swedish Academy of Sciences (*see* THERMOMETRY: *Early Development*). Celsius died at Uppsala on April 25, 1744.

He wrote *Nova methodus distantiam solis a terra determinandi* (1730); *De observationibus pro figura telluris determinanda* (1738); besides many less important works. The centigrade thermometer is often called by his name.

See W. Ostwald's *Klassiker der exacten Wissenschaften,* no. 57 (1904), where Celsius' memoir on the thermometric scale is given in German with critical and biographical notes.

CELSIUS SCALE: *see* THERMOMETRY.

CELSUS (fl. probably *c.* A.D. 178), eclectic Platonist and the most revealing representative of the pagan reaction against Christianity, perhaps lived in Rome or Alexandria. He is known solely through the fragments of his work "The True Doctrine" or "True Word" or "True Discourse" (*Alethes Logos*), preserved in the reply of Origen, *Contra Celsum,* written in 248. Celsus' main thesis is that Christianity is a breach with the ancient cultural and religious tradition of the human race, reaching back to the immemorial past of the golden age. This polytheistic tradition, which is the "true doctrine," has already been gravely corrupted by the Jews with their social exclusiveness and their interpretation of monotheism to mean the rejection of all religions other than their own. But Judaism, however eccentric, is tolerable because national. Christianity, characterized by similar social and religious exclusiveness, has the additional demerit of claiming proselytes from all races. Its missionary success is a threat to the Roman empire, both because the now neglected gods may not continue to be propitious and because the Christians are failing in social duty by their reluctance to serve in the army and in public life. The weight of Celsus' attack falls upon the Christian arguments from Jesus' miracles and the prophecies fulfilled in his life. The miracles are insufficiently attested: the Virgin Birth covers a story of illegitimacy; the resurrection hangs on the testimony of a hysterical female. The prophecies are so obscure that one cannot be sure of the reference to Jesus, and if they were as clear as the Christians claim why did the Jews fail to believe in him? Even if both miracles and prophecies are accepted, how are they superior to the healings of Asclepius or the predictions of Delphi? Philosophically, the nerve centre of Celsus' attack lies in his critique of the biblical doctrine of God, evaluated from the standpoint of an eclectic Platonist. He denies the possibility of an Incarnation partly because the transcendent God cannot be involved in matter, partly because the universality of providence excludes the particularity of a special revelation in history. Celsus' intention is neither destructive nor unconciliatory; he admits that the Christians have some good ideas, but thinks them derived from misunderstandings of Greek sages. His defense of the old polytheism uses weapons forged in the Christian arsenal, in addition to his positive philosophical arguments based upon the so-called "middle" Platonism of the age before Plotinus.

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CELSUS, AULUS CORNELIUS (1st century A.D.), the greatest Latin medical writer. As the son of the patrician family of the Cornelii he spent his life in Rome, probably not as a physician but as a widely learned gentleman. The contemporary physicians ignored his *De medicina,* the most important section of his encyclopaedic treatise, which also dealt extensively with agriculture, the military art, rhetoric, philosophy and jurisprudence. With the Renaissance, however, the *De medicina* was one of the first medical books to be printed (1478). It subsequently passed through numerous editions and became one of the most popular medical textbooks of the era. Written in a superb style that won for him the title of *Cicero medicorum,* his medical treatise deals with diseases treated by diet and regimen and with those amenable to drugs and surgery. Among those treated by diet and regimen appear the first mention of insanity (*insania*) and heart disease (*cardiacus*). His surgical chapters contain the first accounts of the use of ligature and excellent descriptions of lateral lithotomy and herniotomy. The introduction to his work establishes him also as one of the first medical historians, and much of the present knowledge of Hellenistic medicine, Alexandrian anatomy and surgery is derived from his *Prooemium.*

See *Celsus: De Medicina* with an Eng. trans. by W. G. Spencer, 3 vol. (1935–38). (I. V.)

CELT (KELT), a name derived from the plural form *Keltoi* used by Greek geographers, from at least the late 6th century B.C., to denote a great barbarian people widespread in transalpine Europe and in the Iberian peninsula. Whether *Keltoi* was the name of a particular tribe or possessed a wider significance is not known, but the name continued in use by Greek and Latin writers (Lat., *Celtae*) as descriptive of all the interrelated barbarian tribes who dwelt in the regions cited, and who, in the 4th and 3rd centuries B.C., expanded into Italy and the Balkans. The name is not known from any ancient source in connection with the British Isles, and modern usages, which are often inexact, are appropriations stemming from philological deductions made by 16th and 17th century scholars that the Gaelic and Welsh languages were derived from the speech of the ancient Celts of which there are fragmentary records in classical authors and in epigraphy. Greek writers in the 3rd century B.C. made use of *Galatai* (whence "Galatians") as a name for the Celts, and from the 2nd century B.C., *Galli* (whence "Gauls") was used in Latin.

For the origin of the Celts, archaeology shows that the Late Hallstatt culture, in the 6th and early 5th centuries B.C., included the territory known from Greek reports to have been in Celtic occupation, and it is in this cultural setting that Greek luxury objects, mainly bronze and pottery vessels for wine drinking, are found in barbarian chieftains' graves in southwest Germany, and adjacent parts of Burgundy and Switzerland. The earliest Greek imports date to the mid-6th century B.C., and it would appear that the wealthy recipients, who controlled trade routes along the river systems of the Rhône, Seine, Rhine and Danube, were the predominant and unifying element amongst the Celts. The antecedents of these warrior chieftains can be traced back to the earlier part of the 7th century B.C. in Bavaria and Bohemia whence they subsequently moved westward. In this more easterly region, as well as westward up the Danube, and across the Rhine far into France both toward Britain and southwestward into Spain, there already existed the extensive culture province of the North Alpine Urnfield culture. The bearers of this Late Bronze Age culture had colonized and intermixed with older populations throughout all this zone from about the 12th century B.C. The Urnfield people are likely to have spoken dialects that led to Celtic, and to have supported the essentially Indo-European institutions that link the Celts with Italic and other, more easterly, Indo-European peoples. In their westward movement the Hallstatt warriors thus overran peoples of their own kind, incidentally introducing the use of iron, one of the reasons for their own overlordship. For the centuries after the establishment of trade with the Greeks at Massilia, the archaeology of the Celts can be followed with greater precision. By the mid-5th century B.C., the La Tène culture, and its distinctive art style, had begun to emerge amongst the Celts centred on the middle Rhine where trade with the Etruscans, rather than with the Greeks, was now becoming predominant. The La Tène culture went through a number of phases and regional variations between the 5th and 1st centuries B.C., and by this means can be followed the migrations of Celtic tribes in regions beyond the range of contemporary history, as into central and eastern Europe and to the British Isles.

The irruptions of the Celts into Italy at the beginning of the 4th century B.C., and into the Balkans some decades later, are evidenced archaeologically in the same way, and support Greek and Latin historical sources. While it is probable that Celtic bands had penetrated into northern Italy from earlier times, the year 400 B.C. is the generally accepted approximate date for the beginning of the great invasion of migrating tribes whose names, Insubres, Boii, Senones and Lingones, were recorded by later historians. Rome was sacked about 390 B.C., and raiding bands wandered about the whole peninsula and reached Sicily. The Celtic invaders had come through the central Alpine passes, and had settled mainly in Etruscan territory. There is some evidence to suggest a considerable depopulation of parts of southern Germany and Switzerland at this time. The Celtic territory south of the Alps came to be known as Gallia Cisalpina (Cisalpine Gaul), and its warlike inhabitants remained an ever-constant menace to Rome until their defeat at Telamon in 225 B.C. Dates connected with the Celts in their movement into the Balkans are: 335 B.C. when Alexander the Great received delegations of Celts living near the Adriatic, and 279 B.C. when Delphi was sacked but the invaders suffered defeat at the hands of the Aetolians. In the following year, three Celtic tribes crossed the Bosporus into Asia Minor, and created widespread havoc. By 276 B.C. they had settled in parts of Phrygia, but continued raiding and pillage until finally quelled by Attalus I of Pergamum in about 230 B.C. In Italy, Rome had established supremacy over the whole of Cisalpine Gaul by 192 B.C. and in 124 B.C. had conquered territory beyond the western Alps: the *provincia* (Provence).

The final episodes of Celtic independence were enacted in Transalpine Gaul (Gallia Transalpina) which comprised the whole territory from the Rhine and the Alps westward to the Atlantic. The threat was two-fold: Teutonic tribes pressing westward toward, and across, the Rhine, and the Roman arms in the south poised for further annexations. The Teutonic onslaught was first felt in Bohemia, the land of the Boii, and in Noricum, a Celtic kingdom in the eastern Alps. The assailants were known as the Cimbri, a people generally thought to have originated in Jutland. A Roman army sent to the relief of Noricum in 113 B.C. was defeated, and thereafter the Cimbri, now joined by the Teutoni, ravaged widely in Transalpine Gaul overcoming all Gaulish and Roman resistance. On attempting to enter Italy, these marauders were finally routed by Roman armies in 102 and 101 B.C. There is no doubt that many Celtic tribes, formerly living east of the Rhine, had been forced to seek refuge west of it at this period and later, when the menace of Ariovistus and the Suebi gave Julius Caesar the opportunity (58 B.C.) to begin the campaigns which led to the annexation of the whole of Gaul.

The Celtic settlement of Britain and Ireland is deduced mainly from archaeological and philological considerations. The only direct historical source for the identification of an insular people with the Celts is Caesar's report of the migration of Belgic tribes to Britain, but the inhabitants of both islands were regarded by the Romans as being closely related to the Gauls. The archaeology of the settlement in both islands is complex and different, and in view especially of linguistic differences, account has to be taken of late Urnfield and Hallstatt elements in the 7th and 6th centuries B.C., as well as of subsequent migrants bearing the La Tène culture and of Gaulish refugees in the 1st century B.C.

In the eyes of Greeks and Romans, the Celts were remarkable for their height, muscularity and fair colouring. These were characteristics of the warrior class rather than of the whole population, and skeletal remains point to considerable variations in stature and head form. Information on Celtic institutions is available from various classical authors and from the body of ancient Irish literature. The social system was threefold: king, warrior aristocracy and freemen farmers. The druids, who were occupied with magico-religious duties, were recruited from families of the warrior class, but ranked higher. As in other Indo-European systems, the family was patriarchal and kinship was recognized by agnatic descent. Landownership was vested in the kin which was also responsible for many social obligations. The household was of the archaic joint type consisting of a man with his wives, children and grandchildren. The status of women seems to have varied considerably according to rank and the prosperity of the community.

The basic economy of the Celts was mixed farming, and, except in times of unrest, single farmsteads were usual. Owing to the wide variations in terrain and climate, cattle raising was more important than cereal cultivation in some regions. Hill forts provided places of refuge, but warfare was generally open and consisted of single challenges and combat as much as of general fighting. It is doubtful if fighting was actually conducted from chariots although they were used on the field for display and retreat. The decapitation of foes was practised for ritual purposes, and naked combat was an archaic form of invoking magical protection. Trousers, perhaps an eastern innovation, were worn by men of the Cisalpine Gaulish tribes from at least the 3rd century B.C., and are attested in the 1st century B.C. in Transalpine Gaul, but a belted tunic, or shirt, with a cloak seems to have been the most widespread form of male dress. Women wore a single long garment with a cloak. Coarse linen as well as wool was employed, and bright colours were popular. The Celts were noted for their high spirits and love of war and excitement generally. They were hospitable, fond of feasting, drinking and quarreling, and incapable of prolonged concerted action. La Tène art witnesses to their aesthetic qualities, and they greatly prized music and many forms of oral literary composition.

See also references under "Celt" in the Index volume.

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CELTIBERIA, an area of northeastern central Spain occupied in ancient times by tribes of mixed Iberian and Celtic stock (*see* IBERIANS) from the 3rd century B.C. onward. They inhabited the hill country between the sources of the Tagus (Tajo) and Iberus (Ebro) rivers including most of the modern province of Soria and much of the neighbouring portions of Guadalajara and Teruel.

Celtiberia was a term loosely used by ancient authors, but Strabo, Livy, Polybius and Poseidonius agree that the Celtiberians in the strict sense were the Arevaci, Belli, Titti and Lusones. Their settlements were most common in the plains of Soria but also included earlier *castros* ("camps") on hills in Soria and the modern province of Logroño. The basic population of Celtiberia was that of the southeastern Almería culture of the Bronze Age (*see* SPAIN: *History*) over which lay a stratum of Hallstatt (*q.v.*) invaders who occupied these lands shortly before 600 B.C. The tribal name Pelendoni is possibly connected with this Hallstatt people, who in turn were subjected to the invasion of the Arevaci, who dominated the neighbouring Celtiberian tribes from their powerful strongholds at Ocilis (mod. Medinaceli) and Numantia (*c.* 300 B.C.).

The Belli and the Titti were settled in the Jallón valley with the Sierra del Solorio separating them from the Lusoni to the northeast. The Titti occupied a triangle of land to the south of the Belli and had an important city at Segeda. Mundobrega (mod. Munébrega) was the chief city of the Lusones and their name survives in modern Luzón in the northeast of the Guadalajara province. Although all the limits of Celtiberia are ill-defined, the southeastern is least certain. Ptolemy, writing in the 2nd century A.D., mentions Arcobriga (in the province of Guadalajara) as a city in this region, but it might well have belonged to the Carpetani who checked their spread southward. To the east were the strong post-Hallstatt Vaccaei, but in the west a number of ill-defined tribes, perhaps also of mixed racial affinities, lay between the Celtiberians and the Iberian Edetani.

The material culture of Celtiberia was strongly influenced by that of the Iberian people of the Ebro valley as the planning and masonry of Celtiberian villages such as Calatañazor, Izarra and Ocenilla shows. The pottery technique is also of Iberian derivation. Bronze implements and weapons are largely retarded Hallstatt types (antennae-handle swords and horse-shaped fibulae) but there are also La Tène-B fibulae (*see* LA TÈNE). Horse bits, daggers, swords and shield-fittings attest the warlike nature of the Celtiberians.

The Celtiberians first submitted to the Romans in 195 B.C., but they were not completely under Roman domination until 133 B.C. when P. Cornelius Scipio Aemilianus (later surnamed Africanus) destroyed Numantia (*q.v.*), a town of about 8,000 inhabitants. It was restored under the emperor Augustus, but meanwhile the Romans had built the city of Clunia (mod. Peñalba de Castro) as an administrative centre of Celtiberia, and built other towns at Termantia, Uxama (Osma) and Arcobriga.

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CELTIC CHURCH, a title that may stand as a general description of the early Christian church in the British Isles and Brittany, and more particularly from about the middle of the 5th century until the Norman Conquest, when, weakened and distracted by two centuries of Viking invasions and its own inner decline, its organization and special customs disappeared before the reforming zeal of the Norman kings and ecclesiastics. Christianity, following the Roman armies and settlers, was well established in these regions by the 4th century and shared in the general life of the church of the west for another century and a half. The close links existing between Britain and the continent during this period are well illustrated by visits such as those of followers of the Pelagian heresy and of St. Germain of Auxerre (429), their antagonist, while it was through Gaul that monasticism spread to Britain from the east, more particularly under the influence of the monastery of Lérins (in the Mediterranean, off Cannes), which had a Briton, Faustus, as abbot as early as 433.

Among the formative British figures of this period may dimly be perceived St. Ninian in the regions of Galloway, St. Dyfrig (Dubricius) in Herefordshire and southwest Wales, St. Illtud in Glamorgan and, more clearly, St. Patrick (*q.v.*) in Ireland.

After this period, however, from about 450 onward, there was a great change. Saxon invasions exterminated Christianity in England and isolated the Christians in the southwest, Wales, north Britain and Ireland. Thereafter their own conservatism, the ecclesiastical narrowness of St. Augustine of Canterbury and his followers, and national pride made out of such matters as differing dates of Easter and variants in tonsures—themselves theologically unimportant—barriers behind which grew up two churches where previously there had been only one; for a century and a half Christians in the British Isles were divided from one another. The decisive defeat of the Saxons in the battle of Mt. Badon (*c.* 500) was followed by a long period of peace for British Christians, and it was then that the foundations were laid for the great expansion that lasted from the 6th to the 9th centuries and gave to Celtic Christianity its form and special characteristics.

Historical information, in any strict sense of the term, especially for the earlier periods, is extremely scanty, for most of the extant "lives" of British saints were composed not earlier than the 11th century for other than historical purposes, though they often preserve earlier sources. For the later periods information survives only as it has been edited by interested persons whose prejudiced outlook on the Celtic Church was due at least as much to national and political causes as to ecclesiastical differences.

Certain general characteristics of the church, however, can be distinguished. In doctrine and worship it was one with the rest of western Christendom; in both respects it was orthodox and catholic. The charges of heresy later brought against it are misleading; such charges were weapons common to the armoury of both the Celtic Church and its opponents and were freely used in controversy by both sides.

Organization.—The Celtic Church was above all monastic in its inspiration and organization. The revival and expansion that followed the Anglo-Saxon invasions owed everything to monks of devoted austerity, holiness of life and learning. Their asceticism was sometimes extreme and often took unusual forms, but about their devotion there can be no question, and it secured for the monasteries and abbots the principal part of the organization and rule of the British church. Among them, too, special honour was paid to hermits and anchorites, and such ascetics as the Culdees (*q.v.*), who became in a real sense the representatives and defenders of national traditions and customs in religion. The church continued to be episcopal in the sense that such rites as consecration and ordination were always to be reserved to bishops and that only those ordained by them could celebrate the Eucharist, but there was no metropolitan or diocesan organization. Authority of this kind seems to have been disliked, and Celtic missionaries and preachers carried this dislike with them when they went abroad (*e.g.*, the Irish successors of St. Columban gave endless trouble to the diocesan authorities in Gaul throughout the 6th and 7th centuries in this matter). Many abbots, however, such as St. David (*q.v.*) and St. Teilo in south Wales, were themselves bishops; the episcopal office was much sought after and numerous monks were elevated to it. With the breakup of Celtic Christendom as a result of the Scandinavian invasions in the 9th and 10th centuries, and the flight of many Christians abroad, the weakness of this lack of unified organization became apparent. Numerous bishops, subject to no diocesan authority, wandered about the continent, becoming an ecclesiastical menace, so that there developed on the part of the Holy See what has been described as a "marked tendency to look with suspicion on all who came from the islands."

Evangelism.—Another characteristic of the Celtic Church was its evangelistic zeal. British and Irish monks converted Brittany, colonized numerous and inaccessible islands, founded on the continent such important monasteries as St. Gall, Luxeuil and Bobbio, and carried the gospel in every direction. What missionaries like St. Columba and St. Columban (*qq.v.*) achieved was almost incredible, but their comparative lack of interest in consolidating and organizing what they had started meant that their work often had to be continued by men of different culture and tradition, such as St. Boniface (*q.v.*), whose more lasting achievements have tended to obscure the pioneering work of the "men from the islands."

Learning.—The Celtic Church was also a learned church. Classical learning was preserved in such schools as those of St. Illtud, perhaps at Llanilltud Fawr (the modern Llantwit Major) in south Wales, where Gildas, the 6th-century author and champion of monasticism, was brought up, of the Sulien family at Llanbadarn Fawr in the 11th century and others in south Wales, and in Armagh and Clonmacnoise and similar establishments in Ireland. Particular attention was paid there, too, as might be expected, to the study of the Scriptures, and it was Irish masters who taught the Scriptures to such saints as Aldhelm, Alcuin, Willibrord and Chad. Welsh and Irish figures of the 9th century, such as Asser, Johannes Scotus Erigena and Sedulius Scottus, are but the outstanding figures among a number who enriched the intellectual life of Christian Europe from the treasures of the Celtic Church. Collections of ecclesiastical laws and regulations, such as the 6th-century *Canones Wallici,* and the more important *Collectio canonum Hibernensis,* were widely read and copied and played a considerable part in contemporary continental reform movements. More important and influential were the penitentials and the penitential system they developed. Some of these were Welsh and some were Irish, associated with names of such great monastic leaders as David, Finnian and Columban. They all reveal the great importance attached in the Celtic Church to sacramental confession, among both monks and clergy and the laity, and it is not too much to say that it was these penitentials that led to the disappearance of public penance and reconciliation of penitents and the development of private confession and the sacrament of penance (*see* CONFESSION; PENITENTIAL).

Artistic Achievement.—In the field of the arts, particularly sculpture, metalwork and the illumination of manuscripts, the contribution of the Celtic Church was notable. A large number of stone memorials and crosses survive, and the "high crosses" of Ireland such as the "cross of Muiredach" are of great artistic merit; so also is the metalwork of the many shrines, such as that made for St. Patrick's bell now in the Dublin museum. But it is in illuminated manuscripts that the strange genius of the Celtic Church found its most characteristic and brilliant expression. The Irish monastic *scriptoria* in particular produced numerous copies of religious books, some of which, such as the probably 8th-century Book of Kells and the Lindisfarne Gospels, must be ranked among the finest illuminated manuscripts in the world. Their fertility of invention, their grotesque fancies, the felicity and complexity of their interlacing patterns, and the devotion and patience that lie behind them provide no small clue to an understanding of the church from which they came (*see* ILLUMINATED MANUSCRIPTS).

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CELTIC LANGUAGES. The Celtic languages form one branch of the Indo-European (*q.v.*) family, being distinguished (1) by certain phonological characteristics such as the loss of initial and intervocalic *p* (Irish *athair* "father") and the change of *ē* to *ī* (Gaulish *-rix*, Irish *rí*, "king"); (2) by lexical peculiarities; *e.g.*, Irish *nert*, Welsh *nerth*, "strength"; Irish *már*, Welsh *mawr*, "great"; Gaulish *Nertomarus* (personal name), "of great strength." On both geographical and chronological grounds they fall into two divisions, usually known as Continental and Insular.

Continental Celtic is the generic name for the languages spoken by tribes known to classical writers as Keltoi and Galatae, over an area stretching from Gaul to Iberia in the south and Galatia in the east, and over a period of roughly 1,000 years, from the middle of the 1st millennium B.C. to the middle of the 1st millennium A.D. The great bulk of the material consists of the names of persons, tribes and places recorded by classical writers; only in Gaul and northern Italy are inscriptions found, and the interpretation of these is in cases doubtful. Given the nature of the evidence, knowledge must be confined largely to the phonology and vocabulary of these languages and no certain conclusions can be reached as to their historical development or the differences between them. The Insular languages are those of the British Isles and of Brittany: there is some evidence of them from classical sources, but the main body of the material consists, first, of inscriptions and, second, of literature from the 7th century onward; they are divided into two groups, Goidelic (from Old Irish *Goidel*, modern Irish *Gael*) and Brythonic (from Welsh *Brython* "Briton"), representing the descendants of the Celtic languages of Ireland and Britain, respectively. There are no traces of dialects of Goidelic, and the modern Irish dialects, together with Scottish Gaelic and Manx, are all modern developments of Old Irish. In the Brythonic group there is evidence that the language of northern Britain was somewhat different from that of the rest of the country; it was the latter, however, which split up, as a result of the English invasions, into the languages known as Welsh, Breton and Cornish. The outstanding difference between the Goidelic and Brythonic groups is that in Goidelic the IE labio-velar *qu̯* appears first, in the Ogham inscriptions (see *Irish*, below), as *q*, later losing its labial quality and coinciding with *k* (written *c*), while in Brythonic this sound becomes *p*. Since Continental Celtic shares the latter development, the Celtic languages are sometimes divided into Q-Celtic and P-Celtic, the first group being represented only by Irish, while the second contains all the other known Celtic languages; it may be doubted, however, whether a division based on the realization of one phoneme is a useful one.

The reconstruction of common or primitive Celtic is of necessity very tentative: while Continental evidence is invaluable for the phonology, most of the information as to morphology is derived from Irish, the most archaic of the Insular languages. It has been suggested that Celtic stood in an especially close relationship to Italic, and P. J. A. Meillet went so far as to speak of a period when an Italo-Celtic nation existed, toward the end of the 2nd millennium B.C.; the fact that the *q/p* opposition existed inside Italic too (Lat. *quattuor*, but Oscan *petora*, like Gaulish *petor-*) no doubt seemed to support this theory, but much of the argument is based on accidental resemblances (*e.g.*, the Irish future in *f-* and the Latin future in *b-*) or on formations like the deponents and passives in *-r*, which at one time were known mainly in Italic and Celtic but have since been found in Hittite and Tocharian as well. The common features which are certain, such as the genitive singular ending *-i* of *o*-stems and the superlative formations (Lat. *-issimus;* Irish *-em*, Welsh *-haf*, from *-isamo*), are hardly sufficient to justify the assumption of a special relationship, and the whole concept of an Italo-Celtic unity was powerfully criticized by C. J. S. Marstrander who based his arguments mainly on the lack of agreement in vocabulary.

The Continental Celts found themselves neighbours of the Germanic peoples and were often confused with them by classical writers, but it is permissible to infer that the Celts had attained a higher stage of social organization than the Germans from the existence of words like Gothic *reiki* and *andbahts* (modern German *Reich, Amt*), which appear to be borrowed from Celtic *rīgion*, "kingdom," and *ambactos*, "officer." To the Greeks and Romans, however, they represented a lower civilization; Celtic words in Greek are restricted to those describing Celtic institutions, like *bardoi;* and while in Latin they are somewhat better established, they belong usually to a few restricted categories, such as war (*lancea* "lance"), transport (*carrus* "baggage wagon," *carpentum* "carriage") and agricultural products (*cervesia* "beer"). But the last stronghold of Continental Celtic fell with Caesar's conquest of Gaul, where it was rapidly replaced by Latin, though it probably lingered on in remote places until the 5th century, and J. U. Hubschmied advanced strong arguments for believing that Alemannic directly replaced Celtic in the territory of the Helvetii. The extent to which the Celtic substratum influenced the Latin spoken in Gaul and thus contributed to the evolution of French is a much-disputed problem: apart from a number of words, mainly belonging to rural life (*mouton* "sheep," *ruche* "hive," *arpent* "acre," *bruyère* "heath," etc.), it was suggested that the change of *u* to [*y*] and of *ct* to *it* (*e.g.*, *nuit* from *noctem*), both of which have parallels in the Brythonic languages, are of Celtic origin, but these changes in Brythonic can hardly be dated before the 6th century, so that the exact nature of the Celtic influence remains very uncertain.

When the Romans first invaded Britain it would appear that, with the solitary exception of a non-Indo-European Pictish which shared the far north with a Celtic Pictish, the whole island was of Celtic speech. The Roman occupation had no permanent effect on the Brythonic language, apart from the introduction of a great number of loanwords; although Latin was the language of the administrators and of the towns, it is probable that Brythonic had regained most of this ground by the time the English raids began to assume the status of an invasion, that is, by the middle of the 5th century. It is during the 5th and 6th centuries, the period of the consolidation of the English power, that Brythonic develops into the languages known as Welsh, Breton and Cornish. The change is a drastic one, comparable with the evolution of French from Latin: whereas Brythonic, like Continental Celtic, was an archaic Indo-European language of the same type as Latin, Greek or Sanskrit, the new languages, having lost nearly all their final syllables and undergone considerable internal reductions, are of the modern European type. It would be easy to account for this rapid evolution by saying that a time of troubles is likely to accelerate linguistic development, were it not for the fact that a precisely parallel evolution from Goidelic, a language of the old type, to Irish takes place during the same period, when the only foreign influences of importance were those associated with the introduction of Christianity.

The new languages, the only forms of Celtic which are known thoroughly, present a considerable number of peculiarities, many of which are innovations, and scholars such as J. Rhŷs and J. Pokorny suggested that these may be due to the presence of a large non-Celtic substratum. The most remarkable phonological feature is the development of a double series of consonants, long, strongly articulated consonants being opposed to short, weak ones; while the two series were originally merely phonetic variants, the strong variety occurring in initial position, as a result of gemination, and in certain consonant clusters, the opposition gradually became phonological, *i.e.*, phonematic, in the same way in which *rr* and *r* have become differentiated in Spanish. In the languages as now known considerable phonetic changes have taken place in the system; in Irish the opposition strong:weak in the stops has been replaced by the opposition stop:spirant, while in the Brythonic languages this development has taken place only in the voiced stops, the opposition with the unvoiced stops being strong unvoiced:weak voiced. These changes by themselves are not very different from the lenition of intervocalic consonants which occurs in the Romance languages (*cf.* Welsh *pader* from Lat. *pāter*, Sp. *padre* from *patrem*), but in Insular Celtic they occurred not only inside the word, but also inside the phrase, so that the initial consonant of a word preceded by another word ending in a vowel is weakened; when the final syllables were lost in the evolution to the modern languages these variations remained and a system of initial mutations was thus set up. If, for example, we assume a Goidelic nominative and genitive *sindos kattos koilos, sindi katti koili*, we find in Old Irish *in catt coel, in chaitt choil*, where the *k* sounds in strong position before *s* have been preserved, but the weak intervocalic variety appears as *ch*. These alternations become a system of initial mutations which form an essential part of the grammar of the Insular Celtic languages; thus, in Irish, *a* means "his," "her" or "their" according to the mutation which follows.

Morphologically, the most striking feature of the Insular languages is the verbal system, best preserved in Old Irish. There are two verbal flections, absolute and conjunct, according to the absence or presence of a preverbal particle; thus *beirid* "he bears," *ní beir* "he does not bear." These forms appear to derive from the Indo-European primary and secondary endings, but how these came to be used in this way is not clear. The stressed pronouns cannot function as either subject or object of the verb; if it is wished to stress the subject an emphatic particle is added and the object pronoun is either proclitic or enclitic to the verb; thus *beirid-som* "he bears," *beirthi* "he bears it," *do-beir* "he gives," *da-mbeir* "he gives him." It may be noted that the pronouns are enclitic to the prepositions also, so that from *for* "upon," come *form* "on me," *fort* "on thee," and so on. This system of conjugated prepositions, as it is usually called, is found in both branches of Insular Celtic, but it is impossible to reconstruct common forms, thus suggesting that they are parallel developments. But the outstanding point in the verbal system is the part played by the verbal noun, which is a true noun, followed by the genitive case; in both branches it is used from the earliest times in construction with the verb "to be" to indicate continuous action: Irish *táim ag dul*, Welsh *yr wyf yn mynd*, "I am going," literally "I am at going" (the prepositions used are of different origins in Irish, Welsh and Breton). The history of the Insular Celtic languages shows a steady expansion of the use of the verbal noun at the expense of the finite forms of the verb; where Old Irish expressed the perfect by a verbal prefix or similar devices (*léicis* "he threw," *ro léic* "he has thrown"), modern Irish and Welsh have *táim tréis dul, yr wyf wedi mynd*, "I have (just) gone," literally "I am after going." It will be seen that these developments have striking analogies in English, and it is hard to resist the conclusion that the development of the latter has been influenced by its geographical position.

Breton is the descendant of the Brythonic dialects brought to Armorica (Brittany) in the 5th and 6th centuries by refugees from the English invasions, and there is therefore a faint possibility, though no conclusive evidence, that Continental Celtic may still have lingered on when Insular Celtic was imported; Breton *brug* shows the same treatment of initial *u-* as Fr. *bruyère*, in contrast to Welsh *grug*. Old Breton, however, which is known only from glosses from the 9th century onward, is very close to Old Welsh and Old Cornish. Literary texts are not found until the 15th century: these, which are mainly mystery plays and similar ecclesiastical material, are written in a standardized language, heavily laden with French loanwords, called Middle Breton. From the 17th century onward, the modern dialects appear, usually divided into those of Léon, Cornouaille and Tréguier, all of which have the stress accent on the penultimate syllable, and that of Vannes, which has a final accent, as well as many other individual features. (D. Ge.)

Cornish, the native language of the people of Cornwall, was an analytical language which developed from a southwestern dialect of the older synthetic Brittonic. In phonology, morphology and syntax it was nearer to Breton than to Welsh. Distinguishing features of its phonology were the early change of medial and final *t* and *d* into *s* or *z*, the absence of nasal mutation (except sporadically as in Breton) and the regular provection (or "hardening") of *b, d, g, gw, v, th* into *p, t, c, qu, f, t*. Like Breton it used the past participle in passive verbal constructions and the verb "to do" as an auxiliary to a degree not found in Welsh. English influence on its orthography, vocabulary and syntax was far greater than on Welsh even in medieval times. Until the 15th century the river Tamar was the boundary between English and Cornish, but by about 1600 Cornish was spoken only in the westernmost parts of Cornwall; by 1735 it was losing ground even in those parts, and by about 1800 it was virtually dead. Attempts to revive the language as a spoken and literary medium have had but artificial results. Certain Cornish words have survived in the English of Cornwall, and Cornish place names occur from the Tamar to Land's End. (T. Js.)

Gaulish is the name given to the Continental language, or languages, formerly spoken in Gaul; in spite of the existence of nearly 200 inscriptions, little is known about the language beyond a limited vocabulary and certain declensional forms. All the evidence points to its having belonged to the P-Celtic rather than the Q-Celtic group, for none of the occurrences of the sound *q*, such as *equos* in the Coligny Calendar, can be traced with certainty to a Celtic $q^{\underset{\frown}{u}}$; the treatment of original *u*, however, differs from that of Insular Brythonic, as is shown by Fr. *bruyère* as opposed to Welsh *grug*. There is sufficient variety in the forms of the attested words to lend some support to Caesar's statement that dialect variations existed, but there is not enough material to arrive at any conclusions as to their nature.

Irish.—The history of Irish may be divided into four periods: (1) that of the Ogham inscriptions (*see* OGHAM WRITING), probably A.D. 300–500; (2) Old Irish, 600–900; (3) Middle Irish, 900–1200; (4) Modern Irish, 1200 to the present day. This division is, of course, arbitrary, and archaizing tendencies confuse the situation, especially during the period 1100–1600, after which the literary language ceases to dominate and the modern dialects, among which may be reckoned Scottish Gaelic and Manx, appear.

Although there are more than 300 Ogham inscriptions, none is of more than a few words and the great majority are names in the genitive case, so that their evidence is almost entirely phonological. No doubt the system of strong and weak consonants which is characteristic of Insular Celtic had already been evolved at this time, but the Latin alphabet, on which the Ogham alphabet is based, offered no means of distinguishing these phonetic variations, the more so since the weak stops had not yet developed into spirants. The sound *q* is still distinguished from *k*, and original final syllables are preserved. These inscriptions are the only remains of the archaic or Goidelic period of Irish.

The Latin alphabet was introduced into Ireland in the 5th century and by the end of the 6th century was being used to write Irish; the problems of interpretation are complicated by the fact that the British pronunciation was used so that, *e.g.*, internal *-t-* and *-c-* are usually to be read as *d* and *g*. Old Irish *Pátraic* is to be read *Pádraig*, as it is spelled in modern Irish. The weak forms of the consonants could only be written where there were Latin spellings which could be utilized: *ll:l, rr:r, nn:n, c:ch, t:th, p:ph* and, with the help of the *punctum delens, s:ṡ, f:ḟ*; but many ambiguities remain; *e.g., a bráthair* can stand for either "his brother" or "her brother." only sporadically being written *ab-bráthair* in the latter case. Nor was the Latin alphabet capable of dealing with the new system of consonant quality which appears in Irish alone among the Celtic languages; from Celtic nominative singular and plural *bardos, bardi*, come Welsh *bardd, beirdd*, with a vowel alternation of the same kind as in English "foot," "feet," but in Irish it becomes *bard, baird*, where the *i* of the second word is purely graphic and serves to indicate that the following consonants are palatalized. All consonants have two pronunciations, velarized and palatalized, as in Russian, and in the case of the continuants *l, n* and *r* which continued to oppose strong and weak forms, there were therefore four distinct varieties of each sound.

It was suggested by T. F. O'Rahilly that the Goidels were comparative latecomers to Ireland and that there was a previous Brythonic population which formed a linguistic substratum. But, although there is a remarkably large number of Brythonic loanwords in Irish, they are recognizable precisely because they show a distinctive Brythonic development which can hardly be placed earlier than the 6th century and are thus contemporary with the great bulk of Latin loanwords in Irish, which bear the stamp of British origin. There is, however, a small number of Latin loanwords which were borrowed at a sufficiently early date for them to undergo the same changes as native Celtic words, that is, not later than the 5th century; there is no way of determining the earlier limit. These are sometimes known as the *Cothriche* loanwords, this being the old form of *Patricius*, showing early substitution of *q* (later *c*) for *p* as well as the Irish lenition, as opposed to the *pátraic* loanwords, which come into Irish in their British form and remain substantially unchanged.

Old Irish, which represents a language which has just emerged from the archaic stage, has a remarkably complex structure of compound verbs and infixed pronouns which survives for some centuries but is simplified in the Middle Irish period to a point resembling that which the earliest recorded Welsh had already reached, the infixed pronoun being replaced by the independent pronoun, first as object and then as subject, when it takes the third person form of the verb. This tendency, which can be traced to the beginning of the modern Irish period, has developed farthest in Scottish Gaelic and Manx where, as in modern Danish, there is only one verbal form for each tense. Southern Irish is considerably more conservative.

Manx.—Very little is known of the linguistic history of the Isle of Man, but a strong Scandinavian element is evident both in the place names and in the Manx language itself, which was first written down in the version of the Book of Common Prayer made by Bishop Phillips in 1610. Manx is clearly an Irish dialect, but its sound system in the 17th century is hard to determine, since it was written down in an orthography based on that of English; by the time that the first scientific study was made the language was far advanced in decay. The Prayer Book and later documents show that the morphological system had also evolved considerably, declension and verbal flection having been almost abandoned and the latter being replaced by constructions using the verbal noun. No native speakers now exist.

Scottish Gaelic.—Scottish Gaelic does not emerge as a distinct dialect until the 16th century: although Irish was introduced into Scotland from Ireland about the end of the 5th century there is no evidence that the language spoken in Scotland began to diverge from that of Ireland until a late period. The modern language, especially in the Hebrides, shows many innovations, notably a displacement of the opposition between voiced and unvoiced stops to one between unaspirated and aspirated voiceless stops. Scottish Gaelic, like Manx, has lost the Irish nasal mutation and has shifted the verbal system in the same way as Welsh, the continuous present (*tha mi a' dul* "I am going") replacing the old present forms, which in turn take on a future meaning (*théid mi* "I will go"), with the consequent loss of the old future tense.

(D. Ge.)

Welsh, known to those who speak it as *Cymraeg*, the language of the *Cymro* "a fellow countryman," developed from British, the language spoken by the ancient Britons. This was a fully inflected language, with terminations for person, number, case, gender, mood and tense, like Latin or Greek. These terminations have been lost in Welsh, or, to be more exact, the final syllable of every word has been lost. There must have been a strong stress accent in British on the penult, so that the syllables before and after it were pronounced lightly. In the course of time this led to the universal dropping of final syllables, and in many cases other unaccented syllables were either lost or their vowels were shortened. The first change, when completed, marks the passing of British into Welsh.

But the shortened Welsh word suffered further changes, which must have started in the British period. A consonant between two vowels was mutated (*p, t, c* became *b, d, g*, etc.) even when the first vowel came at the end of a previous word; *e.g., landa Petri* "the church of Peter," became *llan Bedr; merca teca* became *merch deg* "a pretty girl," etc. Many feminine nouns ended in *-a*, and the initial of a following adjective, if a mutable consonant, was thus flanked by vowels and was regularly mutated. By analogy, this became the rule for all; every feminine noun preceded by the article and every adjective following a feminine noun mutates in Welsh. So this consonantal change must have happened before the final syllable was lost completely. Similarly, if the final syllable in British contained a long vowel (*ā, ī, ū*), this affected certain vowels in the penult; *e.g., ī* affects *ă* to *ei*. British *branos* "a crow," became *bran* in Welsh, but *branī*, genitive singular or nominative plural, gave *brein* in medieval Welsh, *brain* in modern Welsh. This was a purely phonetic change, but in later Welsh it became one of the signs of the plural (*cf.* English *man, men*). To explain it we must go back to the British form.

In the verb, too, dropping the final syllable must have meant considerable confusion and a fairly long period was required before a regular pattern appeared. Indeed the process went on and on and is uncompleted even now.

At what time the main changes had become standardized and a new language was born is very difficult to decide in the absence of contemporary documents. It can only be conjectured that the last centuries of the Roman occupation were the most likely period for the evolution of British into Welsh. Latin by then had long been the language of the army, administration, law, commerce and town life generally. British lived on in the wilder country districts where romanization was not so complete. On the departure of the Romans, the men of the hills were called on to take the lead in repelling the raids of Picts, Scots and Saxons. These new leaders and their followers spoke a different language, a rough, uncouth, clipped form of the old British. By A.D. 550 this had been developed into a language fit to be employed by bards to sing the praises of the new heroes. Aneirin sang to the Gododdin, Taliessin to Urien, the opponent of Ida (547–559) and Cynan, the father of the Selyf who fell at the battle of Chester in *c.* 615. That is the Welsh tradition and it fits the known facts. How much of the late versions of their poems is authentic is another matter. Cadwallon, slain near Hexham in 633–634, is praised in stanzas resembling Aneirin's *Y Gododdin.* The death in 642 of Domnall Brecc, king of the Scots, in battle with the men of Strathclyde, is the joyous theme of another poem, now added to *Y Gododdin.* There are plentiful indications in Bede (before 735) that Welsh is well established; *e.g.*, personal and place names, such as *Carlegion, Bancor, Brocmail, Dinoot;* still more in Nennius (*Mailcun, Cunedag, Morcant*) who wrote about 796.

The inscriptions on stones tell the same tale; there are Welsh forms of the names on the Llangaffo stone (*c.* 620) and the whole is in Welsh on the Towyn stone (*c.* 750). Glosses in 9th-century manuscripts are fairly frequent, but by that time Welsh was in common use.

Sir John Morris-Jones divides the history of Welsh into periods: Early Welsh up to the 8th century; Old Welsh from the beginning of the 9th to the end of the 11th century; Medieval Welsh from the beginning of the 12th to the end of the 14th century; and Modern Welsh from Dafydd ap Gwilym to the present day. He notes that the language of the bards from the 14th to the 16th century might be called Early Modern Welsh and then Late Modern Welsh might represent the literary language from the printing of the Scriptures in the 16th and early 17th centuries to modern times.

See also references under "Celtic Languages" in the Index volume. (I. W.)

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CELTIC LITERATURE: *see* BRETON LITERATURE; CELTIC LANGUAGES; CORNISH LITERATURE; IRISH LITERATURE; SCOTTISH LITERATURE; WELSH LITERATURE.

CELTIC MYTHOLOGY. Although the Celts of Gaul understood Greek, they do not appear to have committed their own myths to writing. There is thus no mass of contemporary material such as is found concerning the myths of the classical world. The Celtic mythology that exists was either written down from oral tales by Christian writers hundreds of years after the myths were a functional part of pagan religious life, or to some extent collected by modern students of folklore. A considerable body of ancient literature indeed has survived, particularly from Ireland and Wales, but since it was already of great antiquity when it was written down, scholars differ widely over its interpretation and also as to what is myth (*i.e.,* fabrication of a religious nature) and what is legend (the true story of actual events distorted by frequent retelling). Two types of story illustrate this.

First, a large body of tales exists, known in Irish as *imramha* ("rowing about," "voyaging"), which ranges from prosaic tales of Irish saints traveling to Iceland, Greenland and perhaps America, to fabulous stories of pagan heroes adventuring in quest of lands beyond the sunset. It seems reasonable to suppose that these *imramha* are legends, for there is a complete gradation from the matter of fact to the magical. Nonetheless K. Meyer and A. Nutt use the magical type of tale to demonstrate a supposed Celtic belief in a happy otherworld beyond the western ocean. Second, in the cycle of Cú Chulainn (often wrongly described as a saga) opinions have differed as to whether the hero, Cú Chulainn, was a god, a man or even a wooden idol. Whatever Cú Chulainn may have been, there is no doubt that the cycle contains much genuine mythology.

In spite of the magic way in which Cú Chulainn is said to have been conceived (his mother, Dechtire, swallowed the god Lug in a draft of wine), it seems probable that he was once a real man and that the Tuatha Dé Danann, his relatives, were really human and not the gods that some writers have supposed. Cú Chulainn does, however, become involved in incidents where real gods undoubtedly appear.

The Tuatha Dé Danann themselves are the "branch" of the goddess Dana or Danu. She was evidently, like Isis, known by a great number of names, more than 30, of which the Badb, the Cailleach and Macha are the most in evidence. Dana is clearly the great earth mother or the female principle. She is the Celtic Artemis of classical writers, with the fruitful earth and all animal creation under her control. She is goddess of life and death and, as Morrigan or Black Annis, a great slaughterer of men. Her consort Dagda is a rustic Hercules, representing the male principle at a time when descent was matrilineal and the organization of the tribe matriarchal.

The great mother's magic horse, represented as having one leg and being impaled on a chariot pole, suggests links with the Scythians to the north of the Black sea, while many of her characteristics are so like those of the Hindu goddess Kali that, coupled with the known survival of hippogamy in Donegal in the middle ages, it seems probable that these Irish stories belong to a religion which spread from some unknown source both westward and to the southeast, perhaps 3,000 years ago.

The *Táin Bó Cúailnge,* the major portion of this Cú Chulainn epic, is believed to have been written down *c.* A.D. 700, and several ancient copies of it exist. But as the events described in it belong, as Sir William Ridgeway pointed out, to the Irish Early Iron Age, 700 years before the epic was written down, much embroidery has accumulated in their frequent repetition.

The Welsh tales collected in the *Mabinogion* (*q.v.*) were stabilized at a much later period, and *The White Book of Rhydderch,* the earliest surviving manuscript to contain any considerable number of them, dates from the beginning of the 14th century. Here again myth is hard to separate from legend, but a definite underworld, Annwn, can be observed with a king, Arawn, who has relations with the world of men, in much the same manner as that found in classical mythology. The first tales of the *Mabinogion* are myths in which gods, such as Maponus (Mabon), who are known from other contexts, figure largely. It is clear, however, that they belong to a later religious concept than those of the Cú Chulainn cycle in Ireland. The emphasis is no longer on the mother, and the society which composed the myths was patriarchal and patrilineal. Both the Cú Chulainn cycle and the *Four Branches* of the *Mabinogion* are pre-Christian and perhaps of much the same date, but the Welsh stories indicate a change of orientation. There are many links between the two: characters, presumably gods, and magic attributes such as life-giving caldrons are common to both. A Welsh form of *imramha* is also found in the bardic poems of Taliessin, whose work is supposed to date from the 6th century.

There is no doubt that the bulk of mythical tales was once very great and that what remains is but a small fraction of the whole. The work of numerous students of folklore in Scotland and England indicates that similar myths, often relating to the same gods, were once spread over the whole country. The Cailleach, the great mother, is found in western Scotland as well as in Ireland. She was known as Dana, or Black Annis, in the midlands and Yorkshire, as Magog, or Macha, from Land's End to East Anglia. In Italy, with her consort Lucifer, Dana, or Tana, taught her people magic, just as in Ireland and Scotland her people, the Dé Danann, were famous as magicians. Magog is also known far to the east beyond the Carpathians.

Little Celtic mythology survives from Cornish or Breton sources, but the folklore is voluminous and to a large extent remains to be carefully sifted. It seems clear that it belongs to the Welsh rather than the Irish phase. *See* also IRISH LITERATURE; WELSH LITERATURE.

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(T. C. L.)

CELTIS (CELTES), **CONRADUS** (German name, KONRAD PICKEL) (1459–1508), the greatest German humanist and an outstanding Latin lyrical poet, was born on Feb. 1, 1459, at Wipfeld near Würzburg. He studied at Cologne and Heidelberg, lectured at various German centres of humanism, was crowned poet laureate by Frederick III at Nürnberg in 1487 (the first German to receive this honour), spent two years in Italian humanist circles, studied mathematics and astronomy at Cracow and became professor of poetry and rhetoric in Ingolstadt in 1491. In 1497 Maximilian I appointed him professor in Vienna. Celtis founded, on Italian models, the *Sodalitas litteraria Rhenana* at Heidelberg and the Viennese *Sodalitas Danubiana;* in 1502 he became head of the new *Collegium poetarum et mathematicorum* at Vienna. He died in Vienna on Feb. 4, 1508.

Celtis' manuscript discoveries included Hrotswitha's plays and the so-called *Tabula Peutingeriana*, a map of the Roman empire. Among his scholarly works were editions of Tacitus' *Germania* (1500), Hrotswitha's plays (1501) and the 12th-century poem on Barbarossa, *Ligurinus* (1507). The patriotism which partly inspired these editions is an important element in Celtis; German greatness past and present is a recurrent theme, as in his inaugural lecture at Ingolstadt (*Oratio*, 1492), where in a nationalistic, anti-Italian tone he commends the study of poetry, eloquence and philosophy as a foundation for personal and political virtue. Celtis' masques with music, *Ludus Dianae* (1501) and *Rhapsodia* (1505), were early forerunners of baroque opera. His greatest work, however, is his lyric poetry: *Odes* (published posthumously, 1513)—Celtis aimed at being the German Horace—; *Epigrams* (in manuscript till 1881); and especially *Amores* (1502), poems of forthright sensuality and true lyrical intensity, presented in an elaborate symbolical framework characteristic of the age. By his range and versatility, his poetical power and skill, Celtis is the greatest German humanist and supreme German poet of his age; he has no rival until Goethe.

See L. Forster (ed.), *Selections From Conrad Celtis* (1948), with texts, translations, commentary, introduction and full bibliography; L. W. Spitz, *Conrad Celtis: the German Arch-Humanist* (1957).

(J. R. WE.)

CELTIS is a genus of about 70 species of trees and shrubs of the northern hemisphere and tropics. The plants, belonging to the elm family (Ulmaceae; *q.v.*), are deciduous or, rarely, evergreen. *See* HACKBERRY.

CELTIUM: *see* HAFNIUM.

CEMBALO (CLAVICEMBALO), the Italian word for harpsichord (*q.v.*), originally derived from the Latin *clavis* a "key," and *cymbalum* a "psaltery" or a "dulcimer": hence *clavicymbalum*, a psaltery with keys. Cembalo is used also in Germany synonymously with *Kielflügel*, the German word for harpsichord.

(R. A. RU.)

CEMENT. The word "cement" is from the Latin verb "to cut," and originally had reference to stone cuttings used in lime mortar. Thus, it is logical that in the middle ages the mortar itself was commonly called cement. In correct modern usage, cement generally means only the chemical binder, and the term may be used with respect to any material serving such a purpose.

Ranking, in volume of production, far above all other cements are the general construction cements—powdered inorganic cementitious materials that are mixed with water and sand to make mortar; and with water, sand and larger stone particles to make concrete. This article is concerned primarily with such cements; others, to which the term "adhesive" is in general applicable, are discussed below, under *Adhesive Cements*, and in the article ADHESIVES.

Some modern organic plastics are attaining some use as cementitious building materials. When called cements they are often actually mortars, carrying inert filler. They are classed, in this article, among the adhesive cements.

Most construction cements are hydraulic cements; *i.e.*, ones that are not only mixed with water but will set and harden under water. They are composed of the commoner oxides of the earth's crust, and depend for their hydraulic property on chemical compounds of lime that react with water. Of the hydraulic cements, by far the most important is portland cement—the direct descendant of older types which it has largely supplanted. Portland-slag and portland-pozzolan cements are blends containing portland cement.

In the early 1960s, world production of hydraulic cement was over 350,000,000 short tons. The United States produced more than any other country, while the U.S.S.R., Federal Republic of Germany, Japan, China, Italy, France and Great Britain were other large producers.

Because of the great importance of portland cement, it is given major attention in this article; other cementitious materials are briefly discussed under *Other Cements*.

PORTLAND CEMENT

Portland cement is a finely ground powder, usually gray, which when mixed with water hardens and develops strength primarily because of a large content of anhydrous calcium silicates. These and other constituents react chemically with the water by hydration and hydrolysis. The most common raw materials are limestone and clay or shale. The raw mix is finely ground and heated to about 1,500° C. to decompose the calcium carbonate and recombine the calcium oxide; a partly fused clinker of marble size and larger is produced. The clinker is then ground, almost always with a small amount of calcium sulfate (gypsum), which retards set. Portland cements with special properties are produced by varying the oxide composition, and also by adding small amounts of chemical agents at the clinker-grinding stage or later.

Early investigators advanced divergent theories as to why portland cement forms a rigid, strongly coherent mass when it reacts with water. It has since been established that a colloidal gel of high internal surface area is formed. Whatever the extent of direct chemical continuity, it is apparent that large internal surface forces may also be involved.

How Portland Cement Is Used.—A mixture of cement and water is called neat cement paste, whether fresh or hardened. In some grouting operations, including oil-well cementing, the paste is used as such. Generally, however, it constitutes the hardening ingredient in mortar or concrete. This use of sand and stone filler, called aggregate, is an economy, and also reduces shrinkage. The cement paste ordinarily amounts from 20% to 35% of the volume of the concrete. Since plain concrete is not nearly so strong in tension as in compression, steel reinforcement is embedded in structural concrete to provide greater strength in tension. (For information on the technology of concrete, *see* CONCRETE.) Another use of portland cement is in soil-cement mixtures, used as pavement base. Portland cement is also mixed with asbestos fibre and water, and processed to make special products.

In the United States, the annual tonnage of concrete made with portland cement greatly exceeds the combined tonnage of all other construction materials. Concrete is used in residential, farm and public building construction; in pavements, dams, bridges, silos, piping, tanks, reservoirs, revetments, swimming pools, ornamentation, etc. Like organic plastics, it derives much of its utility from the fact that it is readily cast or molded into shape.

Concrete is used extensively for shielding against nuclear radiation. It is used around reactors and particle accelerators, and for construction of radiation shelters. Sometimes special, heavy aggregates are used to reduce required thicknesses.

History.—The Egyptians used impure gypsum plaster as mortar in pyramid construction. Slaked lime was used by the Greeks, and the Romans probably learned of its utility from them. Both the Greeks and Romans made a pozzolanic mortar by mixing finely ground volcanic material with lime, sand and water. Pozzolana hardens by reacting chemically with the lime. The name derives from the Italian town Pozzuoli, where a suitable volcanic tuff was found. The Romans also used powdered pottery fragments as pozzolana. The pozzolanic cements made by mixing such materials with lime and water were found to be resistant if exposed to water, and were for a long time the only cements known to be suitable for such exposure. Pozzolanic cement was used in such structures as the Roman Pantheon, and Colosseum. In the middle ages the quality of mortar declined. It was commonly a sand-lime mortar, and the lime was poorly burned.

In 1756 when John Smeaton was commissioned to rebuild the Eddystone lighthouse off Cornwall, Eng., a lime-pozzolana mortar was the recognized material for underwater construction, but it was not always satisfactory. Smeaton experimented and found that the better limes were those made from limestone containing considerable clay. He is thus credited with being the first to recognize what constitutes a hydraulic lime. In 1796, James Parker in England patented a hard-burned impure lime. His product, which he called Roman cement, attained wide use. It was essentially a natural cement (see *Other Cements*, below) in that it did not slake (absorb water and crumble) but required grinding. This was true of natural cements produced, from the late 1820s, in the United States from "cement rock." A considerable natural-cement industry developed.

In 1824, a process for making "portland cement" was patented by Joseph Aspdin in England. He chose the name because of a fancied resemblance of the cement products to portland stone, a limestone quarried at Portland, Eng. Aspdin, by having conferred the name, is commonly considered to be the inventor of what has become the modern portland cement. Authorities recognize, however, that the matter is controversial because of other similar early developments. Modern portland cement is a logical scientific development from natural cement.

Methods of production have naturally changed greatly over the years. Early firing was in stationary, intermittently operated kilns. Production was on a small scale and the cement was ground with millstones. Kilns underwent various changes, but the most striking was the introduction of the rotary kiln. In 1877, T. R. Crampton obtained a British patent on a rotary kiln process for cement, but it was not a success. Frederick Ransome obtained British and U.S. patents in 1885 and 1886 for a process that achieved first success in the United States and led eventually to complete adoption of the rotary kiln for production of portland cement in that country. In Europe the continuously operating shaft kiln has remained a competitor.

MODERN PRODUCTION OF PORTLAND CEMENT

Raw Materials

Cement raw materials may be divided into those essentially supplying the lime component (calcareous), the silica component (siliceous), the alumina component (argillaceous) and the iron component (ferriferous). In the United States and Canada 30 different raw materials are used as listed in Table I. The oxide composition of various cement raw materials is given in Table II.

Table I.—*Raw Materials for the Production of Portland Cement*

Calcareous	Argillaceous	Siliceous	Ferriferous
Cement rock	Clay	Sand	Iron ore
Limestone	Shale	"Traprock"	Iron calcine
Marl	Slag	Calcium silicate	Iron dust
Alkali waste	Fly ash	Quartzite	Iron pyrite
Oyster shell	Copper slag	Fuller's earth	Iron sinters
Coquina shell	Aluminum ore refuse		Iron oxide
Chalk	Staurolite		Blast-furnace flue dust
Marble	Diaspore clay		
	Granodiorite		
	Kaolin		

Cement rock is a low-magnesium limestone containing clay. The Jacksonburg limestone of the Lehigh valley (Pa.) is a well-known example.

Limestones are composed essentially of calcium carbonate, varying minor percentages of magnesium carbonate and mechanically admixed impurities of clay and sand. Clay and sand are not objectionable impurities when the rock is used for the manufacture of portland cement. They supply the alumina, silica and iron oxide necessary for the formation of the desired silicates in the cement. The term "limestone" is used to include all carbonate rocks containing major quantities of calcium. However, because of its high magnesium content, dolomite (a carbonate of calcium and magnesium), cannot be used for the production of portland cement.

Table II.—*Per Cent Oxide Composition of Typical Cement Materials*

Type	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Ignition loss
Limestone . . .	1.2	0.5	0.4	54.0	0.6	43.2
Limestone . . .	5.6	1.0	0.5	50.7	0.8	41.2
Cement rock . .	14.2	4.8	1.6	40.2	2.8	34.2
Sand	89.7	2.4	0.7	0.6	0.7	5.9
Clay	67.8	14.3	4.5	0.9	1.2	8.0
Shale	63.0	20.0	5.5	0.7	2.7	6.0
Pyrite cinders . .	6.3	2.1	86.7	0.02	0.1	2.6
Slag	37.8	11.4	1.0	46.1	2.0	—
Sea shells (washed) .	1.5	0.4	1.2	52.28	0.7	41.8
Fly ash . . .	51.2	25.6	8.5	1.6	0.9	8.6

Marls are earthy, friable accumulations of calcareous material secreted by plants and animals in lakes and marshes. Over long periods of time the skeletal remains of plants mixed with shells of animals may form beds as much as 30-ft. thick, containing substantial tonnages of material suitable for cement manufacture.

Shell marls consist of mixtures of fossil shells, shell fragments and varying amounts of clay and sand.

A process used in several places in England and France is based on simultaneous production of sulfuric acid and portland cement from gypsum with addition of argillaceous components.

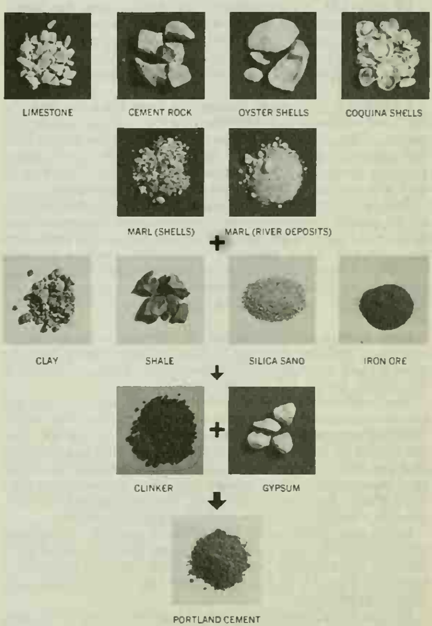
Oyster and clam shells of recent origin have been collected and burned for lime from Nova Scotia to Texas. Tonnage adequate for cement manufacture, however, is not known on the Atlantic coast of North America. In San Francisco bay shells occur in brackish water deposits as much as 30-ft. thick, and are suitable for cement manufacture. Along the Gulf of Mexico, oyster shells are the principal source of lime for cement manufacturers at Corpus Christi and Houston, Tex., Baton Rouge, La., and Mobile, Ala.

Coquina shells, used in Florida, are excavated under water and cleaned completely or partially of their sand content by washing.

Chalk, a soft, friable form of calcium carbonate of high purity, is used for cement manufacture in Denmark, England, France and Belgium, where it occurs abundantly.

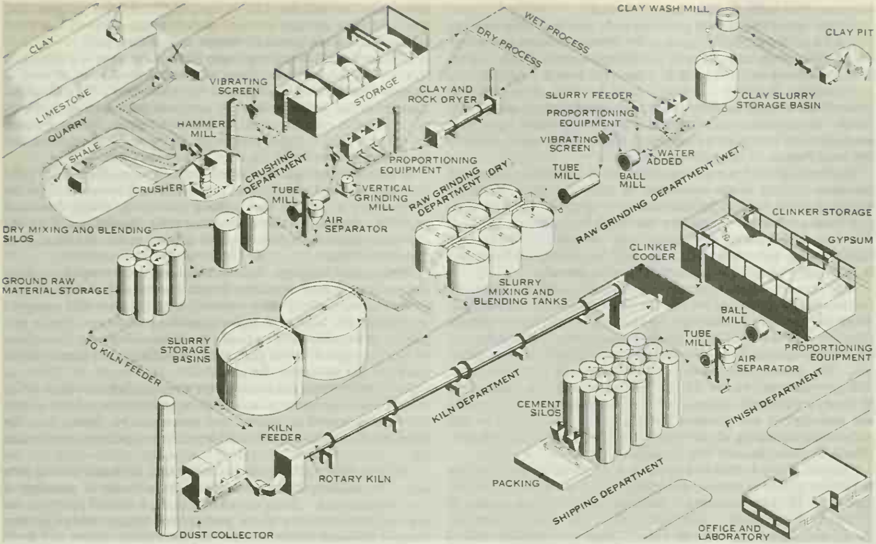
Clay and shale must be added where alumina and silica are not present in the limestone in sufficient amounts (and this is true for operations other than those based on cement rock). Clay is earthy, easily disintegrated and widely distributed; shales are composed of clay minerals deposited in water in thin layers and subjected to some pressure and cementation, with some lithification. Shales are weak rocks but do not disintegrate as readily as the unconsolidated clays and therefore require grinding.

Basic blast-furnace slag may be substituted in part for the raw materials used in the production of portland cement. The slag is mixed with limestone and serves to introduce a part of the lime, silica, alumina and iron oxide.



BY COURTESY OF PORTLAND CEMENT ASSOCIATION

FIG. 1.—RAW MATERIALS USED IN THE MANUFACTURE OF PORTLAND CEMENT


CLAY
LIMESTONE
QUARRY
SHALE
VIBRATING SCREEN
HAMMER MILL
CRUSHER
STORAGE
CRUSHING DEPARTMENT
TUBE MILL
AIR SEPARATOR
PROPORTIONING EQUIPMENT
VERTICAL GRINDING MILL
CLAY AND ROCK DRYER
DRY PROCESS
WET PROCESS
RAW GRINDING DEPARTMENT (DRY)
CLAY WASH MILL
CLAY PIT
CLAY SLURRY STORAGE BASIN
SLURRY FEEDER
PROPORTIONING EQUIPMENT
VIBRATING SCREEN
WATER ADDED
TUBE MILL
BALL MILL
RAW GRINDING DEPARTMENT (WET)
DRY MIXING AND BLENDING SILOS
GROUND RAW MATERIAL STORAGE
SLURRY MIXING AND BLENDING TANKS
CLINKER COOLER
CLINKER STORAGE
GYPSUM
BALL MILL
TUBE MILL
AIR SEPARATOR
PROPORTIONING EQUIPMENT
FINISH DEPARTMENT
TO KILN FEEDER
SLURRY STORAGE BASINS
KILN DEPARTMENT
CEMENT SILOS
KILN FEEDER
ROTARY KILN
PACKING
SHIPPING DEPARTMENT
DUST COLLECTOR
OFFICE AND LABORATORY

BY COURTESY OF PORTLAND CEMENT ASSOCIATION

FIG. 2.—FLOW OF MATERIALS THROUGH A CEMENT-MANUFACTURING PLANT SHOWING BOTH WET- AND DRY-PROCESS METHODS

A raw material which was not used much in the first half of the 20th century but which showed promise of becoming important is fly ash from power stations employing direct-firing coal mills. Such fly ash has a composition fairly close to that of portland-cement argillaceous raw material.

Iron materials commonly used are iron ores, pyrite cinders (the product of the calcination of pyrite) and mill scale (from hot-rolling of steel).

Processing

Processing of the raw materials into finished cement embraces four stages (*see* fig. 2): (1) size reduction (blasting, crushing, grinding) to obtain the fineness and surface which will permit the chemical reactions to take place between the components, and formation of the cement compounds during the subsequent pyro-processing (burning); (2) blending, correction and homogenization of the raw mix to obtain exactly the desired composition and uniformity; (3) liberation of carbon dioxide (calcination) and burning to form new compounds; (4) fine pulverization of kiln product (clinker), with addition of gypsum.

Crushing.—Various types of crushers are used in the cement industry depending on the nature (hardness, lamination, quarry-product size) of the rock. These include gyratory crushers in which a steel cone moves eccentrically inside a cone-shaped housing; jaw crushers in which the rock is broken between breaker plates whose motion is substantially horizontal; roll crushers where the reduction takes place between two rolls or between one roll and a breaker plate, the rolls frequently being equipped with case-hardened steel teeth; hammer mills in which the rock is fractured by heavy hammers swung from a horizontal shaft and flung against the rock by centrifugal action; and impact mills, a variation of hammer mills where no internal grates are required and where the hammers bounce the pieces of rock against breaker plates. When hammer mills are used, the rock is sometimes screened ("scalped") for removal of pieces too large to be handled by the crusher.

Grinding.—The various components are usually moved from raw material storage by overhead crane and deposited in roughly the desired proportions in concrete bins above feed hoppers serving the grinding mills.

In the grinding of the raw materials, two processes are used: the dry process in which the materials are dried to less than 1% moisture and then ground to a fine powder; and the wet process in which the grinding takes place with addition of water to the mills to produce a pulp or "slurry."

The use of the two processes in the United States is distributed approximately as shown in Table III.

Table III.—*U.S. Use of Wet and Dry Processes in Grinding Cement*

Distribution	Per cent wet	Per cent dry
By production capacity	58	42
By plants	60	40
By number of kilns	41.5	58.5

Dry Process.—The product is normally reduced from a size of 2 to 2½ in. to a powder of from 75% to 90%, passing a 200-mesh sieve. The first stage, reducing the material size to approximately 20 mesh, may be done in vertical, roller or ball-race mills. Another type, the so-called ball mill, is a cylindrical machine equipped with heavy lining plates. It rotates at from 15 to 18 r.p.m. and is charged with 4–5 in. iron or steel grinding balls. The second stage is done in tube mills, which are similar to ball mills but are longer and of smaller diameter. Tube mills are charged with grinding balls of ¾ to 2 in. The tumbling, cascading and cataracting motions of the balls inside the mills reduce particle sizes by impact and attrition.

Frequently ball and tube mills are combined into a single machine consisting of two or three compartments, separated by perforated steel diaphragms and charged with grinding media of different sizes. This is called a compartment mill. In the process of grinding, an important relationship exists between the maximum size of the product being ground and the size of the grinding media.

Dry-process ball mills, compartment mills and tube mills may all be operated in closed circuit with air separators which separate the mill stream into coarse and fine fractions. The coarse fraction is returned to the mill for further grinding, whereas the fine fraction may pass on to another mill or to silos.

Before limestone, cement rock and shale can be ground to a fine powder it is frequently necessary to dry them to remove free water. Such drying may take place in cylindrical dryers, typically 6 to 8 ft. in diameter and 60 to 150 ft. long. The heat is supplied from a combustion chamber. If coal is used for fuel, the chamber is stoker-fired to keep the flames from impinging directly on the material. In modern installations the drying and grinding operations are frequently combined by supplying hot air from an oil-, coal- or gas-fired furnace to the grinding system.

The finely ground raw meal is conveyed by pneumatic pumps, or by elevators and screw conveyors, to concrete silos. Frequent sampling of the finished product, followed by circulation, agitation and homogenization, enable the operators to arrive at the final blend by proportionate withdrawal from several silos. The final blend is again agitated and homogenized for one to two hours and is then ready to be conveyed to the kiln department.

Wet Process.—Ball, tube and compartment mills of essentially the same construction as for the dry process are used for grinding. Water or clay slip is added at the feed end of the initial grinder together with the roughly proportioned amounts of limestone and other components. Vertical mills are rarely suitable for wet grinding. The closed circuit involves vibrating screens to remove oversize particles for return to the ball mill, and rake classifiers, hydroseparators and cyclones for the tube-mill product. In modern installations wet grinding is sometimes accomplished in ball mills alone, operating with excess water in closed circuit with classifiers, hydroseparators and thickeners.

Finished slurry is then conveyed by centrifugal pumps to slurry basins designated as mixing, correcting, blending and storage basins according to their functions. Sedimentation and segregation in all tanks are prevented by constant agitation, by either compressed air or mechanical agitators or both. When a correcting tank is full, a representative sample is analyzed, and desired amounts can be drawn from various tanks into one or several blending tanks for complete homogenization. The output of the blending tanks is pumped to an agitated storage tank, or a kiln basin, which holds a supply equivalent to three to seven days' production. In this manner any remaining small fluctuations in the slurry composition are further equalized, providing a uniform kiln feed.

Beneficiation.—Cement raw materials can almost always be proportioned to provide the correct chemical composition, but in some cases it has been found to be economically advantageous to use froth flotation for removal of carbon and excess silica or alumina from quarry-run materials and thus avoid selective quarrying.

Burning.—The kiln department is especially important in a cement plant, since fuel consumption is a major item in the cost of manufacture and since the quality of the finished cement depends on the proper heat-treatment. Since raw- and finish-grinding departments most often are designed with higher capacities than those of the kiln department, a steady, high kiln output is also of the greatest importance for obtaining a low plant overhead.

Vertical kilns or shaft kilns, of the type used during the infancy of the cement industry, and still used in modernized versions in Europe, are not used in the United States and Canada for the production of portland cement, but in some locations are used for the burning of natural cement. The fuel economy of a shaft kiln is highly attractive, but it requires considerable labour for operation and the production capacity is relatively low.

The modern rotary kiln consists of a welded or riveted steel cylinder from 6 ft. in diameter and 60 ft. long (now rare) to 18½ ft. in diameter and 610 ft. long. These cylinders ride on steel tires and roller supports; they incline a few degrees, and rotate at a speed of between 50 and 90 revolutions per hour. The kiln feed or raw mix ("slurry" for wet-process kilns and "raw meal" for dry-process kilns), fed into the upper end, flows slowly through the kiln in a matter of hours, leaving the discharge end as clinker. Heat is supplied at the discharge end by combustion of coal, fuel oil or natural gas, providing a process temperature of 2,600° to 3,000° F. For protection of the steel shell and for conservation of heat, rotary kilns are lined with refractories. The combustion gases pass through the kiln in counterflow to the material and leave the kiln through its feed end at temperatures of 600° to 1,600° F. depending on kiln length and process used.

Fuel consumption in dry-process kilns can be kept to a minimum through the use of internal heat exchangers, consisting of steel or ceramic crosses and flights, and by preheaters. The so-called suspension-gas preheater lets the raw meal pass through a system of cyclones, in countercurrent with kiln exit gases. When entering the kiln the feed is highly preheated, improving fuel economy and increasing materially the capacity of the rotary kiln.

In still another system (which may be termed semi-dry) the raw meal is mixed with 10% to 12% water and formed into pellets of one inch maximum size. These pellets are either dried and partially calcined on a slowly traveling grate through which the hot exit gases from the rotary kiln are passed, or are fed directly to the rotary kiln.

Wet-process kilns are somewhat longer than dry-process kilns inasmuch as a portion of the length (between ¼ and ⅕) is used for evaporation of the slurry water. Such kilns are also equipped with elaborate heat exchangers consisting of heavy chains suspended in loops or curtains inside the kilns to increase the surface of slurry exposed to the gases and to facilitate the heat transfer from the gas stream to the material.

Hot clinker from the rotary kilns goes to clinker coolers which serve the dual purpose of reducing the temperature of the clinker before it is stored or ground and regaining the clinker heat for reuse inside the kiln as preheated secondary or primary combustion air.

Modern rotary kilns are equipped with intricate control systems. Visual inspection is also possible by means of openings at the discharge end. Using coloured glasses, a trained operator can inspect for consistency of the semi-molten charge, size of clinker, place of the exothermic reaction, ring formation, colour and flame position.

Fuels.—The selection of kiln fuel is a matter of economics: the coal, oil or natural gas is selected which can be purchased at lowest cost per 1,000 B.Th.U., consistent with dependability of supply, uniformity and quality. In the United States and Canada, coal, oil and gas are used in cement plants, singly or in combination, or one fuel can be used as the main supply with another as a stand-by.

The manipulation of the combustion process in a cement kiln requires great skill and is of the highest importance to the quality of the clinker, fuel economy, production capacity of the kiln and preservation of the refractory lining.

Clinker Storage.—The cooled clinker is conveyed by drag chains, vibrating troughs or steel-band belt conveyors to storage. It is considered important to store the clinker under a roof, particularly in northern wet climates. This is true even though the exposed surface of clinker may be less than 1,000th of the exposed surface of finished cement of the same weight and though only a small amount of hydration would take place if the kiln clinker were wetted. At some plants, however, it has been found satisfactory to store large quantities of clinker outdoors, either unprotected or covered.

Finish Grinding.—The final stage in the manufacturing process involves grinding the clinker with a 4%–6% addition of gypsum. This product is the finished cement. The mills, essentially similar to the roller, race, ball, compartment and tube mills described under dry-process raw grinding, almost invariably use closed circuits with air separators. Cement fineness, formerly measured by the percentage passing certain screen sizes (*e.g.*, 96% passing a 200-mesh sieve and 90% passing a 325-mesh sieve), is now most frequently indicated in specific surface (surface area per gram). This measure can be determined by the Wagner (turbidity) method or the Blaine (air permeability) method. Both are relative indicators. The Blaine method lends itself to quick process control, whereas the Wagner method makes possible calculations of particle-size distribution. The average size of cement grains is about 10 microns (μ).

From the finish mill the cement is pumped pneumatically to silos and stored, ready for shipment. There it is again thoroughly tested for complete conformance to specifications. Total silo capacity for cement plants may be between 10% and 24% of annual production, depending on whether the plant is located in the southern part of the U.S., where the seasonal pattern of construction is fairly level, or in a northern climate where construction and cement shipments are interrupted by the winter months.

The finished product may be shipped in bulk or in paper bags. Specially designed hopper cars or trucks, railroad boxcars, and barges are used.

Composition and Testing

In Great Britain, portland cement must meet specifications of the British Standards institution. In the United States, the specifications of the American Society for Testing and Materials (ASTM) are typical. Most countries place maximum limits on ignition loss, insoluble residue, magnesia (MgO) and sulfur trioxide (SO_3). Respective percentage limits of 3, 1, 5 and 2.5 are fairly typical. These respective limits protect against undue exposure, adulteration, delayed expansion and expansion from excess calcium sulfate. Where permitted, additions other than calcium sulfate and water are commonly limited to about 1%. Other chemical limitations are sometimes imposed concerning oxides, oxide ratios or calculated compounds. When certain reactive aggregates must be used, a maximum limit of 0.6% may be placed on alkali oxides.

Portland cements must meet physical requirements for fineness, setting time, soundness and strength. Because of the high fineness of modern cements, sieving tests are being supplemented and supplanted by determinations of specific surface by the sedimentation and air-permeability methods. By the latter method, the usual product in the United States has a specific surface of 2,800 sq.cm. per gram or better. British specifications do not require so high a value.

So-called initial and final setting times are determined by the increasing resistance of neat cement paste to weighted needles (Gillmore or Vicat). Initial set must generally not occur short of 30 to 60 min. Final setting time is generally limited to 10 hours.

Soundness is evaluated by expansion tests, generally involving heat-treatment of neat cement pastes previously cured for one day. In the Le Chatelier test, used in Great Britain and many other countries, a split cylindrical mold with projecting indicators gives the expansion of the specimen after a period in boiling water. The ASTM specifies an autoclave treatment of neat bars, which must not expand more than 0.8%.

Tensile- or compressive-strength tests, or both, may be required. Tension tests are made with small figure-eight-shaped mortar briquettes. Compression tests are made with mortar cubes or cylinders. Because of different test conditions, strength requirements of the various countries are usually not closely comparable. Mortar tensile strength requirements for general construction cement seldom exceed 400 lb. per square inch (p.s.i.), or 28 kg. per square centimetre, even after 28 days of moist curing. In contrast, compressive strength requirements run up to several thousand pounds per square inch. Strengths of mortar and concrete are greater the lower the water-cement ratio, and they continue to increase even for years under prolonged moist curing.

Composition and Its Effect on Properties.—The approximate oxide composition ranges—given in Table IV—are wide enough to cover most portland cements of practically all types.

Table IV.—*Composition Ranges of Portland Cement*

	Per cent
Lime, CaO	60 –67
Silica, SiO_2	17 –25
Alumina, Al_2O_3	3 – 8
Iron oxide, Fe_2O_3	0.5– 6
Magnesia, MgO	0.1– 5.5
Alkali oxides, Na_2O+K_2O	0.5– 1.3
Sulfuric anhydride, SO_3	1 – 3

Source: F. M. Lea, *The Chemistry of Cement and Concrete*, revision of book by Lea and Desch, Edward Arnold Ltd., London (1956).

Tests made for free (uncombined) CaO generally show less than 2%, and often less than 1%. Compounds formed in the clinker are tricalcium silicate ($3CaO.SiO_2$), dicalcium silicate ($2CaO.SiO_2$), tricalcium aluminate ($3CaO.Al_2O_3$) and a ferrite phase commonly calculated as tetracalcium aluminoferrite ($4CaO.Al_2O_3.Fe_2O_3$). A shortened symbolism has developed which represents these solids as C_3S, C_2S, C_3A and C_4AF. The amounts of these compounds that can theoretically be formed can be calculated from the amounts of the four oxides of which they are composed.

In modern technology, the calculated amounts of these compounds provide a basis for estimating the properties of the cement. Early strength development is attributed largely to C_3S, whereas, with continued moist curing, C_2S causes increase in strength at the later ages. The need for retardation of set is attributed mainly to the C_3A, and the content of C_3A is related inversely to ability of the concrete to resist disintegration by sulfate-bearing water. Raising the amount of C_4AF, by raising the iron-oxide content of the mix without increasing the alumina content, is one means of reducing the amount of C_3A. The C_3A and C_3S are the compounds that release the most heat when the cement hydrates, or hardens.

Standard Types of Portland Cement.—The ASTM has defined five types of portland cement, identified in the specification (C150–61) by the Roman numerals I to V. These types, discussed below, serve to indicate variations in properties that can be brought about by varying composition and fineness.

Type I.—ASTM type I cement is intended for general concrete construction where special properties are not necessary. The British counterpart is "ordinary" portland cement. Type I is less restricted in chemical composition than the other types. A representative composition is 48% C_3S, 27% C_2S, 12% C_3A and 8% C_4AF.

Type II.—This cement is intended for use where concrete may be exposed to moderate sulfate action or where no more than moderate liberation of heat is advisable. The desired properties are obtained by placing moderate limits on C_3A and C_3S.

Type III.—Type III is high-early-strength portland cement, the British counterpart of which is called "rapid hardening." It is high in fineness, and at least moderately high in C_3S. It develops good strength within one day, and is used where concrete must be placed in service as soon as possible.

Type IV.—This is called low heat cement, and has a British counterpart with the same name. It is used where considerable thicknesses of concrete are required and temperature rise might be excessive, thus leading to excessive volume change and cracking. The British specification has direct limitations on heat evolution. The ASTM specification places limits on C_3A and C_3S. Type IV cement is generally produced only for special, large projects.

Type V.—This cement, which also is not always available, is for use where high sulfate resistance is required. It is low in C_3A. A sulfate-resistant portland cement known in Europe as Ferrari cement has a weight ratio of Al_2O_3 to Fe_2O_3 between about 0.6 and 1.0.

Air-Entraining Cement.—The ASTM adds "A" to its type numbers to indicate air-entraining cement. Various organic chemicals may be added in amounts up to a few hundredths of 1% (by weight of cement) to entrain fine bubbles in the mix. A concrete containing 4% to 7% by volume of these fine air bubbles has greatly increased resistance to scaling from frost action. The entrained air also produces a more workable mix.

Special Portlands.—Portland cements modified by small additions of chemical agents have acquired such names as oil-well, plastic, waterproofed and hydrophobic cement. Oil-well cement for use at the high temperatures in deep wells is prepared or treated to avoid quick set. The plastic cements have improved workability and may be used in stucco or exterior plaster. The waterproofed cements are treated to improve the resistance of the concrete to penetration by water. Hydrophobic cement is treated to minimize adsorption of water vapour during storage before use.

Coloured portland cements are made by adding pigment to either the white or gray cement. A white portland cement can be produced from materials very low in iron oxide.

Portland Blends.—Portland cement is sometimes ground with other material of cementitious value, gypsum being added as desired. The portland-slag and portland-pozzolan cements have already been mentioned. In these types, the portland cement and the other material are both substantial proportions of the whole, but the proportions are widely different in different instances.

In portland-pozzolan cement, the pozzolana—a siliceous material—reacts with lime liberated by hydrolysis of the portland cement. Natural pozzolanas are commonly of volcanic origin. Artificial ones include furnace fly ash and certain burned earths, clays and shales. The portland-pozzolans have a lower rate of heat liberation than type-I portlands. With proper curing they develop comparable eventual strengths if good pozzolana is used. Some of these cements protect against alkali-aggregate reaction.

In portland-slag cements a quick-cooled high-lime blast-furnace slag is used which is cementitious when activated by lime. Portland-slag cement has properties comparable with those of portland cement. It has relatively low heat evolution.

Expanding cements have been developed, for special purposes, in which portland cement is blended with expansive material. The original expansive cement, produced in France, relies for its expansion on formation of calcium sulfoaluminate hydrate.

Masonry cements are commonly made by finely grinding portland cement with limestone and an air-entraining agent. The entrained air improves workability, and the limestone, though not cementitious, is considered desirable as a filler.

Blends of portland cement with natural cement are sometimes made. Also portland cement and high alumina cement (*see* below) are sometimes mixed to obtain a quick-setting product.

OTHER CEMENTS

Other Hydraulic Cements.—The hydraulic limes and natural cements, made by calcining lumps of natural clayey limestone, are usually distinguished by the ability or lack of ability of the calcined lumps to slake in water. The hydraulic limes slake sufficiently to avoid the necessity of grinding, and are commonly sold as the screened, hydrated product. The natural cements require grinding. In both cases the firing temperatures are lower than for portland cement, but some recombination of lime occurs and is responsible for the hydraulic properties—which are, however, of relatively low order. Since the development of portland cement, the markets for these earlier products have dwindled.

Pozzolanic and slag cements, made by using hydrated lime with the pozzolana or slag, are employed in some countries but are of less general utility than their counterparts in which portland cement replaces the lime.

A superior type of slag cement, called supersulfated cement in Great Britain, is made by grinding slag with calcium sulfate. It develops good strength and shows sulfate resistance.

High alumina cement, also called aluminous cement, and in France *ciment fondu*, differs from portland cement in being dependent on calcium aluminates rather than calcium silicates for its strength development. It is manufactured by fusing a mixture of limestone and bauxite. The calcium aluminates formed are lower limed than C_3A. The cement gives high early strength, and has refractory qualities.

Other Construction Cements.—The limes produced by calcination of nonclayey limestones are not hydraulic, and are not ordinarily called cements. They are supplied both as quicklime (CaO) and hydrated lime. They are used in plasters and mortars that harden by drying out and reacting with carbon dioxide from the air. For stronger mortar, the lime may be partly replaced by portland cement.

Various gypsum plasters are made by partial or complete dehydration of gypsum (*q.v.*), $CaSO_4.2H_2O$, commonly with addition of special retarders or hardeners. They set and harden by recombining with water. Pure plaster of Paris, $CaSO_4.\frac{1}{2}H_2O$, sets very quickly. With added retarder it is called wall or hard wall plaster. For especially hard-finish plaster, the gypsum is completely dehydrated at high temperature, and chemicals such as alkali sulfate, alum or borax are added. Keene's, Mack's and Parian cements are hard-finish plasters. Hair or fibre and lime or clay may be added to the wall plasters during manufacture. Except for some finish coats, plaster coats are sanded.

Magnesium oxychloride cement, also called Sorel cement, is obtained in the hardened state by mixing magnesium oxide with a solution of magnesium chloride. Fibrous matter and sand are also incorporated. The cement is used mainly for flooring, but also for plaster, tile, decorations, etc. Prolonged contact with water is detrimental.

Refractory mortars are sometimes made with refractory aggregate, and clay as binder, and depend for strength development on vitrification of the clay as the temperature is raised. In other refractory mortars, high alumina cement may also be used. Other "air-setting" mortars consist of refractory aggregate, clay and sodium silicate solution. Additional chemicals may be used as binders or fluxes. Often the purpose is to produce only a temporary bond (as in making refractory brick) until vitrification can take over. For such a purpose, lime, hydraulic cement or organic materials such as tar may be used.

Pipe-sealing Cements.—In the gas and oil industries several kinds of jointing cements or pipe-sealing preparations are used. Among these are lead paints, graphite and oil, shellac in methyl alcohol, litharge and glycerin, iron filings and ammonium chloride, and various pasty materials.

Adhesive Cements.—The ancient water-soluble adhesives based on protein glues, vegetable gums and starches are now supplemented by both aqueous dispersions and organic solutions of synthetic plastics. Household rubber, pyroxylin and other cellulose cements are examples of adhesives that bond by the drying out of organic solvent.

Ancient waxes and pitches and the sulfur, asphalt and coal-tar cements are hot-melt cements similar in function to the modern polymeric thermoplastic solids that soften and become adhesive under the action of heat.

In contrast, thermo-setting plastics are generally low-molecular-weight chemicals or "pre-polymers" that are polymerized and set by heating or by chemical action of catalysts or curing agents. Of this nature are the phenolic, furan, epoxy, urea and melamine resins. All can act as adhesives.

Some adhesives, based on rubber or other elastomers, remain tacky and are used as removable pressure-sensitive tape, labels, etc.

Adhesives are often spoken of as cements even when used only to form thin films. Often, however, distinction is made between adhesives and cements, or mortar cements, that are based on adhesives but involve the use of a filler, or fine aggregate.

Catalyzed thermo-setting cements are used in special chemical-resistant masonry, and even for more general construction purposes. Epoxy resin cements bond strongly to concrete.

Bituminous, rubber and synthetic resin emulsions have been used integrally in concrete, along with portland cement, to confer special properties.

Silicate cements are generally based on aqueous sodium or potassium silicate solution as adhesive, usually with addition of graded silica as filler. The newer ones are mixed with a chemical agent at time of use, to obtain quicker set. Dental silicate cements, however, do not contain silicate solutions but glasses or fritted silicate reactive to phosphoric acid. *See* ADHESIVES; MORTAR IN BUILDING.

See also references under "Cement" in the Index volume.

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(A. A. BA.; C. F. CL.; H. H. ST.)

CEMENTATION, a metallurgical term which describes a process of introducing elements into the outer layer of metal objects by means of diffusion at high temperatures. As an example, an iron object packed in carbon and heated at a temperature lower than its melting point will gradually absorb carbon so that a layer of high carbon steel is formed on the low carbon core.

Continued heating will give complete conversion of the iron to steel; this was the method used for making steel until the development of modern processes. (*See* also METALLURGY: *Heat-Treatment: Surface Hardening;* NITRIDING; SURFACE HARDENING.)

Cementation is also the term used for obtaining a metal from solution through displacement by a more active metal. One commercial application is to add iron scrap to copper sulfate solutions so as to precipitate "cement" copper. (*See* COPPER: *Commercial Production Processes: Precipitation.*)

Geologists refer to the deposition of mineral matter in the spaces between grains of sediment as cementation. The most common cements are silica, either as quartz or chalcedony, calcite, and iron oxide.

Such cementation is one of the means by which sediments are converted into rock.

See SEDIMENTARY ROCKS. (A. W. S.)

CEMENT ROCK. A cement rock is an argillaceous (clayey) limestone whose composition is such that it may be used for the manufacture of cement without the addition of other earth materials or with the addition of only relatively small amounts of such materials. Some cement rocks contain the mineral quartz as silt or sand particles along with their argillaceous component. The principal carbonate in cement rocks employed for portland cement manufacture is calcium carbonate; magnesium carbonate must be low, in accordance with the usual specifications for portland cement raw materials. High-calcium limestone, clay or shale may be blended with the cement rock to modify its composition. Rock used for making natural cement, sometimes referred to as a natural-cement rock, is of similar character to that mentioned above but the allowable amount of magnesium carbonate is flexible. Both dolomitic and calcitic argillaceous limestones have been used as natural-cement rocks.

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CEMETERY, literally a sleeping place, the name applied by the early Christians to the places set apart for the burial of their dead. These were generally outside the city walls and unconnected with churches, the practice of interment in churches or churchyards being unknown in the first centuries of the Christian era. The term cemetery has, therefore, been appropriately applied in modern times to the burial grounds, generally extramural, which have been substituted for the overcrowded churchyards of populous parishes.

United States.—In the United States cemeteries were the final outgrowth of individual burial places on the farms or near the homes of the earliest settlers. Later the burial place was connected with the church, a custom that is not entirely obsolete. Prominent men were buried beneath the church building during the 17th and 18th centuries, but the crowded conditions together with the fact that the practice was recognized as unsanitary caused it to be abandoned. In villages and small towns the church "graveyards" grew into disrepute many years ago because of the neglect they were subjected to. There was no provision for care of such burial places except the slight attention a sexton would give, and disorder resulted. Detached cemeteries have been in use in the United States since 1832 when Mt. Auburn was established in Boston. Philadelphia soon after set up some notable burial places, and Greenwood in New York city had its beginning in 1842. From 1860 churchyard burials have gradually been discontinued until today they are but exceptions to the rule of beautiful community cemeteries. From single burial plots on private property, to church graveyards, to cemeteries and now to "memorial parks" where the graves are marked with flat metal markers instead of the customary gravestones, has been a notable transition.

During the days when cemeteries were maintained by and in connection with the church, members and their families were entitled to a burial site. No expense was attached to the burial except the cost of opening the grave. The absence of funds for upkeep, however, led to the deterioration of the property and to the ultimate abandoning of that type of burial. In the modern cemetery, lots are sold by the city or village, if owned by such a body, or by the association, which has charge. A definite fee is charged for perpetual care, and a charge is made for opening the grave and other duties performed by the sexton or superintendent. Generally speaking, cemeteries are supposed to be maintained with no idea of profit, and this is the case in a great majority of places.

Some religious denominations, notably the Roman Catholic Church, have their own cemeteries, though not in connection with the church building itself. The Jews have many burial sites, and now and then one comes across a cemetery maintained by one of the Protestant sects.

Throughout the country there are many cemeteries maintained by the Masonic or other fraternities for their own members and members of their families.

There are many state and national cemeteries in the United States that have been created by statute for the burial of army and navy men and men connected with state institutions (*see* ARLINGTON NATIONAL CEMETERY; WAR GRAVES).

England.—By the middle of the 18th century in England, the consequences of overcrowded churchyard burial and the lack of adequate space for further burial within city limits had become a matter of public apprehension.

From 1840 to 1855 attention was repeatedly called to the unsanitary condition of the London churchyards by the press and by parliamentary committees, the first of which reported in 1843. The vaults under the pavements of the churches and the small spaces of open ground surrounding them were crammed with coffins. In many of the buildings the air was so polluted that it was a direct source of disease and death to those who frequented them.

In the churchyards coffins were placed tier above tier in the graves until they were within a few feet (or sometimes even a few inches) of the surface, and the level of the ground was often raised to that of the lower windows of the church. To make room for fresh interments the sextons had recourse to the surreptitious removal of bones and partially decayed remains, and in some cases the contents of the graves were systematically transferred to pits adjacent to the site, the grave diggers appropriating the coffin plates, handles and nails to be sold as waste metal. As a result of these practices the neighbourhood of the churchyards was always unhealthy and their sight intolerable.

In all the large towns these evils prevailed in a greater or lesser degree. In London, however, because of the immense population and the consequent mortality, it forced itself more readily upon public attention; and after more than one partial measure of relief had been passed the churchyards were, with a few exceptions, finally closed by the act of 1855.

The cemeteries, which occupy a large extent of ground on all sides of the city, became the burial places of the metropolis. Several London cemeteries had been established by private enterprise before the passing of the Burial act of 1855 (Kensal Green cemetery dates from 1832), but that enactment marks the time from which the general development of cemeteries in Great Britain and Ireland began. Burial within the limits of cities and towns was almost everywhere abolished, and where it was still allowed it was surrounded by safeguards that made it practically innocuous. The increasing practice of cremation (*q.v.*) has assisted in the movement for disposing of the dead in a more sanitary manner; and the practice of burying the dead in more open, ventilated coffins, and abandoning the old system of family graves, has had considerable effect in improving the situation.

In England a cemetery was made either the property of a private company incorporated by act of parliament or of a local authority and was made subject to the Cemeteries Clauses act, 1847, the Public Health act, 1875, and the Public Health (Interments) act, 1879. For further legislation and practices regarding cemeteries and burial, *see* DEATH (LEGAL ASPECTS); FUNERARY RITES AND CUSTOMS.

CENACLE, the term applied to the eating room of a Roman house in which the supper (*cena*) or latest meal was taken. It was sometimes placed in an upper story. The Last Supper in the New Testament was taken in the cenacle, in the "large upper room" cited in Mark (xiv, 15) and Luke (xxii, 12).

The Society of Our Lady of the Cenacle, a society of Roman Catholic nuns founded at La Louvesc, France, in 1826, provides facilities for retreats for women; hence, the term also has come to signify a retreat house.

CENCI, BEATRICE (1577–1599), famous for her tragic history and for the fables to which it gave rise, was born in Rome on Feb. 6, 1577, the daughter by his first wife of Francesco Cenci (1549–98), a vicious and violent Roman nobleman of great wealth and influence. Francesco had 12 children by his first wife, but his second wife, Lucrezia Petroni, brought him none. He was constantly embroiled with his family and in 1595 he took Lucrezia, with Beatrice, to the lonely castle of La Petrella in the province of Aquila, imprisoning them there in the upper rooms and treating them with great brutality. After various attempts at freedom, Beatrice found refuge in a liaison with the castellan, Olimpio Calvetti. With Calvetti, her brother Giacomo and others, she finally planned the murder of her father. He was assassinated on Sept. 9, 1598, and his body thrown from a balcony to create the appearance of an accident. The facts, however, soon came out, and the whole Cenci family was arrested. Lucrezia, Giacomo and Bernardo, another brother, confessed the crime, and Beatrice, who at first denied everything even under torture, also ended by confessing. Great efforts were made to obtain mercy for the accused, but Pope Clement VIII refused to grant pardon. In Rome, on Sept. 11, 1599, Beatrice and Lucrezia were beheaded, and Giacomo was torn with red-hot pincers, killed with a mace, drawn and quartered. Bernardo's penalty, because of his youth, was commuted to perpetual imprisonment, and after a year he was pardoned. The Cenci property was confiscated, and this, it was rumoured, was the pope's object in destroying them.

The story of the Cenci has been the subject of poems, dramas and novels and occupies a larger place in literature than in history. Shelley's tragedy (1819) and F. D. Guerrazzi's novel (1854) may be mentioned.

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CENNINI, CENNINO DI DREA (*c.* 1370–*c.* 1440), late medieval Italian painter and writer on art, was born near Florence and was supposedly a pupil of Agnolo Gaddi for 12 years. No authenticated paintings by his hand have been discovered and his fame rests upon his *Il Libro dell'Arte* or *Trattato della Pittura*, the first Italian art treatise in the Giottesque tradition. Painting, according to Cennini, holds a high place among human occupations because it combines theory or imagination with the skill of hand, "to discover things not seen, hidden by the shadow of natural objects." The aspiring painter is advised to study with a master as early and for as long as possible, to copy from the masters and to cultivate a steady hand by moderate living. Detailed instructions are given for the preparation of pigments and brushes and for painting panels and walls. There are directions for other tasks, such as painting on glass and making of casts from life. Two manuscript copies of the treatise are preserved in Florence. Various editions of the Italian text have been printed including one by D. V. Thompson (1932), who also brought out an English translation in 1932–33. Translations have been made into French and German.

See V. and R. Borradaile, *Student's Cennini* (1942).

CENOBITE, one who shares a communal religious life under vows, as opposed to living solitarily as a hermit (*q.v.*) or anchorite. A mixture of the eremitic and the cenobitic life is found in the Carthusian order and in the lavra system of the Orthodox Eastern Church. *See* further MONASTICISM.

CENOMANI, in ancient times one of the largest Celtic tribes to settle in Cisalpine Gaul, occupying territory in the modern Italian *regioni* of Lombardy and the Veneto. Their territory was probably bounded by the Ollius (Oglio), Padus (Po), and Athesis (Adige) rivers with the Insubres as their western and the Veneti as their eastern neighbours: their principal towns were Brixia (Brescia), Verona, Cremona (until the foundation of a colony there in 218 B.C.), and possibly Bergomum (Bergamo). They were allies of Rome against their kinsmen led by the Boii and Insubres in the Gallic war of 225; and though they joined the rising led by the Carthaginian general Hamilcar in 200 soon after the Second Punic War, they deserted the Insubres during the battle at Lacus Larius (Como) in 196, and secured a satisfactory treaty from the Romans (though in common with other Gallic states they accepted a provision, perhaps inserted at their own request, that none of their members should receive Roman citizenship). Their subsequent history followed that of the rest of Cisalpine Gaul.

The origin of the Cenomani is doubtful. Pliny states that they had lived in Gaul near Massilia (Marseilles), but in imperial times a tribe called Cenomani Aulerci lived in the modern *département* of Sarthe. The *civitas Cenomanorum* gave its name to the town of Le Mans which under the ancient name of Suindinum or Vindinum was its capital.

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CENOTAPH, a monument or tablet to the memory of a person whose body is buried elsewhere. The custom arose from the erection of monuments to those whose bodies could not be recovered, as in the case of drowning. The term is often used of the monuments raised in many places in memory of those who perished in war; *e.g.*, the cenotaph in Whitehall, London; the Soldiers' and Sailors' monument, New York city. *See* also SCULPTURE, SEPULCHRAL; TOMB.

CENOZOIC ERA, the latest major division of geologic time, starting about 70,000,000 years ago and extending to the present. Generally the era is divided into two periods: Tertiary (*q.v.*), which ended about a million years ago; and Quaternary (*q.v.*), which is in progress. Evidence bearing on geologic history improves with recency and the Cenozoic periods are divided into well-established epochs. In order of decreasing age the Tertiary epochs are Paleocene, Eocene (*see* EOCENE AND PALEOCENE), Oligocene, Miocene and Pliocene (*qq.v.*); the Quaternary epochs are Pleistocene (*q.v.*) and Recent. Major crustal movements of the era include formation of the Alps, Himalaya and related mountain chains of Eurasia and northern Africa; repeated uplifts of the American Cordilleras; development of great island arcs within the Pacific ocean and the Caribbean region; and broad continental uplifts. Widespread glaciation occurred in the northern and southern hemispheres during the Pleistocene epoch.

Geologic Time Chart

System and Period	Series and Epoch	Distinctive Records of Life	1,000 Years
CENOZOIC ERA			
Quaternary	Recent	Modern man	11
	Pleistocene	Early man	1,000
Tertiary	Pliocene	Large carnivores	
	Miocene	Whales, apes, grazing forms	
	Oligocene	Large browsing mammals	
	Eocene	Rise of flowering plants	
	Paleocene	First placental mammals	70,000
MESOZOIC ERA			
Cretaceous		Extinction of dinosaurs	130,000
Jurassic		Dinosaurs' zenith, primitive birds, first small mammals	160,000
Triassic		Appearance of dinosaurs	200,000
PALEOZOIC ERA			
Permian		Reptiles developed, conifers abundant	235,000
Carboniferous			
Upper (Pennsylvanian)		First reptiles, coal forests	260,000
Lower (Mississippian)		Sharks abundant	285,000
Devonian		Amphibians appeared, fishes abundant	320,000
Silurian		Earliest land plants and animals	350,000
Ordovician		First primitive fishes	400,000
Cambrian		Marine invertebrates	500,000
PRE-CAMBRIAN TIME			
		Few fossils	3,500,000–4,000,000

Deciduous trees, well-developed in late Mesozoic time, the era of middle or intermediate evolution of life, have remained dominant in the Cenozoic, or era of modern or recent life, with much further diversification. Continued evolution of plants includes development of grasses, cereals and fruits, which have become suitable foods for specialized types of animals. Birds have evolved from the Mesozoic reptilelike ancestors into a legion of modern forms. Mammals, small and primitive in early Cenozoic time, rapidly became diversified, commonly with increase in size. Some large types became extinct in mid-Tertiary; others, including horses, elephants and camels, evolved with continued specialization and generally increased size into the Quaternary. Primitive men lived in early Pleistocene time, and modern man witnessed widespread glaciation in northern lands. In addition to the separate articles on the periods and epochs of the Cenozoic referred to above *see* GEOLOGY; PALEOBOTANY; PALEONTOLOGY. (C. R. L.)

CENSER: *see* INCENSE; THURIBLE.

CENSOR, in ancient Rome, the title of two magistrates who took the census (from Lat. *censere*, "to assess"), the registration of individual citizens and property. Instituted in 443 B.C., perhaps to relieve the consuls of this duty, they were, like them, elected in the *comitia centuriata* (*see* COMITIA), and only with a consul presiding. At first patricians alone were eligible, but plebeians were elected from 351 onward. Re-election was prohibited in 265. Intervals between elections were about five years, but tenure was limited to 18 months. Acts of one censor were invalid without the assent of his colleague, but decisions of the two were valid without appeal. As no substitutions were allowed, the death or abdication of one censor removed his colleague from office. Their acts did not bind their successors. Though without imperium (*see* EMPIRE), fasces or lictors (*qq.v.*), they held the highest auspices, sat on curule chairs, wore the *toga praetexta* (the toga with a purple border worn by curule magistrates).

The functions of the office eventually raised it above the consulship in dignity, and made it the crown of a political career. After 300 B.C. all but three censors were of consular rank. Their functions were: (1) the registration of citizens, old and new, with estimates of the value of their property, in tribes and classes, the former as a basis for voting in the tribal and plebeian assemblies, and for the levy for military service, the latter for assignment to centuries in the centuriate assembly; (2) the assessment of liability to tax based on the value of the citizen's property; (3) exclusion from public functions, such as a place in a tribe or a century, voting, military service, membership in the equites (*q.v.*), change of tribal registration, and assignment to the *aerarii* (*q.v.*), of citizens on moral grounds for disgraceful or criminal acts. (This function was known as the *regimen morum* or guardianship of public morals, and the action resulted in a stigma, *infamia*); (4) a solemn religious act of purification of the citizen body and vows for its future well-being (lustrum), which closed the census. Subsequently further functions were added: (5) the selection of the senate (*q.v.*), just before 312 by the *lex Ovinia;* and (6) various financial functions such as the leasing of contracts for the repair and the construction of public buildings and for the collection of taxes.

The censorship was suspended during the dictatorship of L. Cornelius Sulla and suspended, not abolished, during the rule of the emperor Augustus. The last regular censors were elected in 22 B.C., but the emperors assumed censorial powers; Claudius (A.D. 47–48) and Vespasian (in 73) took the title, and Domitian was censor for life.

In modern times the word "censor," apart from its use in connection with censorship proper (*see* CENSORSHIP), is used in some institutions, notably in academic ones, for one who exercises supervision over the conduct of others: for instance, as a title for certain offices in some universities in the United Kingdom. The Council of Censors, in U.S. constitutional history, was the name given to a council provided by the constitution of Pennsylvania, 1776–90, and by the constitution of Vermont, 1777–1870. Under both constitutions the Council of Censors was elected once in seven years, to inquire into the working of the government departments, the conduct of the state officers and the working of the laws, and to discover whether the constitution had been violated in any particular. The Vermont Council of Censors, limited in number to 13, had power to call a convention if it thought the constitution required amending. A convention summoned by the council in 1870 amended the constitution by abolishing the censors.

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(T. R. S. B.)

CENSORSHIP. "Every idea is an incitement," said Justice Oliver Wendell Holmes. Censorship—*i.e.*, restriction on ideas prior to, or prosecution following, their publication—historically was based on the principle that ideas are always important as incitements to action, as guarantors of salvation or damnation of the soul or as confessions of character, and therefore in any case a matter of grave social concern. Recognition of what Holmes spoke of as "free trade in ideas" was a late development in history and has never been universally accepted. The history of censorship demonstrates that every idea may be an incitement to persecution.

But the history of censorship, fortunately, was also the history of liberty and toleration; otherwise there would have been no growth of political, social and religious ideas, and mankind would be without an intellectual history. Certainly a large part of history was the struggle of liberty against forces of repression—against ignorance and superstition, love of ease and fear of change, vested interests and love of power.

It seems that historically religious ideas were the first target of censorship, through persecution for blasphemy and heresy; then with the development of strong states came political ideas, with persecution for sedition and treason; most recently came ideas relating to the emotional and, more especially, the sexual nature of man, leading to persecution for obscenity. New means of communication called for new measures of control: this was true of the printing press, the cinema, the radio and television, the establishment of public libraries, the development of texthooks for school use and the introduction of the paperback book and the comics.

HISTORICAL DEVELOPMENT

Means.—The English common law as known to Sir William Blackstone conceived of censorship as previous restraint on publication. This form of censorship was achieved through official licensing of newspapers, plays and books, or their suppression before publication. Another form of previous restraint was the requirement of a licence to permit distribution of a publication in a public place or from door to door, or to permit the making of a speech in a public place. Previous restraint was also imposed on the disclosure of official data considered confidential, secret or restricted—*i.e.*, censorship on sources of information. When suppression could not be achieved the government resorted to prosecution after publication, charging that the matter published or distributed constituted a criminal offense for which imprisonment or other punishment was the sanction.

Censorship was also achieved through administrative withholding or withdrawal of postal privileges or punishment for illegal use of the mail, and through bans on imported books imposed by customs officials.

Legislative investigations into opinions, affiliations and publications have had the effect of censorship, mainly, perhaps, by leading to self-policing policies adopted by some communications industries seeking to ward off legislative enactments that would mean governmental control or regulation. The effects of censorship were also accomplished by voluntary citizen groups which used persuasion or mass pressure, involving the threat of economic boycotts, to keep publications that they considered offensive off newsstands and bookstalls and to edit or suppress movie scripts.

Greek.—For the western world it may be that the Athenians and Ionians were the first to assert the principle that persuasion is better than coercion. The first laws that imposed limits on speech were those that protected reputation. Truth, however, was a defense, so that the major value remained liberty of expression, not security of reputation. Philosophers questioned the appearances of the material world, and sophists and dramatists placed before the masses questions that went to the foundations of the political, religious and moral world.

But occasionally there were instances of repression and persecution. In Periclean Athens (5th century B.C.) the philosopher Anaxagoras was fined for impiety. Likewise Protagoras was charged with blasphemy; he fled from Athens but his books were burned. Euripides probably was prosecuted for impiety. A law repressing dramatic invective was enforced for two years in wartime but was repealed in 437 B.C. Phrynichus was fined for presenting a play that brought to mind the destruction of Miletus, and the Athenians "forbade forever" the acting of that (lost) play. These laws seem not to have intimidated authors and philosophers. In fact, free speech came to be accepted as the most important differentiation between the citizen and the slave or the alien.

Yet history concedes that the most famous Athenian of all, Socrates, was the first martyr to freedom of speech. Socrates was executed in 399 B.C., when he was 70 years of age. Because he exercised freedom of inquiry to the annoyance of some fellow citizens, Socrates was charged with worshiping strange gods and corrupting the youth.

In Plato's *Apology* Socrates pleaded for intellectual freedom by asserting the supremacy of his conscience over the verdict of the jury and by maintaining that when he exercised freedom of inquiry he was a public benefactor—that free discussion had a supreme public value. Socrates was, then, not only the first great martyr to freedom of speech, but also the first philosopher to formulate a rational, principled defense of this freedom.

His pupil Plato cannot, however, be reckoned among the defenders of intellectual liberty. In his *Republic* Plato said that he would, in the ideal state, establish a censorship of fables. Censors would reject and prohibit tales that they considered bad, and mothers and nurses would be permitted to relate to children only authorized tales. Furthermore, he would censor the plays of dramatists who tell untruths about the gods. Art, to Plato, could function only as an aid to education; and what might be harmful to the young should be prohibited. In the *Laws* Plato would punish for impiety in deed or word.

The point of view of Plato is one that dominated Greek and Roman society and much of Christian civilization: namely, that religion is not a purely personal affair; that a man lives his life—and his religion—openly, in the city, in public view. From this standpoint censorship is inevitable. The view that public life does not exhaust man's nature, that man has also a private life, that his religion and opinions are his private affair and that therefore he must have and enjoy liberty of conscience—this view was a late development in history.

Roman.—Although the word "censor" is derived from the ancient Roman censor (*q.v.*), a public official who had charge of the census and supervision of public morals, one does not find much about censorship in ancient Roman history. During the republic the liberty to criticize was highly valued. Lucilius, Catullus and other writers published strong epigrams against Pompeius (Pompey) and Caesar by name and there were at that time many political pamphlets in circulation that spared neither names nor insults. During the Second Punic War only Naevius was brought to punishment for ridiculing a leading Roman family. According to some authorities this satirist was punished on the basis of a provision in the Twelve Tables (451 B.C.) protecting reputation from offensive speech. Early in the 2nd century B.C. a law imposed a fine for defamation by name from the stage. But under the empire restraints appeared in the senate, the popular assembly and the courts. Virgil and Horace hid their meanings in cryptonyms because repression was extended from drama to verse.

There were prohibitions against seditious speech and writing. Yet the tradition of free speech was strong and many instances of unrestrained speech survived. Augustus (27 B.C.–14 A.D.), by extending the *lex majestatis*, made it possible for his successors to repress criticisms. In A.D. 8 he banished Ovid. Tacitus cites cases of severe punishment for writings allegedly seditious but certainly scurrilous. Caligula (37–41), when overcome by illness, used harsh, repressive methods and ordered a writer who had published a few double-edged lines to be burned alive. Nero (54–68) deported his critics and burned their books. Domitian (81–96) suppressed free speech. Because a historian made slighting references to him in his history Domitian had him put to death and his secretaries crucified; he ordered a slanderer thrown to the dogs in the arena and a dramatist was put to death for having reflected on him adversely. Juvenal was banished for writing protests against the moral laxity in the court of Domitian.

Under the empire Rome practised a policy of toleration toward all religions and religious opinions and there was no punishment for blasphemy. "If the gods are insulted," said Tiberius, "let them see to it themselves." But the Jews and Christians were an exception. While to pagans worship of the imperial person or image was a political act, like an oath of loyalty, to the Jews and Christians it was idolatry; and so Roman toleration was not extended to them.

Christianity.—The persecution of Christians ended when, in 313, the emperor Constantine issued the Edict of Milan, which decreed toleration of Christianity and its legal equality with paganism. Constantine, following the edict, persecuted disobedience and instituted orthodox conformity. In 380 the emperor Theodosius I was baptized and he made Christianity the established state religion. Theodosius defined orthodox Christianity and made Christian heresy a crime against the state. Then the church and the Roman government began to persecute pagan and Christian heretics. In 445 an edict of Theodosius II declared that the pope would be the final authority in church government and that the state would use force to compel obedience to the decisions of the pope. These edicts set the pattern for the maintenance of Christian orthodoxy and the persecution of heresy for well over 1,000 years. It was believed that the safety of society was dependent upon Christian unity and that Christians had the duty not only to maintain the purity of the faith themselves but also to seek out and exterminate heretics.

The theory of the church was that it had the right and the duty to prohibit books that were opposed to faith or morals, as defined by the church, or that in some other way endangered man's eternal salvation, and that the secular force had the duty to carry out the decisions of the clergy against heretics, heresy and immoral publications.

The first formal condemnation of a book was issued by the Council of Nicaea in 325 against a book by Arius, declared to be heretical. Eight years later Constantine ordered the burning of all books by Arius under pain of death. In 400 Theophilus, the patriarch of Alexandria, in council with other Egyptian bishops, condemned the books of Origen. This pattern was frequently followed. In 496 Pope Gelasius issued a decree at the Roman synod that contained a catalogue of books that had been condemned and prohibited. The church reached the peak of its power under Innocent III at the beginning of the 13th century; but at the same time fear of the spread of heretical opinions became more intense and the church began to systematize its efforts to exterminate heresy and heretics. In 1215 Innocent decreed that it was the duty of every Christian to seek out and "exterminate" heretics. In 1233 Gregory IX instituted the Inquisition and turned over to the Franciscan and Dominican orders the power to investigate, judge and sentence heretics. The secular authorities co-operated by punishing heretics as the foulest criminals, often burning them at the stake. In 1252 Innocent IV authorized the use of torture in heresy trials to elicit confessions.

With the invention of printing in the 15th century it was thought necessary to institute preventive censorship by examining manuscripts before publication and authorizing or prohibiting their publication. In 1487 a papal bull was promulgated ordering that no works were to be published without prior ecclesiastical permission and this was to be granted only after thorough examination of the manuscript. In 1521 the emperor Charles V issued an edict making it a civil offense to publish a book proscribed by the church and providing for prior ecclesiastical censorship. In 1542 Paul III instituted the Universal Roman Inquisition or Congregation of the Holy Office, one of whose functions was the examination and condemnation of heretical and immoral books. The first Roman Index of prohibited books was published by the congregation in 1559. Five years later Pius IV published the Index of the Council of Trent (1564) which contained, in addition to a catalogue of forbidden books, ten general rules regulating the censorship, expurgation and reading of books. In 1571 Pius V formed the Congregation of the Index, which was entrusted with all functions relating to the censorship and prohibition of books; but the Holy Office continued to enjoy jurisdiction to examine and proscribe books. In 1753 Benedict XIV promulgated rules to be followed in the censorship and prohibition of books and these rules constitute the norm subsequently followed by the Congregation of the Index and the Holy Office. In 1897 Leo XIII issued new legislation without replacing that of Benedict XIV. Perhaps the most important provisions in the legislation of Leo XIII are the broad prohibition of books *ex professo* obscene and the requirement that all the faithful must submit for previous censorship books dealing with religion or morality. Benedict XV abolished the Congregation of the Index in 1917 and assigned its duties to the Holy Office. Editions of the *Index librorum prohibitorum* have been frequently published. Over 4,000 books were on the Index by mid-20th century.

Reformation.—The leaders of the Protestant Reformation in the 16th century—John Calvin, John Knox, Martin Luther, Huldreich Zwingli, Martin Bucer, Théodore de Bèze—claimed liberty of conscience for themselves but denied the same liberty to others. They did not believe in religious liberty or even toleration except as temporary expedients needed in a struggle for power. Like the Roman Catholic Church, the reformers placed heavy emphasis on obedience to authority and preservation of social order and on the indissoluble, intimate connection between a religious establishment (if a reformed church) and the state. They sought out and persecuted papists and heretics.

The same forces of persecution operated in England in that century. Henry VIII in 1531 compelled the English clergy to recognize him as head of the Church of England, displacing the pope. In 1534 parliament enacted the Act of Supremacy, which declared the king to be head of church and state and vested in him final authority over creed and church government as well as power to declare and punish heresies. He beheaded Thomas More and John Fisher in 1535 for their refusal to acknowledge his supreme power over religion and he persecuted William Tyndale and burned copies of his English translation of the New Testament—thus persecuting both papists and reformers. Under his successor Edward VI (1547–53) the Reformation was welcomed to England and Catholics were persecuted. Under Mary (1553–58), Anglicans and Protestant reformers were persecuted; non-Catholic preaching, teaching, worship and books were prohibited; and Thomas Cranmer, archbishop of Canterbury, and Hugh Latimer, bishop of Worcester, were burned at the stake as heretics. Under Elizabeth (1558–63) the kingdom reverted to Anglicanism and she persecuted both Catholics and Puritan reformers. Thus, whoever was in power sought to achieve conformity by coercion.

But the Reformation had in it the seed of liberty of conscience; for its origin was due, in part, to the assertion of the priority of conscience over authority. This in time inevitably led to claims of liberty against the reformers themselves. It became apparent that it was inconsistent to affirm both personal conscience and theocratic power, for the former involves liberty and pluralism, the latter compulsion and uniformity. But the libertarianism that was latent in Protestantism took a long time to make itself effective. It was aided by the development of the secular, national states, which had political and economic interests that at times made intolerance itself intolerable; and it was aided by the principle that every man had the right to read and study the Bible, for this meant that a diversity of interpretations would necessarily result, leading to a diversity of sects.

From Censorship to Liberty.—In 1531 Henry VIII established the first licensing system under secular authority with ecclesiastics as licensers. This system of controlling writers and publishers was continued in one way or another until 1695. The end of the 17th century and the beginning of the 18th mark the start of the modern period, in which emphasis shifted from censorship and persecution to toleration and liberty. Men at that time were beginning to share with Michel de Montaigne, their 16th-century forerunner, his hatred of cruelty and violence, and were thinking with him that "it is setting a high value on one's opinions to roast men on account of them." They also were beginning to respond to the influence of some of the Renaissance humanists, *e.g.*, Sébastien Castellio (*De Haereticis*, 1554). They also were influenced by Faustus Socinus, forerunner of modern Unitarianism, who in 1574 repudiated coercion in the interests of religion. John Robinson (*Justification of Separation from the Church*, 1610), William Chillingworth (*The Religion of Protestants a Safe Way to Salvation*, 1638) and Jeremy Taylor (*The Liberty of Prophesying*, 1647) wrote influential tracts advocating a measured toleration. In the American colonies Roger Williams demonstrated that in his Rhode Island settlement it was possible for Protestants and Catholics, and even Jews and atheists, to live together in peace (1644); and Lord Baltimore, a Catholic, established the mutual toleration of Catholics and Protestants in the colony of Maryland (1632). John Clarke and William Penn worked in the same libertarian spirit in the colonies, and in the next century they were followed by Thomas Paine, Benjamin Franklin, Thomas Jefferson, George Mason and James Madison.

The Toleration act of 1689, a statute granted by William and Mary, provided freedom of worship to nonconforming Presbyterians, Congregationalists, Baptists and Quakers; but it excluded Catholics and Unitarians. (Unitarians were not freed of all disabilities until 1813, Catholics until 1829, Jews until 1858 and atheists until 1888.)

Almost simultaneously with the promulgation of the Toleration act, John Locke's first *Letter Concerning Toleration* (1689) was published. This tract was the first systematic repudiation of the view that dominated ancient and medieval society; namely, that religion is a matter of supreme communal concern and belongs to a man's public or social life. Locke, on the contrary, argued that states are constituted for the maintenance and enhancement of only the secular interests of men and that they have nothing to do with religious beliefs and observances. Toleration should extend to nonconformists and even pagans; but Locke excepted Catholics and atheists. Apart from his exceptions, Locke's theory, marking off a private sphere on which the state may not trespass, remained firmly fixed in liberal thought as a support of freedom of speech, press and religion.

Another classic rationale of freedom from censorship was John Milton's *Areopagitica: a Speech for Liberty of Unlicensed Printing* (1644). To Milton the first freedom was "the liberty to know, to utter, and to argue freely according to conscience, . . ." Milton's arguments against censorship and for the maximum liberty of expression were less theoretical and doctrinaire than Locke's argument a half-century later, for Milton tried to show the social evil of censorship and the social utility of liberty. John Stuart Mill's essay *On Liberty* (1859) was written in the spirit of the *Areopagitica*, while much of American constitutional law relating to the first-amendment freedoms of religion, speech, press and assembly has developed in the spirit of the Lockean theory.

MODERN AND CONTEMPORARY WORLD

At the end of the 18th century the fruit of the libertarian thought of that and the preceding century, joined with propulsive material forces, was evidenced in the American Declaration of Independence (1776) and the American Revolution, in the French Revolution and Declaration of the Rights of Man and of the Citizen (1789) and in the adoption, in 1791, of the Bill of Rights to the United States constitution. The reverberations of these events were heard everywhere but some nations responded by intensifying their means of repression and becoming more autocratic, while other nations responded by adopting liberalizing attitudes and measures and becoming more democratic. England, the United States and France continued to exert libertarian influences.

The prime instance of suppression of liberties (following the end of Naziism in Germany and Fascism in Italy) occurred in the Union of Soviet Socialist Republics. Andrei Vishinsky wrote authoritatively in *The Law of the Soviet State* (Eng. trans. by Hugh W. Babb, 1948): "In our state, naturally, there can be no place for freedom of speech, press, and so on for the foes of socialism." But in this totalitarian country there was no freedom of speech and press even for the friends of socialism who wished to express some criticism or raise some questions. The test in a totalitarian country was not whether the publication was treasonable or seditious, but whether it tended to advance official ideology. Following Nikita Khrushchev's secret address on the crimes of Joseph Stalin (Feb. 24–25, 1956) there was some relaxation of the strict censorship over speech and press but the nature of a dictatorship made reliance on any relatively liberal policy hazardous.

After the first quarter of the 19th century prosecutions for blasphemy became rare in the U.S. and England. It became widely recognized that such prosecutions were more scandalous than were the publications. The public and governmental interest moved away from the blasphemous to the obscene, and the interest in the latter was sustained for over 150 years.

Obscene Literature.—As long as books were expensive and literacy was confined to a small minority there was little concern over obscene literature. But as public education and cheap books reached the masses, guardians of public morals made their appearance and stimulated governments to suppress obscene writings. (The Society for the Suppression of Vice was founded in England in 1802; Anthony Comstock founded the New York Society for the Suppression of Vice in 1873.) Following the end of licensing in Great Britain in 1695 efforts were made to persuade the courts that censorship could be achieved through the operations of the common law. In Curll's case (1728) prosecution for publication of an obscene libel was sustained under common law.

The modern law of obscene literature takes as its point of departure Lord Campbell's act (Obscene Publications act, 1857). In the Hicklin case (1868) Lord Chief Justice Alexander Cockburn held that the test for obscenity under the statute was "whether the tendency of the matter charged as obscenity is to deprave and corrupt those whose minds are open to such immoral influences, and into whose hands a publication of this sort may fall." The test of literary morality was what a father could read aloud in his own home. While there were many successful prosecutions for outright pornography, the law was also invoked against works of literary merit and works with a social or moral purpose. In addition to prosecutions other sanctions were used: seizure of books by the post office, customs officials or police, and their destruction.

The law was subject to continuous attack, for it was widely felt that it often compelled authors to falsify social realities. The law was also attacked for reducing literary standards to the level of what was morally proper for the young. The application of the law by judges in specific cases was also attacked, for judges permitted prosecutions on the basis of isolated passages; and judges also refused to permit evidence of the author's intent or purpose or of his literary reputation, or testimony of recognized literary critics. The law was also attacked because the prosecutions were often directed against booksellers, who were indifferent to the fate of the attacked book.

In some respects these faults in the law or its use no longer obtain. Notable progress was made by Justice Wintringham Norton Stable in a case before him in Old Bailey (central criminal court, London) in *R.* v. *Warburg* (1954). In charging the jury Justice Stable laid down the Hicklin test of obscenity but made a sharp differentiation between "filth for filth's sake" and literature. The former type of publication has no message, no inspiration, no thought; it is just "filthy bawdy muck" and such publications are obscene libels. The latter type of publication is one in which the author has "an honest purpose and an honest thread of thought"; it should not be condemned because it deals with the realities of life, love and sex. He told the jury that sex is not dirty or a sin, and that the literary-moral-legal test ought not to be what is suitable for a 14-year-old schoolgirl to read. He also stated his belief that novels are not to be belittled, for they are valuable sources of knowledge about the way people act, feel and think. The jury brought in a verdict of acquittal.

In 1954 an undertaking was initiated in parliament to change Lord Campbell's act and the effort resulted in enactment of the Obscene Publications act (1959), the most important provisions of which are: (1) that a person shall not be convicted if publication was "in the interests of science, literature, art or learning"; (2) that the opinion of experts as to the literary, artistic, scientific or other merits of the publication may be admitted as evidence; (3) that the work is to be read as a whole; and (4) that authors and book publishers may speak in defense of the work though they have not been summoned in the case. In Nov. 1960 a jury in London found that D. H. Lawrence's *Lady Chatterley's Lover* was not obscene.

In the U.S. the Hicklin test was taken over by the courts and Lord Campbell's act was more or less duplicated by every state legislature. In the federal courts two acts of congress were relevant: an act regulating imports and an act concerning nonmailable matter. The latter, by far the more important one, was passed in 1873. It was the use of the former statute, however, that ushered in the more modern law of obscenity.

Until the law was changed by congress, customs officials prevented the entry of such classics as Rousseau's *Confessions*, Voltaire's *Candide* and Boccaccio's *Decameron*. In 1930 congress amended the Tariff act to authorize the secretary of the treasury to admit classics and books of recognized scientific or literary merit when imported for noncommercial purposes. In 1933 an attempt was made to keep out a copy of *Ulysses* by James Joyce. When the case came before Judge John M. Woolsey of the federal district court in New York city he held that the book was not legally obscene. In his opinion Judge Woolsey referred to the reputation of the book in the literary world and took into consideration the intent with which the book was written. The judge read the book in its entirety and not merely the passages singled out by officials. The use of "dirty words" in "a sincere and honest book" did not make the book "dirty." The book should be tested by its effect "on a person with average sex instincts," for the law is concerned only with "the normal person."

Several decisions of the U.S. supreme court had a liberalizing effect. In 1957 the court held that a state may not prohibit the sale of a book generally to the public because of its tendency to affect adversely the morals of youth. While holding that obscene publications are not subject to the first-amendment guaranty of freedom of the press, the court held that the standards for judging obscenity must be such as will "safeguard the protection of freedom of speech and press for material which does not treat sex in a manner appealing to prurient interests." Accordingly the court rejected the Hicklin test as unconstitutionally restrictive since it permitted judgment on the basis of the effect of isolated passages on the most susceptible persons. A book must be judged as a whole and only its effects on a normal person may be considered. When tested by these decisions many state statutes may be of doubtful constitutionality and earlier federal and state decisions that banned works may not serve as binding precedents.

The dramatic change in the law effected by court decisions can be seen in the treatment of *Lady Chatterley's Lover*, mentioned above. In 1928 the book was published in Italy. Through devious ways copies reached England and pirated editions appeared in the U.S. despite the vigilance of officials. In 1959, however, the book was published by a reputable publisher in New York city. The U.S. post office department banned the book from the mails but the federal courts set aside the ban, holding that the book did not fall within the category of "hard-core pornography."

Policing the Comics.—Throughout the English-speaking world there was concern over the problem of comic books, which achieved phenomenal circulation records in the mid-20th century. In 1911 the first publication devoted exclusively to comics appeared but it was not until the late 1930s that it became apparent that there was a lucrative market for the newsstand sales of this type of publication. By mid-20th century comic publications had become big business.

At the same time—following World War II—a rise in juvenile delinquency was noted almost everywhere in the world and much of the blame was placed on the comics. Demands for their suppression or regulation were widespread and many states adopted statutes specifically regulating the publication, sale or distribution of comics. Since the constitutionality of the legislative approaches was uncertain, however, there was widespread reliance on informal actions. Local and state officials and citizen groups in communities acted on the basis of lists prepared by private agencies and endeavoured to persuade dealers to withdraw from sale comics on these lists. Frequently the police co-operated by turning over to dealers or distributors lists of objectionable publications. In several states the legislatures set up commissions to examine publications and advise prosecutions. In some instances the procedures led to black-listing paperback books and magazines as well as comics. When tested in the courts, informal official censorship activities were generally declared illegal. But such tests were seldom tried, for the distributor or vendor, though suffering economic injury, found it less burdensome to implement the censorship black list than to risk having himself placed on an economic or social black list.

Self-policing by comics publishers was undertaken. In 1948 the Association of Comics Magazine Publishers was formed and the members adopted a code banning "sexy, wanton comics," "sadistic torture" and other offensive material. In 1954 the Comics Magazine Association of America was formed. Its code prohibited torture, glorification of crime, salaciousness and other evil features, and insisted that the stories should show the triumph of virtue over vice. It was not possible to measure the success or failure of these self-regulation policies. But efforts to censor publications, especially magazines, comics and paperback books, have not abated. especially on the level of local police and local citizen-group action. There is similar legislation in the United Kingdom, *e.g.*, the Children and Young Persons (Harmful Publications) act of 1955.

Motion Pictures.—Prior restraint was directed more at motion pictures than at any other medium of expression. The first movie censorship measure was an ordinance of the city of Chicago adopted in 1907. In 1915 the U.S. supreme court held that motion pictures were not protected by the free-speech guaranty of the first amendment; they were, said the court, mere "spectacles."

Between 1922 and 1927 there was growing indignation over the unconventional conduct of some movie stars and over sensational films and there was a movement for strong controls. The motion-picture producers responded with a plan for self-regulation that resulted in the Motion Picture Association of America Production code. Compliance was universal until a number of films that were denied the seal of approval were exhibited successfully. In 1956 certain features of the code were relaxed to permit more latitude in dealing with drug addiction, race relations, childbirth and the use of certain swearwords.

Official censorship perhaps proved to be weaker than self-regulation. In 1952 the supreme court, overruling its earlier decision, held that films are protected by the free-speech guaranty of the constitution. Following this and subsequent decisions some state courts declared their state censorship laws unconstitutional. While at one time there were about 90 local censorship boards, their number was sharply reduced and the legal foundation of whatever remained of film censorship on the state or local level was badly shaken. The supreme court struck down censorship of films that are "sacrilegious," "immoral" or "prejudicial to the best interests of the people." In 1959 the court condemned as unconstitutional the ban on the film "Lady Chatterley's Lover." The broad grounds of the decisions would probably make subsequent punishment no less difficult than prior restraint had become.

In Great Britain censorship is achieved through the county licensing of motion-picture theatres; the licences are dependent upon condition that the licensee will exhibit only films that have the approval of the British Board of Film Censors (a private body founded in 1912 that enjoys no statutory foundation but is supported by the film trade). There is no written code; each film is judged on its merits. Some films receive an "A" certificate, which means that they may be shown only to adults. It was argued that this system of classification resulted in the approval of films for adults that otherwise might have been banned. One unforeseen result was the establishment of many small cinemas that specialize in foreign films devoted to sex and nudism. The British Board of Film Censors said that there was no ban on any subject, provided the subject was treated with sincerity and restraint.

The Stage.—In the United States censorship of the legitimate stage seldom was discussed in mid-20th century. There was no legal authority—as was the case with films—devoted specially to acting as guardian over the morals of stage productions. Theatres were licensed generally on an annual basis by local authorities and the apprehension that a licence might not be renewed served as a restraint. The general obscenity laws applied to the stage but prosecutions were extremely rare.

In London the lord chamberlain, senior officer of the royal household, became censor of plays by a law of 1843 that provided that the lord chamberlain may ban a play if he considers the ban necessary "for the preservation of good manners, decorum, or of the public peace. . ." The licensing rules provided that there must be no stage profanity or impropriety of language, no indecency of dress, dance or gesture, no offensive personalities or representations of living or dead persons, nor anything likely to produce a breach of the peace or a riot. Sacrilege was ground for a ban. About 1,100 plays were examined annually, of which about 1% were banned. In 1949 a bill in parliament to abolish play censorship failed. To avoid jurisdiction of the lord chamberlain, small theatres for members were formed, where private performances were presented.

By the 1950s about 250 plays had been banned by the lord chamberlain, including plays that were shown on the U.S. stage. Critics of the censorship system charged that it had a crippling effect on the stage as a cultural force and that it was an aristocratic relic that had no place in a democracy. Responding to the criticism, the lord chamberlain liberalized the rules and the leading private-membership theatre went out of existence because its sponsors felt that its purpose had been achieved.

Broadcasting.—In the United States radio and television stations operated on licences from the Federal Communications commission (FCC), which began its operations in 1934. The Communications act of 1934 expressly prohibited censorship or interference with free speech. There was, therefore, no direct broadcast censorship. However, a station's licence was reviewed every three years and, upon an application for renewal, the FCC reviewed the applicant's total performance; licences were granted as being in the public interest. Criteria for public interest or public service were not formalized. The FCC was given power, by an act of 1952, to suspend a licence for obscenity. In the quarter-century after 1934 only 12 station licences were revoked and only one licence was not renewed.

In 1939 the radiobroadcasting industry adopted a code dealing with program and advertising content and in 1952 an industry-wide code for television was adopted. Extensive monitoring was done by the broadcasting industry for program and advertising content. The television code of 1952, more detailed than the code for radio, emphasized the station's active responsibilities but neither code was directed toward morality as much as was the movie code. Newscasts were not generally subject to prebroadcast editing. Most editorial changes on programs involved references to sex.

In addition to self-policing, broadcasting was responsive to pressures from various groups. Concern was expressed over the degree of control of programs exercised by commercial sponsors, for there was evidence of many changes in content as a result of pressure from the sponsor or its advertising agency.

The disclosures in 1959–60 of widespread "fixing" of quiz shows and "payola" led to grand-jury and legislative investigations in the U.S. A congressional committee in 1960 concluded that self-regulation by the broadcasting industry had proved to be insufficient and that the FCC had been too passive as a guardian of the public interest. The committee called for stricter regulation; for statutory remedies, including possibly a ban on control of programs by advertisers; for closer checks by the FCC on the performance of licensees; for the licensing of the networks; and for more competition among companies for licences. But the broadcasting industry, the FCC and the public generally were reluctant to resort to measures that might lead to censorship by government.

(M. R. K.)

Most of the problems mentioned do not exist in Great Britain. Broadcasting in sound and television is carried out by the British Broadcasting corporation (BBC) and, in television only, by the Independent Television authority. The BBC is not a government department, but a public corporation created by royal charter. It derives its legal powers from its licence and agreement with the postmaster general but, subject to the requirements of its charter, it enjoys complete independence in the day-to-day operations of broadcasting, including programs and administration. The BBC may not derive any revenue from advertising in programs.

Censorship as such does not exist in independent television in Great Britain. Many of the problems experienced in the United States do not arise, because the nature of British independent television is radically different from that of U.S. commercial television. The Independent Television authority was established by the Television act, 1954, to provide broadcasting services, but it does not itself produce any programs. Contractors appointed under the act are responsible for this, and they sell advertising time just as a newspaper sells space. The advertiser has no control whatever over the programs. The Television act lays down broad principles of program standards, concerned with over-all balance, good taste and political impartiality. It is the duty of the authority to ensure that programs provided for it by the contractors fulfill these standards. (X.)

School Textbooks.—Some states in the United States have textbook commissions that select textbooks for the public schools; in some states the selection was made by committees of the local school boards; in some communities the selection was left to the school staff or individual teachers. State commissions and local textbook committees sometimes were subjected to pressures from business, political, religious, racial and other groups. Before the American Civil War textbooks were screened to favour or to oppose sectional interests. In the 1920s they were fought over because of questions of evolution and pro- or anti-British attitudes. Textbooks were often changed in response to pressures and changes in the textbooks were made by authors and publishers to accommodate the wishes of groups. After World War II the targets were statements that might be interpreted as favourable to Russia, Communism, Marxism or Socialism, and textbook authors who had been affiliated with suspect organizations.

Libraries.—In 1953 President Eisenhower spoke out against book burning. He spoke at a time when public libraries were targets of groups who sought the removal or destruction of books that they considered "un-American." One proposal urged by a pressure group was that books that they considered pro-Communist should be labeled as such and placed in special sections. Libraries were also charged with refusing to buy conservative or anti-Communist books and with favouring books that were "soft" on Communism.

The American Library association, the American Book Publishers Council, Inc., and other groups fought these efforts at library censorship. In 1948 the "American Library Bill of Rights" was published by the American Library association, stressing the need to resist "all abridgement of the free access to ideas and full freedom of expression. . ." In 1951 the same group opposed book labeling as an attempt to prejudice the reader and as a censor's tool. In 1953 these organizations released their statement on "The Freedom to Read," in which they cautioned against private groups and public authorities who sought to remove, censor or label books. They affirmed their duty "to make available the widest diversity of views and expressions, including those which are unorthodox or unpopular with the majority."

Freedom of Information.—In *Near* v. *Minnesota* (1931), in holding that previous restraint on newspapers was unconstitutional, the U.S. supreme court said that exceptional circumstances may justify such restraint—*e.g.*, in wartime a prohibition on publication of sailing dates of transports or the number and location of troops. But, in fact, government censorship extends far beyond these obvious instances. Wartime restraints were retained long after the need for them passed; and the restraints served to stifle political, economic and social expression. Much information was kept from the public; government agencies kept information from other government agencies. Newspapers in particular claimed that a climate of official secrecy had been developed that kept information from the public; as a consequence, from 1949 newspaper editors systematically promoted public understanding of the need for "freedom of information"; and committees of congress conducted extensive investigations. A report for the American Civil Liberties union made in 1955 stated that the situation had become aggravated and cited many examples of information officially withheld that had no relation to national security. These secrecy practices curtailed the power of the press and of congress, it was argued. A congressional committee report in 1958 pointed out that "science and secrecy have collided head on in the United States. Thus far, secrecy has dominated." The report stated: "There should be no attempts to hide discoveries of the basic laws of nature made in the past, present, or future." Another congressional committee report made in 1958 concluded: "Federal officials appear addicted to the doctrine that they alone can decide what is best for the people to know about their own Government. This dangerous attitude has reached the point where Federal officials are boldly proclaiming that they will decide what even the Congress shall and shall not know about the operations of Federal departments and agencies."

As a result of the numerous investigations and reports congress in 1958 passed a law to change the law of 1789 on which many government officials based their policy to withhold information. The 1789 act was designed to help President Washington set up his cabinet departments and give their heads authority in their organization and management, and provided that a department head should control the custody, use and preservation of records, papers and property. In the 1958 amendment of that law congress provided that the earlier law "does not authorize withholding information from the public or limiting the availability of records to the public." After passage of this act it was pointed out, however, that 80 statutes authorizing secrecy remained on the books. The 1946 Administrative Procedure act vested wide powers in government officials to withhold information and this act was not changed by the 1958 statute.

The same problem of secrecy often was noted on state and local levels. A special problem was the public agency that refused to make its meetings open to the press and public. In some states newspaper editors organized to win support for open-meeting legislation.

There was no direct censorship in Great Britain and in other countries where the tradition of press freedom is strong but the governments of these countries probably imposed restrictions on news sources; since the restrictions had not been the subject of legislative investigations, however, little was known about them. In Great Britain a voluntary Press council was set up in 1953 to safeguard high standards of journalism and the free flow of news. The clearest restraints in Great Britain are exercised on the reporting of court cases while they are pending and, through the Official Secrets acts of 1911 and 1920, on the dissemination of information obtained in the course of their work by persons in confidential government employment. Elsewhere, as in the U.S.S.R., the nations of the Communist bloc, Spain, Portugal, Turkey, Egypt and other countries, there was either strict censorship or strict laws that amounted to indirect controls over the press, including foreign correspondents.

Freedom of information is a problem with which the United Nations showed continuous concern. In 1955 the Economic and Social council urged all member states to cease the practice of censoring outgoing news dispatches in peacetime in order to provide a free flow of information throughout the world and to facilitate the unrestricted transmission of news by telecommunication services.

Birth-Control Literature.—In 1873 the U.S. congress banned the use of the mails to birth-control literature. Several states followed with similar statutory bans and in 1890 the Tariff act forbade the importation of such literature. While the laws on this subject have changed very little, in practice such literature is generally unmolested. Judge Woolsey in 1931 ordered the admission of books on this subject as imports from England; in mid-20th century periodical literature and books dealing with techniques of birth control passed through customs and the mails and were openly sold everywhere, even in Connecticut and Massachusetts, states that had gone furthest in efforts to keep information on the subject from readers. In 1959 test cases the Connecticut courts upheld the ban on physicians' giving advice on birth control to patients and the case went up to the United States supreme court which in 1961 declined to rule on the law's constitutionality.

Postal Censorship.—The first postal law on obscenity in the U.S. was enacted in 1865 but the basic law was the so-called Comstock act of 1873. Basically it was a prohibition against sending obscene matter through the mail and it declared it to be a felony to import obscene matter, to deposit such matter in the mails and to transport such matter in interstate or foreign commerce for sale or distribution. Congress provided that matter deposited in the postal system for transmission should be divided into four classes, and that mail of the second, third and fourth classes shall be wrapped in such a manner as to facilitate the examination of its contents. The government may not open sealed letters or mail sent first class. Printed matter sent other than first class is not entitled to the protection of the fourth amendment against unreasonable search and seizure. Newspapers and magazines are sent by second-class mail, which is relatively inexpensive and its use is, therefore, referred to as a privilege. In the important *Esquire* case (1946) the supreme court held that the post office may not cancel the second-class mailing privilege of a periodical because the magazine was not considered to be for the "public good" while concededly not obscene. The court rejected the argument that the use of the mails is a privilege which the government may regulate at will; it cast doubt on the power to revoke mailing privileges affecting future publication on the ground of the past publication of obscenity.

In 1951, in compliance with the Administrative Procedure act, the post office set up hearing procedures for "nonmailability" cases. An adverse decision may be appealed to the courts (as was done in the case of *Lady Chatterley's Lover* in 1959–60). A publisher against whom a decision had been rendered might ship by private express but this was normally prohibitively expensive. It should be noted, however, that there were about 35,000 postmasters, not many of whom undertook to examine books offered for mailing, and book rulings made in Washington, D.C., were not circularized locally.

There was, however, the "hard-core" type of pornography that presented heavy problems for the authorities. A 1959 congressional committee report spoke of this as "big business." In 1958 the post office received complaints from 50,000 persons, mainly indignant parents, and in fiscal 1959 there were more than 70,000 complaints.

Propaganda from abroad falls within the jurisdiction of the customs bureau, but this agency worked closely with the post office. The 1938 Foreign Agents Registration act required registration of foreign principals engaged in the United States in the dissemination of "political propaganda." In 1939–40 it became apparent that much Nazi propaganda was being sent to the U.S., though there were no disclosed resident "foreign principals." The propaganda was seized by the post office and destroyed. After the start of the Korean war in 1950 a similar problem developed with respect to Communist propaganda. But much of this material was addressed to libraries, scholars and journalists, who claimed the right to receive the publications. The department also held up pacifist and other publications. After considering objections to its actions the post office modified its rules to exempt from screening all materials not coming from behind the "iron curtain."

The handling of foreign propaganda, as well as of "hard-core" pornography, were problems that had vexed the authorities—as well as congress, the courts and citizens generally—for many years; they presented difficult questions of constitutional law, public policy, public administration, administration of the criminal law and the freedom to know.

See BILL OF RIGHTS, UNITED STATES; BILL OF RIGHTS, ENGLISH; CIVIL LIBERTIES; NEWSPAPER; *see* also references under "Censorship" in the Index volume.

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CENSUS, an enumeration of people, houses, firms or other important items in a country or region at a particular time. Used alone, the term usually refers to a population census—the type to be described in this article. However, many countries, including the United States, take censuses of housing, manufacturing and agriculture.

Since it relates to a particular moment of time, a census differs from registration statistics. A census corresponds to an inventory in business, whereas registration statistics (called vital statistics when they refer to human events) correspond to the daily record of sales, purchases and other transactions. To a certain extent, census and registration statistics can be substituted for each other. For instance, by enumerating women by age, duration of marriage and number of children ever born, a census provides information on natality (birth rate) in a population even when the record of births and marriages is inadequate. Normally, however, both census enumeration and continuous registration are used to obtain a knowledge of population dynamics. For example, birth and death rates are calculated by dividing the number of births and deaths registered during a certain period by the average population living during that period.

Censuses, being expensive, are taken only at infrequent intervals: every ten years in many countries, every five years or at irregular intervals in other countries. In noncensus years the population is estimated with the aid of vital statistics if these are sufficiently satisfactory. For instance, the population in postcensal year X equals the population at the last census plus the births, minus the deaths, plus or minus the net migration during the intervening years.

History.—Strictly speaking, the modern population census began to evolve only in the 17th century. Before that time, inventories of people, taxpayers or valuables were certainly made, but the methods and purposes of such inventories were different from modern ones. The most important difference was that early inventories were made to control particular individuals; *e.g.*, to identify who should be taxed, inducted into military service or forced to work. Since it was usually not to an individual's interest to be counted or to give correct information for these purposes, the premodern enumerations tended to be inaccurate. A second difference was that early inventories did not seek to count all the people or even a representative sample of them but only those in particular categories, such as family heads or males of military age. The Old Testament mentions two military enumerations: one at the exodus of the fighting men of Israel and the nonmilitary Levites (Num. i, 45–47); the other by Joab at the command of David (1 Chron. xxi). In Babylonia in the 3rd millennium B.C., a complete cadastral survey, *i.e.*, of real estate, and an agricultural census appear to have been made for fiscal purposes, and surveys are known to have been made in ancient Persia, China and Egypt. Every five years, the Romans enumerated citizens and their property to determine their liabilities. This practice was extended to include the entire Roman empire in 5 B.C. After the collapse of Rome the practice was discontinued until the modern period. The main exception was the Domesday inquest of England in 1086 made to acquaint William the Conqueror with the landholders and holdings of his new domain. Under the threat of siege, the German city of Nürnberg made an almost complete count of its people in 1449.

The modern idea of a population census as a complete enumeration of all the people and their important characteristics for purposes of understanding the basic structure and trends of the society rather than for identifying and controlling particular individuals slowly arose in the 17th and 18th centuries. There is no such thing as "the first census" because, although early efforts embodied one or another modern feature, none of them embodied all modern features. Perhaps the first effort in an area larger than a city to count everyone at successive intervals was made in La Nouvelle France (Quebec) and Acadie (Nova Scotia), where 16 enumerations were made between 1665–1754. In 1749 the Swedish clergy, who had long kept lists of parishioners, was required to render returns from which the total population of Sweden (including Finland) was obtained, and a similar development began in Denmark in 1787. Certain Italian states conducted approximately accurate enumerations: Sardinia in 1773 and 1795; Parma in 1770; and Tuscany in 1766. Enumerations occurred in several German states from 1742 onward. Although several American colonies, such as Virginia in 1624–25 and subsequently, had made full enumerations, the United States made history when it took its first census in 1790, not only because of the size of the area enumerated and the effort to obtain data on characteristics of the population, but also because of the political purpose for which it was undertaken: representation in congress on the basis of population. England took its first census in 1801, and although France tried to do so in 1800 and 1806 the administrative machinery was poor and the results untrustworthy until 30 years later.

Only gradually did the early census takers learn what was basic information and how to obtain it. The first United States census did not, for example, secure data on occupation, birthplace, marital status or exact age. A five-year age classification of whites was provided by the 1800 census, but other items had to wait until later, and until 1850 the unit used was the family rather than the individual. In England no satisfactory attempt was made to secure age data until 1841, and no effort to secure marital status until 1851.

The history of modern census taking thus involves three parallel developments: (1) the invention and gradual spread of the idea of country-wide enumerations for general scientific and governmental purposes; (2) the improvement of administrative machinery, techniques and accuracy of enumeration, including legal safeguards assuring that individual answers would be kept in confidence; and (3) the deepening and systematization of the types of information obtained. All three developments tended to increase the effectiveness of censuses as sources of essential information.

It is a mistake to think that in the history of each country there is a date, marked by the first census, before which the size and characteristics of the population were totally obscure and after which they were totally clear. Usually some fragmentary information based on partial enumerations and administrative evidence was available even before the first census, and afterward some time was required before the census record became reasonably full and accurate. As the countries pioneering in census taking gradually worked out better systems of enumeration, however, these could be transferred to new countries without repeating all the trials and errors. Canada's first dominion-wide census was taken in 1871; India's in 1871–72; and Egypt's in 1897. In fact, the rise in census taking after 1850 was remarkable, as can be seen from the following table:

Decade	No. of national censuses	Decade	No. of national censuses
1855–64	42	1915–24	64
1865–74	39	1925–34	78
1875–84	58	1935–44	66
1885–94	83	1945–54	88
1895–1904	61	1955–64	99
1905–14	63		

In addition to the national censuses, others were taken in colonial territories, parts of countries, cities, etc. It is estimated that in the decade after World War II at least 150 countries or areas took censuses collecting individual data on more than 2,000,000,000 persons. The large number of countries having censuses in the 1950s was partly due to the United Nations program, World Census of 1950. A similar program in 1960 proved equally successful. Not only does the United Nations encourage countries to take censuses, but it sponsors regional statistical committees which suggest minimum standards and offer technical assistance in the planning and conduct of enumerations. When China reported a census in 1953, the last large part of the world was removed from demographic darkness. The population of the entire world is now known with a degree of accuracy never before approximated, and the structure of populations (including their socio-economic characteristics) and their patterns of change are understood as never before.

Modern Census Procedure.—Because of their expense and their compulsory and confidential character, censuses are conducted by governments under enabling legislation with public funds. Censuses refer to a precisely delimited territory and subareas, and for this reason are normally planned and conducted with the aid of detailed maps. They aim to enumerate every person within the designated territory. Occasionally, but fortunately with growing rarity, a country elects to ignore some segment of the population in its census (usually aborigines) but, if so, it still should enumerate every person within the included categories. A *de jure* census tallies people according to their regular or legal residence, whereas a *de facto* census allocates them to the place where enumerated—normally where they spend the night of the day enumerated. By either method, the reported territorial distribution is according to where people sleep (nighttime population) rather than where they work (daytime population). For this reason the population of central cities is usually far less than the number employed there and that of suburbs far more than those employed in suburbs.

In addition to being precise as to territory, the census must be precise as to time; accordingly, a specific moment is almost always selected. This "census moment," often fixed at midnight, becomes the chronological line separating the included from the excluded. All persons born after the census moment or dying before it are excluded; all others are included. The census moment is also the reference point for certain kinds of questions, such as age, marital status and citizenship. Although some questions, such as occupation or labour-force participation, refer to a period of time rather than an infinitesimal moment, clarity requires that the exact limits of the period be specified. The need for time precision is necessary because the actual enumeration may take days or weeks. Since during this period many people will have moved about, died or been born, the census is taken as of a certain day, hour and moment.

Most data in a population census refer to individuals as the units. Information applying to a group, such as size of household or composition of the family, is compiled from information on the individuals comprising the group. By obtaining information relating to individuals as units, the census can be cross-tabulated to find the degree of association between individual characteristics.

A census provides a picture of the population as of a given moment. Although some of its questions relate to the individual's past, such as birthplace, previous residences, education and number of children ever born, each census is better as a current report than a historical record. Historical trends in the size, location and structure of the population are properly revealed only by a succession of censuses; therefore, most nations attempt to take censuses at regular intervals, and publications of census results usually include comparison with previous census returns. Accurate trend analysis requires that categories and definitions either remain unchanged or, if changed, be capable of readjustment for comparative purposes. This need for standardization of definitions over periods of time conflicts with another need; namely to gather information that is more precise, more instructive or more relevant to current conditions than that formerly gathered. For instance, in the United States the great depression created an intense interest in unemployment, yet there was no reliable information on the subject. The 1930 census had, like its predecessors, asked whether or not the person was "gainfully occupied" but, if not, there was no way of telling whether it was because he or she could not find work, did not want to work, was a housewife, etc. Therefore, a new concept was incorporated in the United States in the 1940 census: the concept of the "labour force," including those seeking work as well as those working during a specified period. Since the results were not comparable to the previous figures on the "gainfully occupied," the determination of labour-force history in the United States requires statistical adjustments that only a professional demographer acquainted with the data can make.

The requirement that all individuals be enumerated does not mean that all individuals must actually be interviewed. A wife may supply information about her husband; a mother may supply information about her children. Nor does it mean that every question be answered about every individual. If all individuals are enumerated, that is, counted and categorized on a few basic questions, there then exists a basis for sampling with respect to other questions. Such sampling may be done at the time of the census enumeration, as when the persons whose names fall on a certain line of the census sheet are asked additional questions, or it may be done at other times. For example, the United States bureau of the census conducts sample surveys between censuses in order to obtain information of current interest about the population.

Widespread suspicion of the validity of sampling techniques long delayed their use in census taking. If for important purposes, such as voting or the allocation of government funds, the numbers of the population in small areas are required accurately, it is desirable that all individuals should be counted; at the same time at least some characteristics, such as sex and age, would usually be obtained for all. For other characteristics it may not only be sufficient, but even preferable that they are obtained on a sample basis, for instance, so that the staff collecting and handling these data may be only those well trained for the purpose. Modern theory of sampling enables the sample design to be so chosen that adequate accuracy is achieved and that the margin of error is calculable.

In the 1940 census of the United States, certain questions were asked of only a sample of the population and this procedure was extended in 1950 and 1960. At the 1961 census of England and Wales, even the important question of occupation was asked on a sample basis. Another use of sampling in census taking, used in the Great Britain census of 1951, is to obtain a summary set of tabulations with the minimum of delay. The first census of the Sudan in 1955–56 was entirely on a sample basis, and indeed could not have been taken otherwise, because of limitations on funds and skilled personnel.

The machinery used to analyze the results has a profound influence on the whole census. In the 19th century when tabulations were made manually, no complex questions were asked because of the impossibility of analyzing them. This situation was entirely changed with the introduction of punched-card machinery into the analysis of the United States census, which other countries have progressively followed. Modern electronic machinery is leading to a second revolution and, by permitting complex tabulations to be made quickly, has moved the bottlenecks to the data-transfer stages, when the written records are converted for machine use and when the tabulated results are to be turned into print. When adequate mechanical methods are devised to perform these data-transfer operations, it will be possible to make available the results of a census soon after the enumeration. The importance of this is clear from the fact that a census records the instantaneous position which becomes out-of-date and less true with the passage of time.

Scope of Census Information.—Since census information is obtained by using a fixed questionnaire for interviewing, there are two broad types of resulting data: direct data, the answers to specific questions on the schedule; and derived data, the facts discovered by classifying and interrelating the answers to various questions. Direct information, in turn, is of two sorts: items such as name, address, etc., used primarily to guide the enumeration process itself; and items such as birthplace, marital status and occupation, used directly for the compilation of census tables. From the second class of direct data, derived information is obtained, such as total population, rural-urban distribution and family composition. The specific questions on the schedule depend on the interests and condition of the particular country at the time. For example, if there is only one language spoken in the country, no purpose is served by asking a language question. If virtually all people over ten years of age are literate, nothing is gained by asking about reading ability. The following is the list suggested by the United Nations:

Direct Topics (Geographical) 1. Place enumerated and/or place of usual residence; (Familial) 2. Relation to head of household or family; (Demographic) 3. Sex; 4. Age; 5. Marital status; 6. Children ever born; 7. Birthplace; (Economic) 8. Type of activity; 9. Occupation; 10. Industry; 11. Employer-employee status; (Social and Political) 12. Citizenship; 13. Language; 14. Ethnic or religious affiliation; (Educational) 15. Literacy or level of education; (16) School attendance. *Derived Topics:* 17. Total population; 18. Population of towns and local areas; 19. Urban-rural distribution; 20. Household or family composition. Possible additional topics include prior place of residence (for understanding internal migration), farm-tenure status, income, labour-force participation, duration of marriage and number of prior marriages.

A survey of 52 countries taking censuses in the decade after World War II showed that all of them obtained data on items 1, 3, 4 and 5 and on one or more of items 8 to 11. In addition, the number of countries getting information on relation to head of household or family was 51; birthplace, 49; citizenship, 49; education, 45; religion, 32; fertility, 31; language, 26.

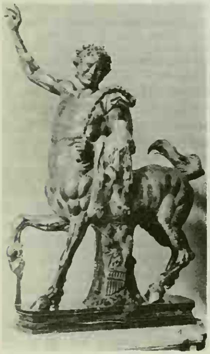
Accuracy of Census Information.—Census information may be incomplete (due to a failure to enumerate everyone) or inaccurate. Accuracy depends on the skill and conscientiousness of enumerators and on the knowledge and veracity of respondents. Carefully selected and trained enumerators can do a great deal to check answers and avoid errors. If the respondent is answering questions about himself or members of his immediate family, he is likely to know the facts; but if a landlady or distant relative is answering, the replies may be partly guesswork. Also, questions that reflect on one's prestige or good name tend to elicit false replies. In the United States, for example, people tend to overstate their educational achievement, adult women tend to understate their age and divorced persons often record their marital status as single or widowed. Inaccuracy can sometimes be corrected by checking one answer against another in the editing and coding of completed schedules; and it can often be detected when data are cross-tabulated. Checks can also be made by using other sources, such as vital statistics, civil registration, etc.; in fact, there are now ways of checking and classifying censuses according to their apparent degree of accuracy. A lay attitude of utter skepticism concerning census accuracy is as fallacious as the attitude that census results, once published, are absolutely true. No census is completely accurate, yet practically none is completely worthless. Information known to be defective often yields useful knowledge. The charge is sometimes made that a country has falsified its census to show more people than it actually has. If, however, the results of the census are published in tables where the data are cross-tabulated, it is virtually impossible to "inflate" a census without detection by demographers.

Uses of Census Data.—The population census is probably the most prolific and fundamental source of information about a nation. It is a multipurpose instrument serving a wide range of goals, both practical and scientific. It reveals not only the basic demographic trends, such as population growth, internal redistribution, urbanization and alterations in the age and sex structure, but also contributes indispensably to a knowledge of changes in the nation's occupational and industrial composition, in its level of living, education and employment and in its regional and group differentiation. Knowledge derived from the census underlies the attainment of other kinds of knowledge. For example, the census is essential to the drawing of samples for all kinds of surveys: for the computation of birth and death rates and the making of life tables; for the analysis of economic development and business cycles. Above all, the census makes possible the estimation of future trends and is therefore essential to all kinds of planning: national, local, public and private. It is essential for knowing future military and economic manpower potentials, future consumer needs, forthcoming school requirements, future growth in metropolitan areas, potential costs of social security measures, future requirements for highways, utilities, parks, water, energy and health services. Given its great utility, there is little wonder that the census is now a necessary feature of virtually every nation, and that the information provided by censuses over the world is contributing to a revolutionary expansion of global economic, sociological and demographic knowledge.

See also references under "Census" in the Index volume.

(K. D.)

CENSUS OF PRODUCTION: *see* ECONOMIC PRODUCTIVITY; PRODUCTION, CENSUS OF.



ALINARI

A CENTAUR, GREEK SCULPTURE. IN THE CAPITOLINE MUSEUM, ROME

CENTAUR (Gr. *kentauros*), in Greek mythology, the name of a race of beings part horse, part man, dwelling in the mountains of Thessaly and Arcadia. They are usually said to be the offspring of Ixion, king of the Lapithae, and they are best known for their fight (centauromachy) with their kinsmen the Lapithae, caused by their attempt to carry off the bride of Pirithous, son and successor of Ixion. In later times they are often represented drawing the car of Dionysus, or bound and ridden by Eros, in allusion to their drunken and amorous habits. Their general character is that of wild, lawless and inhospitable beings, the slaves of their animal passions, with the exception of Pholus and Chiron (*see* CHIRON). The centaur Nessus plays a special part in the traditional legend of Hercules' death.

The centaurs have been variously explained in modern times by a fancied resemblance to the shapes of clouds, or as spirits of the rushing mountain torrents or winds, etc. Perhaps the likeliest suggestion is that they are a distorted folk tale in which wild inhabitants of the mountains and the savage spirits of the forests have been combined in half-human, half-animal form. In early art they were represented as human beings in front, with the body and hind legs of a horse attached to the back; later, they were men only as far as the waist. They fight using rough branches of trees as weapons. In classical art the defeat of the centaurs by the Lapithae (*q.v.*) was used to typify the triumph of civilization over barbarism, and law over disorder. For this reason depictions of the story are to be found in religiously significant contexts; for example, on the metopes of the south side of the Parthenon and on the west pediment of the great temple of Zeus at Olympia.

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CENTAUREA, a genus of the family Compositae (*q.v.*), containing about 500 species, almost all natives of the old world, with the principal centre in the Mediterranean region. The plants are herbs with entire or cut, often spiny-toothed, leaves and ovoid or globose involucres surrounding a showy head of tubular, oblique or two-lipped florets, the outer of which are usually large and neuter, the inner bisexual.

The only native North American species, the basket flower or American star thistle (*C. americana*), is a robust annual two to six feet high, with very showy rose-coloured or purplish flower heads, three to five inches across. It is found in dry plains from Missouri to Louisiana, and westward to Arizona and Mexico, and is also grown as an ornamental plant.

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BASKET FLOWER (CENTAUREA AMERICANA)

In eastern North America the brown knapweed (*C. jacea*), the scabious knapweed (*C. scabiosa*), the Tirol knapweed (*C. vochinensis*), the spotted knapweed (*C. maculosa*), the yellow star thistle (*C. solstitialis*) and the rayless centaury (*C. melitensis*) are more or less extensively naturalized. On the Pacific coast *C. melitensis*, there known as Napa thistle, is a troublesome weed, especially in California, as is also *C. solstitialis*.

Four species, all naturalized in North America, are native in Great Britain. *C. nigra* is the knapweed, common in meadows and pastureland; *C. cyanus* is the bluebottle, bachelor's button or cornflower (*q.v.*), well known as a weed, much grown as a garden annual and the national floral emblem of Germany; *C. calcitrapa* is the star thistle, a rare plant with rose-purple flower heads enveloped by involucral bracts which end in a long, stiff spine.

The best-known garden plants are the dusty miller (*C. cineraria*), the cornflower, the sweet sultan (*C. moschata*) and the mountain bluet (*C. montana*).

CENTAURUS (the Centaur), in astronomy, a southern constellation (invisible in northern lands) rich in bright stars and globular clusters.

The two stars α and β constitute a binary and are known as the southern Pointers since they point to the Southern Cross. α Centauri, the third brightest star in the sky and our nearest neighbour, is 4.3 light-years (parallax = 0.75″) away. It is almost a replica of the sun, having nearly the same brightness and mass but slightly lower surface temperature.

There is also a third, widely separated, faint companion called Proxima Centauri because it is the nearest known star.

The constellation also contains ω Centauri, which is the finest example of a globular star cluster; it is probably the nearest object of this class but the distance is no less than 20,000 light-years. Photographs of it show more than 6,000 stars within a circle of 20′ diameter, but the number must be much greater.

(A. S. E.)

CENTAURY, any herb of the old-world genus *Centaurium*, family Gentianaceae (*q.v.*). The common centaury of Europe, *C. confertum*, occurs in dry pastures and on sandy coasts in Great Britain and is often cultivated for ornament.

The centaury group presents a great number of varieties, differing from each other in length of stem, degree of branching, width and shape of leaves and laxity or closeness of the inflorescence.

CENTIGRADE SCALE: *see* THERMOMETRY: *Early Development*.

CENTIPEDE, a wormlike animal with a distinct head, one pair of many-jointed feelers (antennae) and a long, segmented body, each typical segment of which is provided with a single pair of walking legs. Within the phylum Arthropoda (*q.v.*) the centipedes form the class Chilopoda.

Natural History.—Centipedes are typically carnivorous in habit, running after their prey. The victim is seized and poisoned by venom injected from the tips of poison claws formed by the first pair of trunk limbs. In all centipedes except *Scutigera* (fig. 1) the head is markedly flattened and adapted for catching and eating prey in shallow crevices. By day centipedes live predominantly under stones or bark and in woodland litter and soil; by night they walk abroad foraging for food. *Scutigera* alone hunts by day; it is the fastest runner and possesses the best-developed eyes, features associated with the ability to catch flies.

Centipedes have a world-wide distribution on land, a few inhabit the seashore and can tolerate temporary immersion in salt water, none live in fresh water, and the largest species, up to 12 in. in length, are found in tropical countries. Fossil centipedes occur in amber of Oligocene age, but all older remains tentatively referred to the class Chilopoda are problematical.

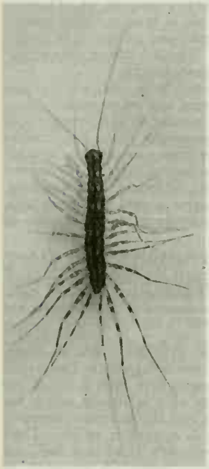

BY COURTESY OF S. M. MANTON

FIG. 1.—HOUSE CENTIPEDE (SCUTIGERA COLEOPTRATA), OF THE ORDER SCUTIGEROMORPHA, RUNNING AT FULL SPEED

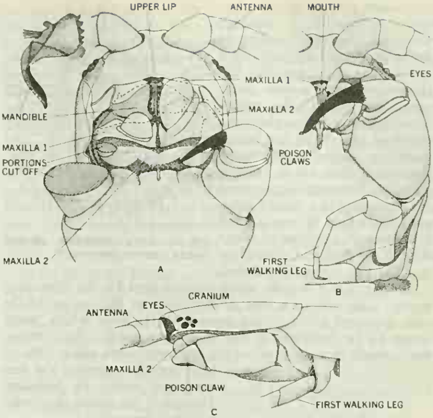
Although they may benefit man by eating slugs and other pests, centipedes kill beneficial insects as well. Sometimes they become vegetarians: *Haplophilus subterraneus* has been known to damage celery, lettuce and onions. Although most centipedes are harmless to man, the bite of large tropical sorts may occasionally be painful and cause danger to life.

Structure.—The head (fig. 2) of a centipede bears, besides the antennae, three pairs of mouth appendages: the mandibles and the first and second maxillae. Right and left first maxillae together form a kind of lower lip (labium) to the mouth. The second maxillae, which lie behind the first, somewhat resemble the walking legs and are not at all like an insect labium. Eyes, in the form of one or many pairs of ocelli, are present in most species other than those which penetrate most deeply into the soil, namely the Geophilomorpha and the family Cryptopidae among the Scolopendromorpha. Abundant head glands supply the mouth parts with fluids used to groom the body and legs.

The head, body and limbs are invested with a cuticle which, though flexible elsewhere, is stiffened to form dorsal, ventral and lateral plates or scutes, differently arranged in the various orders (fig. 3). The dorsal scutes are similar on each segment in the slow-moving Geophilomorpha (fig. 4). Fast running is made possible by, among other things, the dorsal scutes of alternate segments being long and extensively linked by muscles to other scutes, tendons and limb bases. This heteronomy is clear in *Scolopendra* (fig. 5) and more marked in *Lithobius* (fig. 6[A]). In *Scutigera* the alternating very short scutes are invisible. The last three segments of the body, the pregenital, genital and anal segments, are without walking legs.

The cuticle bears a fatty layer at its surface serving to hinder drying of the body under arid conditions; no centipedes, other than *Scutigera*, can survive in a dry atmosphere for long because of the lack of adequate control of the respiratory openings (spiracles) (fig. 3).

The digestive tube is simple (fig. 6[B]); it receives the products of the salivary glands near the mouth, and posteriorly, where digestion is complete, a pair of excretory (Malpighian) tubes empty their products to the hind-gut which opens on the anal segment.



BY COURTESY OF S. M. MANTON

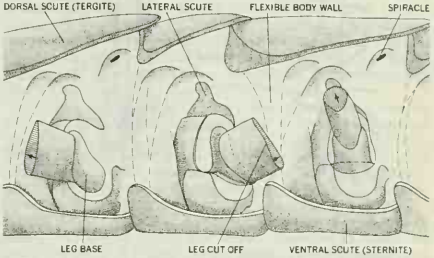
FIG. 2.—HEAD OF SCOLOPENDRA CINGULATA

(A) ventral view showing mouth parts displayed by cutting off poison claw and right maxilla 2 and pulling up right maxilla 1 (detail of separated mandible at upper left); (B) left side showing claw and maxillae in normal position; (C) left lateral view

The brain, composed of supra- and subesophageal ganglia, surrounds the throat and continues as the ventral nerve cord below the gut. Smaller nerves pass out in each segment to supply muscles and sense organs.

The heart is a simple tube situated above the gut, sending blood from behind forward, outward and downward to supply the large vascular spaces which bathe the internal organs. Air tubes or tracheae open on the lateral body surface, except in *Scutigera* where the spiracles are dorsal. Air is carried to all parts of the body by the branching tracheae, but in the Scutigeromorpha the blood transports respiratory gases to the tissues from short tracheae.

Reproduction.—The reproductive system and associated glands vary in different species. The single ovary and the testes (numbering from 1 to 24) lie above the gut and below the heart. The main ducts open on the genital segment. Because of the retiring and nocturnal habits of centipedes little is known about their reproduction. Copulation has not been observed and



BY COURTESY OF S. M. MANTON

FIG. 3.—SIDE VIEW OF THREE BODY SEGMENTS OF COMMON EUROPEAN CENTIPEDE, LITHOBIUS FORFICATUS; ARROWS SHOW POSITION OF REST OF LEG, STIPPLING SHOWS HARDENED COVERING

it appears that in at least two cases fertilization is achieved without it, the female picking up sperm previously deposited on a web by the male; possibly this phenomenon is of general occurrence throughout the group. Some (subclass Epimorpha) lay a clutch of eggs which the female guards by curling herself round them until they hatch. Others (subclass Anamorpha) pass each egg separately to a pair of gonopods which hold the egg and roll it in the soil, particles of which stick to the shell and camouflage it. The egg is then abandoned.

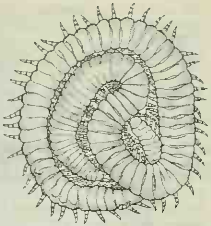

BY COURTESY OF HUGH MAIN

FIG. 4.—ORYA BARBARICA, OF THE ORDER GEOPHILOMORPHA

The egg is rich in yolk, which supplies food for the developing young. The embryo is first differentiated on the surface of the yolk mass and grows at the expense of the yolk, which finally comes to lie internally in the alimentary canal. Body movements result in the rupture of the egg membranes which hitherto have served to protect the embryo and retain its moisture. Thereafter the young centipedes fend for themselves.

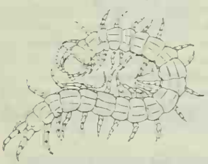

BY COURTESY OF HUGH MAIN

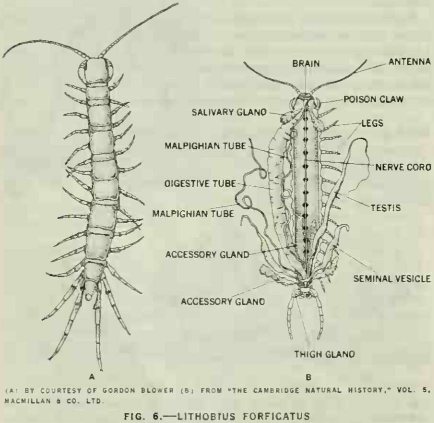
FIG. 5.—SCOLOPENDRA MORSITANS, OF THE ORDER SCOLOPENDROMORPHA

Both sexes of many Geophilomorpha are able to produce light from the secretion of glands on the ventral scutes of the body segments which leaves a luminous trail. Sternal or thigh glands produce also a sticky secretion of unknown function similar to that emitted from the posterior legs of *Lithobius* (fig. 6[B]).

Classification.—The two subclasses Epimorpha and Anamorpha are well defined. Members of each group have perfected the ability to run fast, but by different gaits and associated body structures.

Epimorpha.—In this subclass the young hatch with the full number of body segments and walking legs. Full size is attained after a series of molts. Two orders are present:

1. Scolopendromorpha, *e.g.*, *Scolopendra morsitans* (fig. 5). These are fleet runners having 20 to 22 pairs of legs. Stability is maintained with as few as two or three legs on each side of the body pushing against the ground at a particular moment. The powers of burrowing are limited.



(A) BY COURTESY OF GORDON BLOWER (B) FROM "THE CAMBRIDGE NATURAL HISTORY," VOL. 5, MACMILLAN & CO. LTD.

FIG. 6.—LITHOBIUS FORFICATUS
(A) external appearance; (B) dissection of smaller specimen

2. Geophilomorpha, *e.g.*, *Geophilus carpophagus* and *Orya barbarica* (fig. 4). These forms are less fleet but expert at burrowing by alternately making the body long and thin and then short and thick in the manner of an earthworm. The changes of body shape depend upon the presence of very many telescopic joints and an external armour which freely bends but is very strong. The body possesses from 31 to 177 leg-bearing segments.

Anamorpha.—In the subclass Anamorpha the young hatch with usually 7 but sometimes 12 pairs of legs. Subsequent molting of the skin is followed by growth and the appearance of additional body segments and legs, repeated until the full number is attained; thereafter further molts lead to the attainment of full size. Two orders are present:

1. Lithobiomorpha, *e.g.*, *Lithobius forficatus* (fig. 6). The body is shorter, with 14 pairs of legs used in running; these animals are as fleet as the Scolopendromorpha, and are unable to burrow by changing their body thickness. The last pair of conspicuous legs are used as holdfasts or as sensory organs.

2. Scutigeromorpha, *e.g.*, the common house centipede *Scutigera coleoptrata* (fig. 1). The legs are very long but numerically similar to those of Lithobiomorpha, a number in both orders suited to give easy running by the fastest practicable gaits. Body undulations during fast running are under greater control than in other centipedes, allowing as many as four successive legs to overlap one another during their forward stroke without causing stumbling. The feet are highly specialized to give a good plantigrade grip, even on vertical surfaces. Other centipedes run on the tips of their claws.

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(S. M. Ma.)

CENTLIVRE, SUSANNA (*c.* 1670–1723), English dramatist whose farcical comedies are in the tradition of the Restoration comedy of manners. Many accounts have been given of her adventurous life. She was possibly born in Ireland, and it has been suggested that she spent some time at Cambridge university, disguised as a boy, before living as a strolling actress. Later she married an army officer, subsequently killed in a duel, and in 1707 she married Joseph Centlivre, "yeoman of the mouth" to Queen Anne.

Of her 19 plays her outstanding successes were *The Busy Body* (1709) and *The Wonder: A Woman Keeps a Secret* (1714), which continued to be produced in both England and the United States until well into the 19th century.

Apart from early attempts at tragedy, her plays are all comedies bordering on broad farce. She also published interesting letters and poems. She was a friend of George Farquhar, Nicholas Rowe and Sir Richard Steele, and most of the well-known actors of the period appeared in her plays. She died in London on Dec. 1, 1723.

See J. W. Bowyer, *The Celebrated Mrs. Centlivre* (1952).

CENTRAL, the smallest, most densely settled department of Paraguay (area 1,024 sq.mi.; pop. [1960 est.] 190,420), lies south and east of the capital, Asunción, which is the administrative centre of the department but independent of it. Bounded on the west by the Paraguay river, it is the heart zone of the country and has its major road network and many long-established settlements which process the products of a rich agricultural lowland. These include rice, sugar, maize, cotton; and petitgrain from Yaguarón, a town with one of Paraguay's finest Jesuit-built churches. Itá (*q.v.*) is another important centre of historical interest.

(G. J. B.)

CENTRAL AFRICAN FEDERATION: *see* Rhodesia and Nyasaland, Federation of.

CENTRAL AFRICAN REPUBLIC (République Centrafricaine), an independent landlocked state in west-central

Africa, was until 1958 the territory of Ubangi-Shari in French Equatorial Africa. Bounded north by Chad, east by Sudan, south by the Republic of the Congo (formerly Belgian Congo) and the Republic of Congo (formerly French Congo) and west by Cameroon, the Central African Republic has a population (1959 est.) of 1,187,097 and an area of 241,699 sq.mi.

Physical Geography.—The country forms a plateau ridge averaging 2,000–3,000 ft. and trending east-northeast, forming a watershed between the Congo and Chad basins. The ridge rises toward the Yade massif in the west and in the east reaches 4,593 ft. in the Bongo massif, but a central saddle allows easy access between Bangui and the headstreams of the Shari river.

The granitic summits of the Yade massif decline eastward into sandstone plateaus dissected by the Nana (upper Sanga) and Lobaye rivers. In the east gneisses and quartzites predominate, also surfaced with sandstone but with occasional isolated granitic knolls. The crest of the main watershed is of metamorphic rocks and quartzites, which northward are overlain by sandstones of the final continental period, Tertiary sandstones of the Chad basin and more recent alluviums.

The republic extends from the equatorial to the tropical zone; the climate has a rainy season (June to October) with southwest monsoon winds and a dry season (October to March) brought by the northeast trade wind or harmattan. The southern part belongs to the region of equatorial heat and humidity and has an even temperature averaging about 80° F., with diurnal variations of 15°–20°. The rainfall is highest in the upper Ubangi, in the southeast (71 in. annually) and in the Yade massif (59 in.), and from there decreases to about 47 in. The country is mostly in the savanna zone, well wooded in the south (acacias, baobab, monkey bread trees and cotton trees) but treeless in the north. In the south the density of trees indicates the proximity of the rain forest, which along the course of the rivers extends deep into the savanna area. The dense forest zone is the home of the gorilla and chimpanzee and of arboreal creatures such as monkeys, giant squirrels, bats, snakes, birds and insects. Fish, crocodiles and hippopotamuses abound in the rivers. The savanna is inhabited by grazing animals, particularly by many species of antelope; hyena are numerous; lions occur sporadically.

People.—The population is very thin and unevenly distributed. Moreover it is not homogeneous, forming a mosaic of racial groups of which the principal are the Baya in the west and the Banda and Mandja in the centre. (*See* AFRICA: *Ethnography* [*Anthropology*]: *West Central Africa.*) Cattle-raising Fulani infiltrate from the west, but the population is essentially an agricultural one, growing millet, sorghum and cassava on ground prepared by burning the topsoil. The capital and only large town is Bangui (*q.v.*). (J. D.)

History.—Bifacial hand axes of Acheulean form have been discovered beside the M'bali river northwest of Bangui. At one time, when the rain forest extended farther north, Pygmies appear to have lived in the region.

Early riverain tribes were the Banziri and Sanga. In the 19th century, under pressure from slave traders in Sudan, four waves of migration peopled the savanna: Baya and Mandja from the north; Banda and Azande (*q.v.*) from Bahr el Ghazal (southwest Sudan). The slave traders raided as far as the Ubangi river, but were resisted by the Azande, who were organized in kingdoms by the feudal dynasty of the Avongara. The German explorer Georg August Schweinfurth (*q.v.*) followed one of the slaving bands and journeyed over part of the Azande territory (1870). Bantus from the south occupied the southwest region; petty sultanates (Bangassou, Rafai, Zemio) were created along the Bomu river, the right headstream of the Ubangi. Over the rest of the country political unity did not go beyond the tribe; cannibalism and wars were rife. Some trading (salt, ivory, slaves) took place along the river.

H. M. Stanley, descending the Congo in 1877, discovered the mouth of the Ubangi, whose lower course was in 1885 surveyed by the British missionary explorer George Grenfell. The Ubangi became the boundary between French territory and the Congo Free State (later Belgian Congo) as far as latitude 4° N. The post of Bangui was established by the French on the right bank in 1889 but in the following year the administrator was murdered by local tribesmen. Victor Liotard, who had been appointed governor by Pierre Savorgnan de Brazza (*q.v.*), occupied the confluence of the Bomu and Uele. The northern frontier of the Belgian Congo in this region, for some time disputed with France, was in 1894 fixed at the Bomu river. In 1897 an expedition from Brazzaville under Jean Baptiste Marchand (*q.v.*) ascended the Bomu, crossed to the Bahr el Ghazal and reached the Nile at Fashoda (Kodok) in July 1898, provoking the "Fashoda incident" between France and Great Britain. The resulting crisis was settled by the Anglo-French agreement of 1899 which fixed the frontier between Sudan and French Congo (as the French territories in equatorial Africa were then called) along the watershed between the Congo and Nile basins. Pacification of this part of the colony was achieved by 1911.

In the north the French attacked the slave-trading sultans who had caused so much damage and misery. Sultan Senoussi, a vassal of the triumphant Rabah Zobeir (*q.v.*), in 1891 caused the assassination of the explorer Paul Crampel. In 1900 Émile Gentil, who had succeeded in reaching Lake Chad in 1897, led a military expedition from Bangui and assisted the forces of F. Foureau and F. J. A. Lamy from Algeria in the battle of Kousseri, which resulted in the death and decapitation of Rabah. Senoussi was destroyed by a further expedition in 1911.

French partition of the colony between great commercial concessionaires led to abuses denounced by André Gide in *Voyage au Congo* (1927). From 1928 the governor encouraged the cultivation of cotton and created a good network of roads. The Ubangi-Shari colony, a division of French Equatorial Africa, became in 1946 an overseas territory of France with an elected assembly. Diamond mining and the creation of peasant holdings provided new resources, and the capital Bangui grew rapidly; the route of a Bangui-Chad railway was surveyed.

The former priest Barthélemy Boganda, leader of the Mouvement pour l'Évolution Sociale de l'Afrique Noire, became president of the grand council of French Equatorial Africa in 1957. In 1958 Ubangi-Shari became an autonomous state of the French Community under its new name of République Centre-Africaine. Boganda, who dreamed of a "United States of Latin Africa," was killed in an air accident in 1959 and was succeeded as president by his cousin David Dacko. On Aug. 13, 1960, following the signature of transfer and co-operation agreements with France, the independence of the republic was proclaimed at Bangui. (HU. DE.)

Economy and Communications.—The main export is cotton, which is grown by numerous planters, especially on the Yade massif and around Bambari. Other export crops are coffee, grown particularly in the southwest, rubber from the Lobaye river region, sisal in Haute-Sanga and oil palm products. Timber extraction has decreased in importance, but livestock has increased with Fulani influence. Before the development of cotton, mining was of some importance, but in the 1950s gold mining ceased to be profitable and diamond production (which in 1952 reached 156,000 carats) decreased; most of the mining is near Berbérati. Except for breweries (Bangui) and plants for cotton ginning and sisal cleaning, the only important industrial development is at Bouali (40 mi. N.W. of Bangui) where a hydroelectric power station supplies a textile combine.

Economic progress is impeded by the absence of railways or seacoast. Most export products travel down the Ubangi and Congo rivers, or by road westward to Yaoundé or Duala in Cameroon. There are regular airline services from Bangui to main centres in west and central Africa and to Paris and Rome, with feeder services to Berbérati, Bambari and other places in the republic. (J. D.)

CENTRAL AMERICA, the aggregation of independent republics and United States and British dependencies which occupies the isthmian bridge between Mexico (North America) and Colombia (South America). The region includes Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, Panamá, the Panama Canal Zone and the crown colony of British Honduras (claimed by Guatemala as Belize). The low latitude land area, flanked by the Caribbean sea and the Pacific ocean, extends from latitude 7° 15′ N. to latitude 18° 30′ N., and from longitude 77° W. to longitude 92° 15′ W., or roughly 990 statute miles east and west by 770 mi. north and south. The total area is approximately 200,000 sq.mi. The population, about 11,000,000, has one of the highest rates of increase in the world.

The term Middle America (*q.v.*) is sometimes used as a synonym for Central America. However, geographers usually consider Middle America to include Mexico, the West Indies and Central America.

This article is divided into the following main divisions and sections:

- I. Physical Geography
  - A. Geology and Physiography
    - 1. Northwestern Highland
    - 2. Southeastern Uplands
    - 3. Lowlands
  - B. Climate
    - 1. Temperatures
    - 2. Rainfall
    - 3. Weather
  - C. Vegetation
    - 1. Tropical Rain Forest
    - 2. Tropical Deciduous Woodland and Savanna
    - 3. Xerophytic Vegetation
    - 4. Mixed Upland Forests
    - 5. Alpine Vegetation
  - D. Animal Life
- II. Natural Resources
  - A. Water Resources
  - B. Soils
  - C. Minerals
  - D. Land Use
    - 1. Agriculture
    - 2. Forestry
    - 3. Industries
- III. Anthropology
  - A. Ethnology
    - 1. Spanish-American Tradition
    - 2. Meso-American Tradition
    - 3. South American Tradition
  - B. Language
  - C. Physical Anthropology
- IV. History
- V. Population
  - 1. Number and Distribution
  - 2. Composition
  - 3. Growth of Population

I. PHYSICAL GEOGRAPHY

Central America is more suitably defined as a regional political concept than as a concept in physical geography.

A. Geology and Physiography

The isthmian land mass of Central America, an area of considerable geologic complexity, is dominated by a mountain backbone made up of the elements of two orographic systems. The older mountain system, consisting of a nuclear core of Archean or early Paleozoic rocks and a mantle of volcanic materials, lies in Guatemala, Honduras, Nicaragua and British Honduras. Within the area enormous troughs caused by faulting and folding are prominent relief features. To the southeast, chiefly in Panamá and Costa Rica but extending through southwestern Nicaragua, is the young system of mountains which finally sealed the marine portal between North America and South America. Both upland areas are flanked by narrow coastal plains.

Prominent and striking features of the Central American highlands are the two great series of peaks, most of them young volcanoes (possibly Pre-Miocene in places, definitely Pliocene to Recent), which trend northwest to southeast in gentle convex arcs toward the Pacific. The volcanoes, more than 100 large and 150 minor ones in all, overlie a broad base of older lava and ash beds. The two series of volcanic mountains may be traced from Chiapas (southern Mexico) through Guatemala and El Salvador, and through Nicaragua and Costa Rica into Panamá. Each series lies nearer the Pacific than the Caribbean. Each has a length of approximately 350 mi. (excluding Chiriquí in western Panamá because of its isolation from the others). The lines of volcanoes converge in the region of the Gulf of Fonseca. A broad Pacific belt, southeastward to Panamá, is subject to frequent and violent seismic activity characteristic of such highly unstable volcanic areas. Some earthquakes are associated with eruptive activity, others with faulting. A number of cities have thus been destroyed, notably Antigua Guatemala in 1773 and modern Guatemala City in 1917–18. Seismic disturbances occur with such frequency about San Salvador that the surroundings are termed the Valley of the Hammocks (Valle de las hamacas). Ash eruptions may cover wide areas, as was spectacularly illustrated by the tremendous explosion (1835) of Cosigüina, Nic., which spread ash and pumice over a radius of about 600 mi.

1. Northwestern Highland.—The nuclear Central American highland, composed of granitic and diverse metamorphosed sedimentary rocks, is a complex folded and faulted region dominated by east-west arcs of parallel ranges and valleys. The region, a western segment of the Greater Antilles orographic system, extends into southern Mexico. Collectively northwestern Central America, southern Mexico and the Antillean islands and submarine ridges are termed the Antillian, Caribbean or Middle American system. As an orographic system it is distinct from the north-south trending structures of North America and South America.

Old Mountains.—The oldest-known geologic formations in northwestern Central America are Paleozoic, usually designated as Pre-Permian, since no rocks of proved age older than Permian have been found. Most so-called Carboniferous rocks are of Early and Middle Permian age, and Pre-Cambrian or Archean formations may be no older than Middle Paleozoic. It is probable that the area was insular during part of the Paleozoic era and was linked to the Greater Antilles, although separated from North and South America by narrow straits. Faulting severed the Antillean link during various periods of geologic history, especially in the Late Cenozoic.

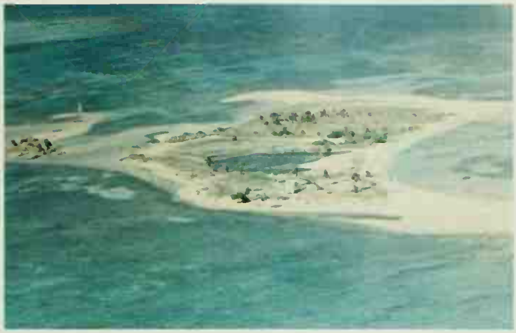
Principal among the mountains of the oldest periods of folding and faulting are the central Guatemalan Sierra de Chuacús and Sierra de las Minas. (Continuing their trend northwestward into Mexico is the Sierra Madre de Chiapas.) Just south of the trough followed by the Motagua river, and roughly parallel in strike with the Sierra de Chuacús, are the Honduran Sierra de la Grita, Sierra Espíritu Santo and the Picos de Omoa. A structural system outlier is the granite-cored Maya mountains in British Honduras.

Other east-west striking mountains of Permian granites, gneisses and schists lie in Honduras and northern Nicaragua. They appear as short, steep and rugged ranges separated by structural basins. While there is little order in the intricately dissected highland, a northern and somewhat higher southern group of cordilleras may be discerned. These mountains, lower than the old Guatemalan mountains, are similar in height and ruggedness to such interior Nicaraguan mountains as the cordilleras Isabella and de Darién (undetermined age) and the Huapi mountains.

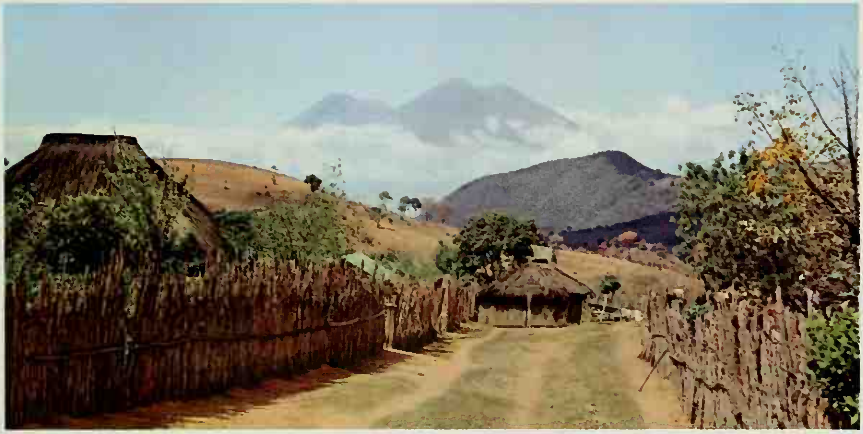
Almost all of the old rock mountain region may be characterized as having considerable relief, the high ridges being deeply fretted with the canyons and gullies tributary to the master depressions that lead toward the Caribbean. In central Guatemala mountain summits reach elevations of over 8,000 ft., and in Honduras and Nicaragua many of them attain 5,000 to 8,000 ft. elevation. Master streams may follow valley floors a half mile to a mile below the sharp divides. At intermediate elevations are a few rolling or hilly basins.

Mountains of Middle and Recent Geologic Times.—Except for the recent and currently active volcanoes which have developed over the older terrain in the south and west, the highlands were uplifted to their present elevations during Mesozoic and Cenozoic (especially Pliocene) time. In central Guatemala, to the north and east of the areas mantled by volcanic materials, lies a band of highlands where nearly horizontal Cretaceous beds occur over large areas. The most impressive of such mountain areas is the Sierra de los Cuchumatanes horst, an elevated block which is contiguous with the Mesa Central of Chiapas (Mexico). The east-west, southward-facing front of this great limestone block rises to a high point of more than 12,000 ft., higher than all the great

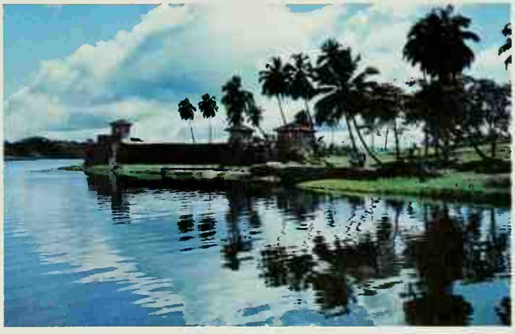
CENTRAL AMERICA



Coral atoll in the Caribbean off the coast of British Honduras. Coral atolls are found in this region of warm waters, permitting the growth of coral polyps, the basic structural units of atolls



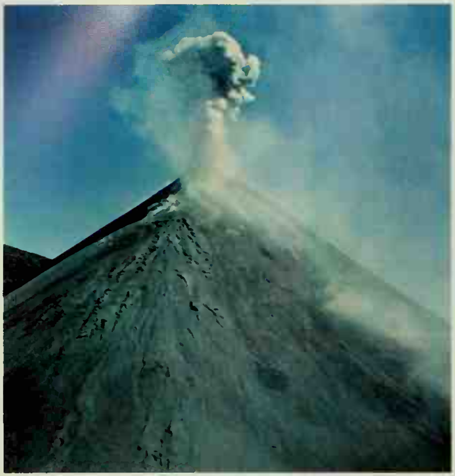
Grass-roofed huts of a farm village in the highlands of Guatemala. The cone-shaped volcanoes in the distance are part of a chain of volcanic mountains extending through Guatemala and El Salvador

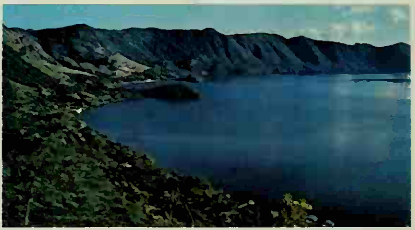


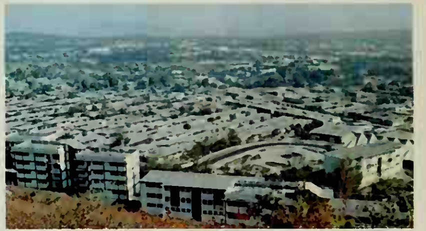
Ft. San Felipe, built during Spanish colonial times, on a peninsula at east end of Lake Izabal, Guatemala

PHOTOGRAPHS, (TOP, BOTTOM) NORMAN THOMAS, (CENTRE) D. FORBERT—IMAGE INTERNAT.

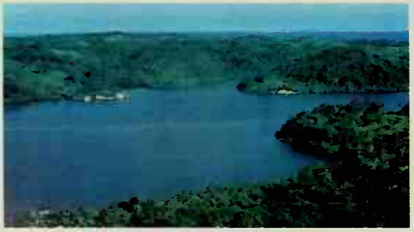
CENTRAL AMERICA

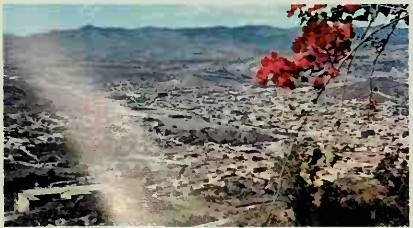


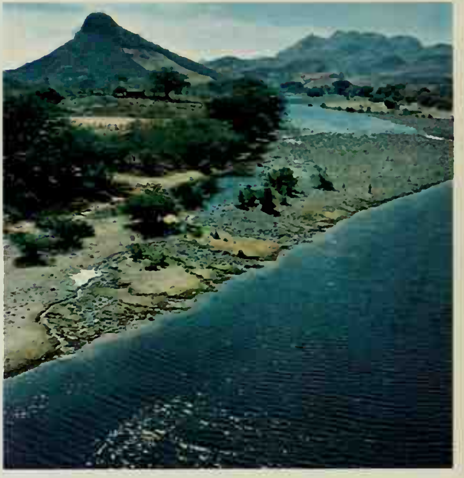




(Left) Izalco volcano, El Salvador, during an eruption. Izalco has been intermittently active since 1770. (Top) Lake Coatepeque, El Salvador. Lake lies between San Salvador and Santa Ana, principal cities of the republic. (Bottom) San Salvador, capital of El Salvador. Shown are the residential district and the mountains behind Las Hamacas valley



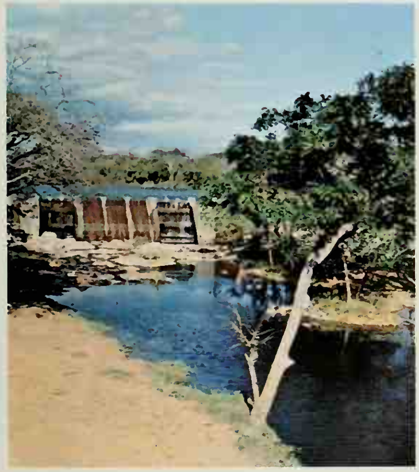




(Top) French Harbour, Roatán, Bay Islands of Honduras in the Caribbean. Roatán Island, an extension of the continental shelf, is 30 mi. long and 9 mi. wide, and its highest point is 900 ft. above sea level. (Bottom) Tegucigalpa, capital of Honduras. (Right) The Río Nacaome and the scrub growth and volcanic mountains along the river, a landscape typical of this part of southwestern Honduras

PHOTOGRAPHS, (TOP LEFT) A. DEVANEY, INC. FROM PUBLIX; (TOP RIGHT) LAWRENCE BERLIN—PHOTO RESEARCHERS, INC.; (TOP RIGHT LOWER, BOTTOM LEFT UPPER) NORMAN THOMAS; (BOTTOM LEFT) D. FORBERT—IMAGE INTERNAT.; (BOTTOM RIGHT) DENNIS J. CIPNIC

Managua, capital of Nicaragua. In the background, Lake Managua



(Left) Small flood-control and irrigation dam on a stream in western Nicaragua, near León. In this region, dependent on seasonal rainfall, water conservation is important. (Right) Partially cutover tropical forest along bank of Río Frío in southeastern Nicaragua, a region of heavy rainfall and warm temperature

PHOTOGRAPHS, (TOP) TOM HOLLYMAN—PHOTO RESEARCHERS, INC., (BOTTOM LEFT) NORMAN THOMAS, (BOTTOM RIGHT) CHARLES R MEYER—PHOTO RESEARCHERS, INC

CENTRAL AMERICA

Extinct volcano, Arenal, in tropical San Carlos valley, Costa Rica

Banana plantation, Coto plains, Costa Rica

Coffee plantation, near Cachí, in the highlands of Costa Rica

Ships passing through a lock of the Panama canal, which connects the Atlantic ocean with the Pacific ocean, across the Isthmus of Panamá

BY COURTESY OF (CENTRE, BOTTOM LEFT) UNITED FRUIT CO., PHOTOGRAPHS (TOP) GILES FROM PUBLIX (BOTTOM RIGHT) STEINMETZ FROM PUBLIX

volcanoes to the south except Tajumulco (13,812 ft.). It presents a nearly straight 40-mi. east-west wall more than 10,000 ft. in elevation above sea level and with relief heights above the Rio Negro from 3,000 to 5,000 ft. This is the dominant single relief block in all the highlands of Central America. The lofty summits are smoothly rolling, with sinkholes characteristic of karst topography in limestone areas, but around the margins of the massif profound canyons drop away to breathtaking depths. Following the crescentic arc farther eastward through the Alta Verapaz, the Pliocene orogeny is manifested in other features of step and block faulting, mostly minor as to relief except for the hill lands south of the Cockscomb mountains of British Honduras.

Major Structural Depressions.—Several structural troughs create prominent relief features in northern Central America. In north-central Guatemala the southern wall of the Sierra de los Cuchumatanes overlooks the valleys of the east-flowing Río Negro and the west-flowing Saleguá (Usumacinta and Grijalva drainage basins, respectively). The Motagua and Polochic rivers, which follow a more direct, generally eastward, course to the Caribbean, occupy deep, ancient furrows. With a strike that is transverse to the nuclear mountain structure, the Honduras depression crosses Central America from north to south. This major fault zone is marked by the Humuya-Ulúa and Goascorán valleys and the intermediately located elevated Plain of Comayagua, a densely populated area some 40 mi. long and 5–15 mi. wide. Many of the rivers of southern Honduras flow through deep box canyons cut in lava beds, and this incision by drainage accentuates structural lines.

Volcanism.—In Guatemala, Honduras and Nicaragua mantles of ash and lava cover an area of 525 mi. northwest-southeast extent and up to 125 mi. in breadth. The mantle of Upper Tertiary or Quaternary ash and lava is deepest in southwestern Guatemala where, found at its highest elevation, it forms the continental divide. The mantle becomes thinner toward the Caribbean.

Studding the Pacific slope of the eruptives-covered highland in Guatemala, and lying to the southwest of the continental divide, is a series of striking northwest-southeast trending volcanic peaks. The string of young volcanoes is parallel to and less than 50 mi. from the Pacific coast. Among the cones are the simple and well-formed Tajumulco (13,812 ft.) and Tacaná (13,333 ft.). Southeastward from these, multiple peaks are common: Santiaguito-Santa María (12,362 ft.), Atitlán-Tolimán (11,565 ft.) and Colina-Acatenango (12,992 ft.); the first-named of each pair is the coastward and younger vent. For centuries Colina has been intermittently active; Santiaguito, active for relatively few years, has had rapid, continued growth. As with the case of Santa María (1902), lateral explosions and the birth of new basal cones result from the blocking of openings by lava, especially by the highly viscous and rapidly solidifying andesitic extrusion.

In El Salvador, where the eruptives are darker and more basaltic, the elevation of the volcanic highlands decreases toward the east. The double row of inactive and semiactive volcanoes includes peaks that rise to between 3,600 and 7,600 ft. Among them may be singled out Izalco (6,183 ft.), "Lighthouse of the Pacific," intermittently active from the 18th century.

Several basins lying in the region of eruptives have fertile soils and long histories of occupation and intensive cultivation. Among these is the Quezaltenango basin, situated at 7,500 ft. elevation. It is drained by the Samalá, one of a number of Pacific streams that follow sharp gradients through the broad gaps which separate the volcanoes. In some cases drainage has been disturbed, and lakes formed, as a result of volcanism. The beautiful Lake Atitlán, which marks a cauldron subsidence, is partly dammed by volcanic ash. Lake Amatitlán, a scenic resort area for the capital, lies within a down-dropped block. In El Salvador lakes

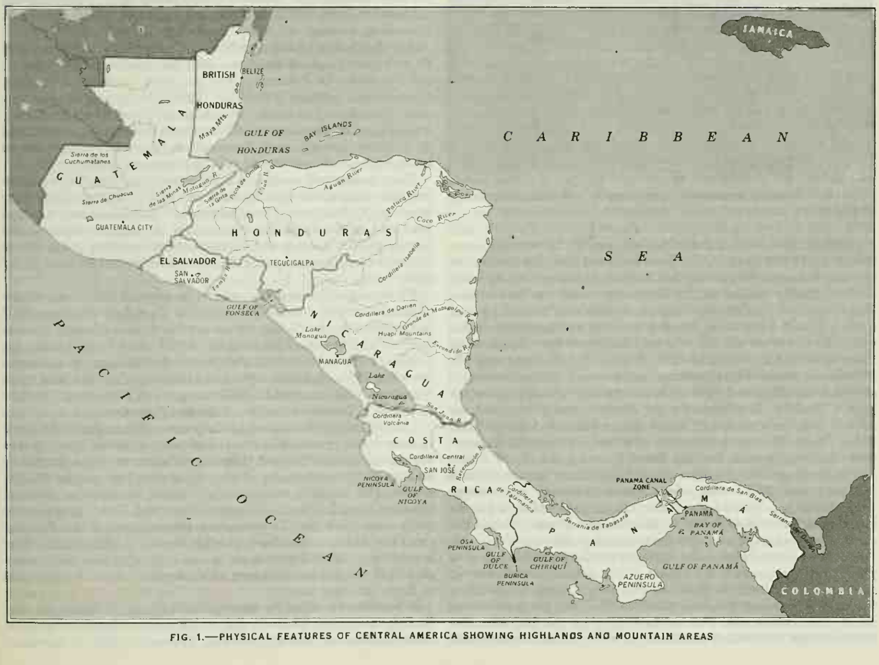

JAMAICA
BRITISH
BELIZE
HONDURAS
Maya Mts.
GULF OF HONDURAS
BAY ISLANDS
C A R I B B E A N
S E A
Sierra de los Cuchumatanes
G U A T E M A L A
Sierra de Chuacus
Sierra de las Minas
Motagua R.
Sierra de la Grita
Picos de Omoa
Ulúa R.
Aguan River
Patuca River
Coco River
GUATEMALA CITY
H O N D U R A S
EL SALVADOR
TEGUCIGALPA
SAN SALVADOR
Lempa R.
Cordillera Isabella
GULF OF FONSECA
N I C A R A G U A
Cordillera de Darien
Grande de Matagalpa R.
Huapi Mountains
Escondido R.
Lake Managua
MANAGUA
Lake Nicaragua
San Juan R.
Cordillera Volcánica
C O S T A R I C A
Cordillera Central
SAN JOSÉ
Reventazón R.
NICOYA PENINSULA
GULF OF NICOYA
Cordillera de Talamanca
PANAMA CANAL ZONE
Cordillera de San Blas
Serranía
P A N A M Á
PANAMÁ
BAY OF PANAMÁ
Serranía de Tabasará
GULF OF PANAMÁ
OSA PENINSULA
GULF OF DULCE
GULF OF CHIRIQUÍ
BURICA PENINSULA
AZUERO PENINSULA
COLOMBIA
P A C I F I C O C E A N

FIG. 1.—PHYSICAL FEATURES OF CENTRAL AMERICA SHOWING HIGHLANDS AND MOUNTAIN AREAS

Coatepeque and Ilopango occupy collapsed, basin-shaped depressions. Between El Salvador's northwest to southeast trending corridor of volcanoes and basins and the steep-faced highlands of Honduras lies a structural corridor which is occupied by broad tablelands composed of eruptives. The area is drained by the Lempa river, a stream that turns westward across the line of coastal volcanoes to enter the Pacific.

2. Southeastern Uplands.—Although the arcuate mountain system of Panamá and Costa Rica is more or less parallel to the nuclear system of northwestern Central America, the two are distinct geologic regions. In addition to the narrow S-shaped Isthmus of Panamá and Costa Rica, the system includes the west Nicaraguan range of coastal volcanoes and the lake-occupied Nicaraguan depression. At its narrowest point, near the Panama canal, the isthmus is about 40 mi. wide, and at its widest part, the Nicoya peninsula, it is more than 150 mi. across.

The land bridge which southeastern Central America forms between northwestern Central America, North America and South America dates from the Late Miocene-Pliocene periods. Earlier, the land links had been broken in the Late Eocene period in Nicaragua-Costa Rica and in Panamá, and in the westerly area during Middle Miocene. The breaches permitted the circulation of water between the Atlantic and Pacific oceans and the development of closely related marine floras and faunas on both coasts. The connecting link between the continents was created by volcanic action, a ridge being formed upon an elongated submarine arch. Intrusive mountains were uplifted upon the ridge crest in Late Miocene-Pliocene, and through the later Pliocene and the Pleistocene were further built up by numerous highly active explosive type volcanoes. The eruptions raised the ridge above sea level. Thereby, intermigration of animals and plants was resumed: first between South America and Central America-West Indies; then (Pliocene to present), after the closing of the Tehuantepec (Mexico) portal, between South America and North America. Several orders of mammals, including some marsupials and primates, probably crossed the Cretaceous-Eocene land bridge from North America to South America, and four orders definitely crossed the later Pliocene-Pleistocene bridge. These included the carnivores, proboscidians, artiodactyls and perissodactyls.

EWING GALLOWAY

PLANTATION WORKERS SPREADING COFFEE BEANS FOR DRYING AT ATEOS, EL SALVADOR

Panamá.—Panamá's axis of rugged low mountains is highest in the eastern and western extremities of the country, and lowest at the Canal Zone where the Panama canal is cut through the isthmus. From an elevation of less than 300 ft. in the Canal Zone the steep-sided hills arc eastward and southeastward as the San Blas and Darién ranges. Although elevations generally do not exceed 4,000 ft., there are peaks that rise to 6,100 ft. in the Serranía del Darién. This eastern segment of the intrusive backbone lies near and parallel to the Caribbean coast. Its western counterpart, more centrally located on the isthmus, is the abruptly rising mountain area which culminates in the 6,000 to 9,272 ft. peaks of the Serranía de Tabasará (Cordillera de Talamanca). The isthmian backbone broadens and rises to the west before entering Costa Rica. In western Panamá many of the peaks exceed 6,500 ft.; the inactive volcano of Chiriquí reaches 11,411 ft. Though primarily volcanic, some sedimentaries, especially limestones, shales and sandstones of the Early Cenozoic cover the igneous rocks. This is best seen in the east, near the Colombian border. The limited Tertiary marine beds of Panamá are thinner and less folded than those of Costa Rica. Folding parallels the coast and often is asymmetric, with steeper slopes toward the Caribbean, especially notable in Darién. A number of north-south thrust faults cut across central Panamá and seemingly have locally affected relief and drainage.

To the south of and parallel to the core highlands are several isolated remnants of a coast range. From east to west they are the Serrania de Baudó and the hilly peninsulas of Azuero (Panamá), Burica (Panamá-Costa Rica border), Osa and Nicoya (Costa Rica). Intermediate between the peninsular remnants and the isthmian backbone are lowlands that suggest a central valley.

Costa Rica.—In Costa Rica the highlands maintain the massiveness which marks the west Panamanian mountains. The intrusive Cordillera de Talamanca has substantial bulk above 4,500 ft. elevation. This largest and highest range in the country attains 12,533 ft. in Cerro Chirripó Grande which is the nonvolcanic summit of an ample crest zone where elevations exceed 8,000 ft. From the cordillera toward both coasts extend great steep-sided mountain buttresses. Two of these link with the Cordillera Brunquena, a range flanking the Pacific coastal plain, thus embracing the moderately high (1,000 to 3,000 ft.) basins of the General and Coto Brus rivers.

The Candelaria highland or Meseta Central is the 3,000 to 4,000 ft. high rolling upland which occupies the transverse gap between the Cordillera de Talamanca and the more northerly Cordillera Central and Cordillera Volcánica. This highland zone of good volcanic and alluvial soils, the core area of Costa Rica's economic, political and cultural life, is drained by the Reventazón and Grande de Tárcoles river systems. Respectively, the valleys afford routes by which Atlantic and Pacific coastal plains are reached.

The Cordillera Central is a nearly west-east trending volcanic pedestal from which rise the Poás (8,875 ft.), Barba (9,533 ft.), Irazú (11,260 ft.) and Turrialba (10,919 ft.) volcanoes. Contiguous and to the northwest of this file of massive peaks is the Cordillera Volcánica, a northwest-southeast trending range which is studded with several peaks that rise to between 4,500 and 6,200 ft. elevation.

Nicaragua.—An extension of the geology of the Costa Rican mountain arc and a continuation of the Cordillera Volcánica may be traced in the line of Nicaraguan coastal volcanoes which reaches the Gulf of Fonseca. This corridor of hills and volcanic peaks, the Cordillera de los Marrabios and Sierras de Managua, is separated from the older highlands of central Nicaragua by the structural depression which contains lakes Managua and Nicaragua (the latter about 110 mi. by 45 mi.) and the San Juan river.

The low trough that cuts diagonally across Nicaragua is the locus of most of the economic, cultural and political life of the country. Managua (the capital) and Granada are situated in the interlakes area, and the second city, León, is nearby but on the Pacific slope. The strategic value of the lowland corridor as a transisthmian route has been recognized for a long time. It was seriously considered for the interocean crossing before the Panama canal was built; it remains a possible alternate canal route. The formation of the lakes may have occurred with the Pleistocene growth of the line of volcanoes which began to form in Oligocene or Early Miocene time.

3. Lowlands.—Besides the structural trough of Nicaragua, the Central American lowlands are restricted to plains along both coasts and to the slightly elevated limestone plain of northern

Guatemala (Petén) and British Honduras. This limestone terrain, a southerly continuation of the Yucatán peninsula (Mexico), and the east coast plain of Honduras and Nicaragua are the most extensive lowland areas.

Petén and British Honduras.—In northern British Honduras and Petén, Mesozoic and Cenozoic rocks underlie the plains that rise gently from east to west. Inland from the Caribbean the limestones are warped into a subdued northeast to southwest trending series of ridges and troughs. The land which lies at 200–300 ft. elevation in the western part of the colony hardly exceeds 500 ft. in Petén, where the alignment of topographic features parallels that of the southerly mountains. Ill-defined lines of surface drainage, sinkholes and knobs are characteristic of this limestone (karst) topography.

Caribbean Lowlands.—The Caribbean lowlands are narrow corridors of alluvium-surfaced marine Pleistocene beds that lie between the mountains and the sea. As a rule the plains are less than 10 to 15 mi. wide, but they may exceed 50 mi. width between the Patuca (Honduras) and Escondido (Nicaragua) rivers. Although the inner margin of the plains may be elevated a few feet, the bulk of the lowlands is poorly drained. Meandering rivers, swamps and tidal lagoons are common; good harbours are lacking.

Broad fingers of lowland reach into the interior along structural furrows. The embayments into the steep-flanked northwestern highlands are numerous. The Polochic and Motagua valleys in Guatemala, and the Ulúa and Aguán valleys in Honduras, are especially important as communications corridors and farming areas. Banks and low cays are common along the shore. Only the Bay Islands (Islas de la Bahía), north of Honduras, have much relief (elevations to 700 and 1,100 ft.).

Pacific Lowlands.—The Pacific lowlands, which rarely exceed a 25 mi. breadth and are generally much narrower, lie behind a straight coast in Guatemala and El Salvador. To the southeast irregularities in the coast line are provided by the gulfs of Fonseca, Nicoya, Dulce, Chiriquí and Panamá, and by the hilly peninsulas of Nicoya, Osa and Azuero. Swamps and bars skirt much of the Pacific coast; there are few good harbour sites.

B. CLIMATE

By far the greater part of Central America has tropical climatic conditions. Cooler, temperate conditions are limited to the higher mountain and intermountain basin and plateau areas.

1. Temperatures.—Locally, throughout Central America, as in certain other parts of tropical Latin America, climates are usually classified into three simple vertical groups: *tierra caliente,* "hot land"; *tierra templada,* "temperate land"; and *tierra fría,* "cold land." This corresponds with and probably stems from the old division of the earth into torrid, temperate and frigid zones dating back to the ancient Greeks. It is difficult to fix any limits to these climates, which are altitudinally conditioned thermal zones. The *tierra caliente* is, of course, the lowest in elevation above sea level. Citing western Guatemala as a typical illustration, this is approximately from 26° C. (78.8° F.) mean annual temperature at sea level to 22° C. (71.6° F.) at 1,000 m. (about 3,281 ft.) above mean sea level. The *tierra templada* extends upward from this point to about 1,900 m. (6,234 ft.), where the annual temperature is normally about 17° C. (62.6° F.). Above that, in the upper mountains and valleys, is the *tierra fría,* culminating with about 5° C. (41° F.) at the summit of Tajumulco volcano (13,812 ft. or 4,211 m.), the highest point in Central America. Both toward the equator and on the eastern side of Central America's uplands climate zones are slightly higher. Any temperature limits can be set arbitrarily, but for world comparisons the Köppen tropical and mesothermal (*i.e.,* temperate) types (with the coldest months warmer and cooler, respectively, than 18° C. [64.4° F.]), are valid in Central America. The Köppen tropical-mesothermal isotherm (equal-temperature line) follows about the 1,450-m. (4,756-ft.) isohyps or contour line, which is just in the centre of the temperate zone of local usage.

2. Rainfall.—This has far greater seasonal variability than temperature, and is not taken into account in the above climate classification. It is, however, the basis for the seasonal distinctions, summer (*verano*) being the dry season, with its clear skies, warm sun and pleasant weather, and winter (*invierno*) being the more dismal rainy season, when cloudy skies actually may reduce daytime temperature maxima to points below those of *invierno.* It must be borne in mind that *verano* is climatologically winter, for the sun during that season (November through April) is higher south of the equator most of the time. Conversely, local winter is climatological summer, the rainy season (May through October), with maxima in June and September. This seasonal rainfall regime is characteristic of the Pacific lowlands which have the Köppen tropical savanna climate. Highland regions nearer the Pacific coast, as in southwestern Guatemala, El Salvador, Honduras and Nicaragua, have the cooler phase of the summer-rain, winter-dry type. Toward the southeast the dry season is shorter, as the total annual rainfall for the region as a whole tends to increase. San José, Costa Rica, has five months of dry season (Dec.–April), and Balboa, Canal Zone, has only three months (Jan. to March), as compared with the six dry months of similarly situated stations in northwestern Central America.

The Pacific coast is in general drier than opposite points on the Caribbean. The greater rainfall of the Caribbean coast can be seen in comparing the annual rainfall of Colón, at the north end of the Panama canal, more than 127 in., with Balboa Heights, at the south end of the Panama canal about 40 mi. away, with 69 in. Colón has two slightly drier months in winter (Feb.–March). East coastal Nicaragua and Costa Rica are especially rainy, Greytown (San Juan del Norte) having recorded an annual average of more than 260 in. Similarly, highlands toward the Caribbean side have rainfall distributed more evenly through the year, as seen as far inland as the Alta Verapaz (Cobán area) of Guatemala. The importance of rainfall concentrated along windward slopes may be observed in the southern (Pacific) Guatemala coffee belt. The area of superior production is favoured by a fairly long season of orographic rain (dry season reduced to Dec.–March) and cool highland conditions. Annual precipitation there ranges between 400 and 550 cm. (160 and 220 in.), according to exposure, in altitudes between 700 and 1,400 m. (about 2,300 and 4,600 ft.). Deep valleys are generally much drier than adjacent highland areas. This is evident not only in the east-west structural valleys of Guatemala, where rain shadow conditions exist with respect to both northerly and southerly rain-bearing winds, but also in such north-south troughs as the Honduras depression.

3. Weather.—Diurnal ranges of temperature generally exceed annual ranges in Central America, as elsewhere in the tropics. In highland Guatemala, for example, daily variations of 15° C. (27° F.) are common in the dry season, while the annual range is less than 5° C. (9° F.). The prevailing winds in most of the region are northeasterly (between east-northeast and north-northeast), characteristic of the northern hemisphere trade winds, especially strong in the winter half year. Northers, strong, gusty north winds which may blow for several days, occur in northern Central America, into El Salvador; they are anticyclonic fronts of cold polar air masses that roll across North America in winter. They bring exceedingly clear skies, even in the afternoon. Because of the narrowness and dominantly marine nature of the isthmus of Central America, land-and-sea breezes are well developed. There in the tropics, daytime heating of land surfaces, especially in the mountains, is intense, creating low pressure and onshore winds. These oppose the trades and, in the dry months of the Pacific region, result only in cloudiness from midmorning to shortly after dark. In the rainy season, when the sun is nearly overhead at noon, or is even to the north, the trades are weakened and southerly winds with greater intensity bring rain. Hail is rare, usually coming in March and April in the high northern mountains. At night, as the land cools, especially in the highlands, the land breeze sets in. Over the southern coast the sky may be swept clear before midnight by a trade wind-strengthened land breeze. At the height of the rainy season there may occur cloudy nights and continuous rain night and day for several days. Mountain fog above 5,000 or 6,000 ft. is common at such times, as it is in afternoons throughout most of the year. On the north coast, as in Honduras, the northerly sea breeze joins forces with the northeast

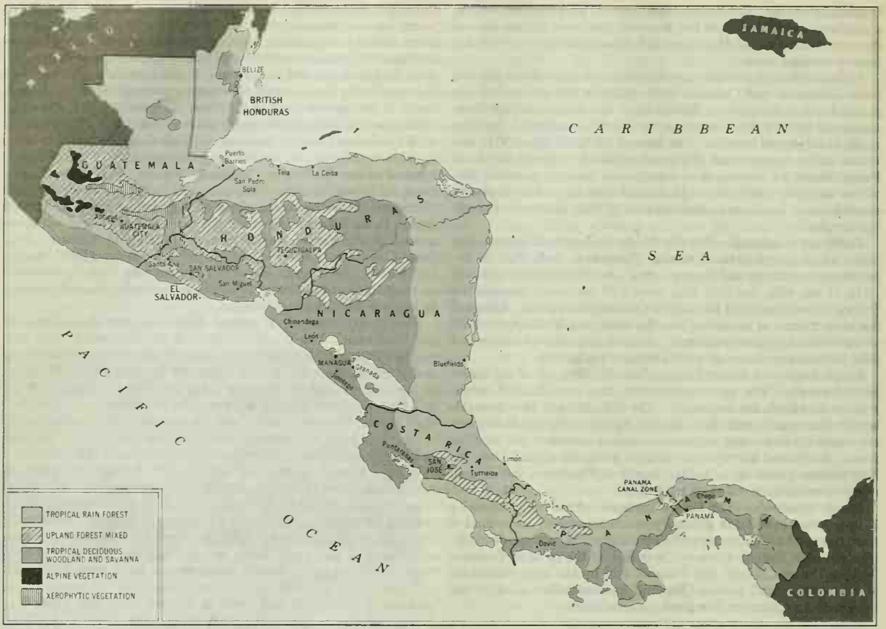

JAMAICA
BELIZE
BRITISH HONDURAS
CARIBBEAN
SEA
Puerto Barrios
GUATEMALA
Tela
La Ceiba
San Pedro Sula
HONDURAS
Tegucigalpa
Antigua
Guatemala City
Santa Ana
San Salvador
San Miguel
EL SALVADOR
NICARAGUA
Chinandega
León
Managua
Granada
Jinotepe
Bluefields
PACIFIC
OCEAN
COSTA RICA
Puntarenas
San José
Turrialba
Limón
PANAMA CANAL ZONE
Colón
PANAMÁ
PANAMA
David
COLOMBIA
TROPICAL RAIN FOREST
UPLAND FOREST MIXED
TROPICAL DECIDUOUS WOODLAND AND SAVANNA
ALPINE VEGETATION
XEROPHYTIC VEGETATION

FIG. 2.—NATURAL VEGETATION OF CENTRAL AMERICA

trades, which are strongest in winter, so that there is actually a winter maximum of rainfall in certain sections (La Ceiba to Puerto Castilla, for example). Rain throughout most of Central America comes usually in the form of intense tropical thunderstorms, from late morning to evening in normal rainy-season weather or at any time of day during periods of *temporales*, or stormy wet spells. At such times relative humidity is constantly high. Hurricanes occasionally strike the northern Caribbean coast, from late July to early October. Belize especially has suffered the effects of these outer-tropical storms, and great destruction has been caused by them in the banana area around Puerto Barrios, Guat., but away from these coasts the effects of such storms are slight.

C. VEGETATION

The flora of Central America is exceptionally diversified, there being thousands of species of many types of plants. This variety is an expression of such factors as the transitional situation between South American and North American phytogeographic regions; areal differences in temperature and precipitation; and local variation in soil (edaphic) conditions. South American, austral flora has extended northward across the Central American land bridge into Mexico. North American, boreal flora occurs from Guatemala to the Nicaraguan depression, and some of its elements are found in Costa Rica. Within this transitional area plant distribution patterns are due to such edaphic factors as soil depth, porosity, water table level and exposure to salinity.

Certain broad groupings may be made with the numerous and infinitely complex plant communities that occur in Central America; however, the boundaries between designated vegetation regions seldom are clearly marked. The heavy tropical rain forest is more or less coincident with the hot lowlands, *tierra caliente*, of the Caribbean. A deciduous forest or a scrub forest with grass ground cover occurs along much of the Pacific *tierra caliente*, where precipitation is moderate and seasonal. Bordering the lowlands along both coasts is a ribbon of mangrove swamp and strand vegetation. With elevation the hot country plants are gradually replaced by oak and pine and other mid-latitude (North American) or highland (South American) plants. Thus, the rain forest of the northeast and the deciduous woodland of the southwest merge into the mixed highland forests of conifers, oak and other hardwoods. The *tierra templada* vegetation is supplanted at higher elevations by coniferous forests and alpine cover. Everywhere, from shore line to upland crests, man has been a significant factor in altering the vegetation. Fire, the plow and livestock have been the chief instruments causing change.

1. Tropical Rain Forest.—The most extensive broad vegetation type is the tropical rain forest, found largely along the Caribbean coastal plain and flanking highland slopes to about 2,500 or 3,000 ft., but also occurring on the lowlands and adjacent mountains in southern Costa Rica and, to a lesser extent, in Panamá. The forest contains a bewildering array of plant species. Generally the tree species are scattered, rather than occurring in pure stands; and many of these broadleaf evergreens become forest giants. Viewed from above, the interlocking crowns of the tall trees form a billowing sombre-green expanse of foliage. Common among the slender trunked canopy makers are the moraceous (*Castilla, Ficus, Brosimum*), the meliaceous (*Swietenia, Cedrela*), sapotaceous (*Manilkara, Chrysophyllum*), and lauraceous genera, *Ceiba*, and many other species. An understory of medium-sized trees (like *Carica, Inga, Pithecolobium, Guarea*) and palms occurs. Treelike species of ferns are abundant in some areas. Commoner is the occurrence of a thin ground cover of shade-tolerant herbaceous plants and shrubs (as *Piper, Siparuna*), some broad-leafed grasses and monocotyledonous plants (like *Heliconia, Calathea, Costus*). Serpentine lianas and slender hanging vines, and such epiphytes as orchids and bromeliads, add to the luxuriance of the forest. In their external aspect the forests are similar to other tropical rain forests of the world, as in the Amazon and Congo valleys and in parts of the East Indies.

Fresh water, open or wooded swamps and marshes are extensive. Appearing in them are grasses and sedges and a number of such aquatic species as *Sagittaria, Pontederia, Pistia* and *Thalia*.

Along the shore, around brackish lagoons, and inland along sluggish streams on both the Caribbean and Pacific coasts rise thickets of mangrove (*Rhizophora mangle;* also *Laguncularia* and *Avicennia*) and other salt-tolerant plants. The mangrove swamps also extend along the coastal margins of plains where deciduous forests predominate.

2. Tropical Deciduous Woodland and Savanna.—Second most extensive among the generalized vegetation regions of Central America is the deciduous woodland and savanna that cloaks most of the Pacific lowlands and slopes to about 2,500 or 3,000 ft., and which also appears in the northern part of British Honduras. The plants are more or less dormant for half the year, during the winter dry season (generally November through April). When the vegetation bursts from the dormant stage after the first rains, a dreary gray and brown open woodland is eclipsed with lush greens.

The vegetation tends to form an open parkland in which the deciduous trees are interspersed with innumerable tall savanna grasses, sedges and low herbaceous plants. Near water courses, gallery forests develop. In general, the trees of the Pacific woodland are smaller than those of the Caribbean lowlands, but tall trees with great spreading crowns are present. Among the larger trees are the *Hura, Enterolobium cyclocarpum, Ceiba pentandra, Casia grandis, Ficus* and *Bombax;* representative smaller trees are the *Coccolobis, Hymenaea, Cochlospermum, Chlorophora* and *Guazuma;* various palms appear as well.

In British Honduras a coniferous and broadleaf deciduous open woodland occurs. The pine (*Pinus caribaea*) and associated broadleaf trees and palms extend over many square miles of deeply weathered coarse soils in the eastern and northern lowlands and on the northern flank of the Maya mountains. Similar woodlands, and characteristic grass and sedge ground cover, may occupy the deeply weathered alluvia of the inner lowlands in eastern Honduras and northeastern Nicaragua.

3. Xerophytic Vegetation.—Within the highlands of Guatemala, Honduras and El Salvador there are areas where prevailing semiarid conditions have resulted in the development of vegetation that is predominantly thornbush, cactus and scrubby trees. The deep middle portion of the Rio Negro or Chixoy valley (Guatemala), and the upper Aguán valley (Honduras) are notable areas of xerophytic cover.

4. Mixed Upland Forests.—Through the zone 2,500–5,000 ft. above sea level there occurs a transition upward from tropical forest and woodlands to vegetation that is more or less temperate in appearance and origin. The belt is not sharply limited vertically, and there are differences of flora between Caribbean and Pacific slopes. Furthermore, ravines and ridges in the path of the humid trade winds are densely wooded, while on leeward slopes and in sheltered valleys and basins there exists an open woodland. Some plants are unique to the belt, but floras of lower and of higher elevations are present. Very large trees, chiefly oaks (*Quercus*), occur but commonly the forest members are not as large as trees in lower elevations. Epiphytes are numerous.

Although oaks and species of *Lauraceae, Euphorbiaceae* and *Melastomaceae* form the larger part of the open parklike forest, there are several thousand square miles in Honduras, Nicaragua and Guatemala where pines, chiefly *Pinus oocarpa,* and various broadleaf species produce the open woodland. In either case, ground cover is provided by various species of flowering plants and short grasses.

Mountain areas of 4,500 ft. or greater elevation, commonly enveloped in clouds by day and drenched with rain at night, develop a dense cloud forest composed of moss, fern and other epiphyte-swathed broadleaf trees of varying size. Vegetation and soil, alike, are saturated with moisture. Dominant over large areas of the cold and wet highlands are oaks, but the flora may be exceedingly diverse over short distances.

Much of the mixed hardwood and coniferous forest has been cleared for cultivation or seared by pastoralists, charcoal gatherers and lumbermen. The pressure on the forests has been greatest in Guatemala, Costa Rica and El Salvador. As in Honduras and Nicaragua, cleared land has been planted to maize and other subsistence crops and to coffee, or it has developed into volunteer or planted grazing land.

5. Alpine Vegetation.—In the highest mountain areas coarse, giant bunch grass, somewhat larger than the common types of the Andean highlands of northern South America, is common. In highland Guatemala it is widely used for roof thatch. Cypress trees, junipers and pines grow on the higher ridges and summits, often in almost pure stands at elevations above 10,000 ft. There also, where summits are smooth and rolling as on the high Cuchumatanes, alpine meadows of short grasses and low flowering plants of many colours are typical. Most of the plants are boreal. In the moorlike islands of alpine vegetation that appear above 9,800 ft. in Costa Rica and western Panamá the flora is similar to that of the *páramo* in the northern Andes.

D. Animal Life

The animal life of Central America reflects a transitional situation between South American, Neotropical, and North American, Nearctic faunas. Although the pattern of transition is complex, the fauna is more Neotropical than Nearctic in all classes of vertebrates except the reptiles. Presumably the strength of the South American representation reflects the suitability of the Central American environment to tropical fauna. The fractions of the southern and northern faunas that interlap become larger, and the zones of overlap greater, with the higher vertebrate forms. Among strictly fresh-water fishes the overlapping that occurs, northward from Guatemala, involves a very few representatives at the family level. The overlap of more salt-tolerant families extends from Lake Nicaragua northward. Transition among the amphibians, largely at the family level, involves relatively more of the faunas; there are families that extend beyond Central America (from the south: caecilians, leptodactylids, brevicipitids, hylids; from the north: plethodontid salamanders, ranids, bufonids). The reptile fauna has a complex distributional pattern that includes northern, southern and some endemics or relict genera and families of reptiles. The bird fauna includes distinct transitional genera and species, migrant and nesting Nearctic groups, and many Neotropical groups. The distribution patterns of many northern and southern genera, species and families extend beyond the limits of Central America, a situation reflecting the birds' relatively great powers of dispersal. An overlapping of northern and southern mammals involves a number of elements that extend well south or north of Central America.

II. NATURAL RESOURCES

A. Water Resources

The Caribbean slope of Central America, which receives abundant precipitation the year around, has plentiful water resources. The Pacific side of Central America is less well endowed, but the supply usually is adequate for existing agricultural and domestic requirements. Irrigation is employed on the Pacific banana plantations and, to a lesser degree, in highland farming areas; pump and gravity irrigation may be resorted to locally in such rain-shadow areas of Caribbean drainage as the middle Motagua valley.

Hydraulic resources are substantial but barely tapped. Hydroelectric development is most advanced in Costa Rica and El Salvador, but only the latter has readily available power. Its fortunate situation is an outgrowth of completion of the Lempa river power plant. In the other countries thermal electric power is more important, but there is a general shortage of electricity. The installation of generating facilities is greatest near the capitals, although the vicinity of San Pedro Sula, Honduras, is well served.

Except for the interoceanic canal across Panamá, the Central American waterways are of little value in transportation. Lakes Managua, Nicaragua and Izabal, and the lower stretches of rivers on both coasts are used by small powered craft and dugouts.

B. Soils

The soils of the humid Caribbean lowlands and Panamá's Pacific coast tend to be of superficial fertility, with shallow humus leaf mold underlain by leached and sometimes cemented subsoils. The best land for farming is found to be the natural levee strips of silt loam and light clay loam. Such land is reasonably fertile and fair to well drained. Once abandoned, the gardens or fields are soon swallowed in a tangle of second growth herbs, vines, shrubs and small trees, among them *Cecropia, Ochroma* and *Trema*.

The better farming areas within the deciduous woodland and savanna region of the Pacific lowlands are developed on soils recently rejuvenated by a thin layering of volcanic ash, or weathered from older volcanic materials of greater depth. Eastern El Salvador's cotton lands and the country's densely populated west-central coffee and subsistence farming areas (upland) are of weathered volcanic materials. Nicaragua's good soils are volcanic too, as are the transported soils of the Pacific coastal plain and adjacent mountain slopes of Guatemala. The northwestern part of the Guatemalan plain, especially near the volcanoes, has areas of excellent and deep silt loams.

The pine forests of the northwestern uplands may be associated with infertile reddish-brown or black clay soils derived from granitic or acidic metamorphosed sedimentary and volcanic rocks. Adjacent broad-leafed forests are associated with moderately fertile soils weathered from the old-rock parent materials. Some of the finest soils of Central America have developed in association with the magnificent primeval forests of the Costa Rican highlands. In the cordilleras Volcánica, Central and (to a lesser extent) Talamanca volcanic parent materials have weathered into friable brown to light brown clay loams. The densely populated Meseta Central possesses deep, excellent dark gray-brown to dark brown silt loams. Elsewhere in Central America the upland volcanic soils can be fairly good too. However, soil erosion is a widespread problem.

C. Minerals

Although Central America's mineral endowment is imperfectly known, the resource potential is thought to be relatively modest. Gold, silver, zinc, lead and very small amounts of other nonferrous metals are produced. The rare metals have been mined since the pre-Columbian (placer gold) and Spanish periods. In recent years the ore concentrates, which are exported for refining, have contributed a small share of the value of Central American foreign trade. However, for many years gold has been an important exchange earner in Nicaragua; the metal, generally found in quartz ores, is produced at Siuna, Pis Pis and a half dozen other mines. El Salvador, Honduras and Costa Rica also mine some placer and vein gold. Silver, which may be recovered from gold ores, lead and zinc ores, or which may be the principal product mined, is produced in Honduras; and to a lesser degree El Salvador, Nicaragua and Guatemala. Guatemala's mines, chiefly near Cobán, yield most of Central America's limited zinc and lead, but neighbouring El Salvador and Honduras have some production.

No commercial deposits of the mineral fuels are known; however, since World War II foreign capital has undertaken petroleum exploration in the lowlands adjacent to the Caribbean. The negligible results are a disappointment to the republics, which spend substantial sums on imported petroleum products. Mineral construction and ceramic materials are widely used but capital involvement is modest. Bricks, tiles and pottery are made. Cement is manufactured in Guatemala (Guatemala City), Nicaragua (south of Managua) and El Salvador (Acajutla).

D. Land Use

1. Agriculture.—Subsistence farming is the predominant activity of the Central American people, however commercial agriculture is of major significance to national economies. The noncommercial peasant farming is developed around crops and techniques which are indigenous to the new world; maize, beans, squash, some tropical root crops (yucca or sweet manioc and sweet potato) and tree fruits are tended in small fields or gardens. The maize acreage is the greatest of all crops. Important staples grown almost everywhere (up to about 5,000 ft.) are bananas and plantains.

Export-oriented commercial agriculture is based largely on plantation techniques and the old world crops, coffee and bananas. Commonly the coffee and banana properties are large, but there are many districts where small operators, who are essentially subsistence farmers, also produce export commodities. The lesser crops may enter domestic as well as foreign commerce and include cotton, cacao, abacá, henequen, essential and cooking oils. Crops which are raised on a large scale and primarily for the domestic markets include sugar cane and rice. Tobacco and produce, and wheat and potatoes (in the highlands) are farmed on a small scale. The rearing of beef cattle, an important and traditional branch of husbandry, is in the hands of large landowners.

With the exception of El Salvador and Panamá, the Central American countries generally are able to produce their basic food requirements. Nevertheless, wheat, dairy products, cooking oils and various preserved foodstuffs are imported.

Subsistence agriculture occurs throughout Central America. Commercial food crop production for the domestic market is best developed in the highlands or in the Pacific lowland areas of traditional settlement. These populated areas are served mainly by roads and railways. The rearing of beef cattle predominates in highlands and the Pacific lowlands where open forests and savannas and a drier climate prevail. Nevertheless, cattle may be numerous near the Caribbean, as in northern Honduras.

Coffee and bananas, which represent about four-fifths of Central America's exports, have different physical requirements for growth. The more important crop, coffee, is raised in the highlands. Superior growing conditions prevail in areas having elevations of 2,000 to 5,000 ft., volcanic soils and a distinct dry season. Major production occurs in districts on the Pacific slope of Guatemala and El Salvador, in the central plateau of Costa Rica and in the upland areas north and south of Lake Managua. Bananas for export are produced in the tropical lowlands of the Caribbean and Pacific sides of Central America. The Caribbean coastal areas of Guatemala, Honduras, Costa Rica and Panamá were areas of early 20th-century plantation development, but the more recent plantings have been made on great tracts near the Pacific. Generally speaking, rail and port facilities have been constructed to serve the banana and coffee industries. Other export crops of the lowlands

GEORGE HOLTON—PHOTO RESEARCHERS, INC

LOADING BURROS AT A BANANA PLANTATION, GUATEMALA include cotton, abacá, henequen, various vegetable oils, cacao and coconuts. Abacá, cacao, coconuts and African oil palm plantings are commoner in the humid Caribbean lowlands. Cotton, henequen, sesame and essential oils are more successful on the drier Pacific lowlands.

2. Forestry.—Central America possesses extensive timber resources, more than one-half of the territory of all countries except El Salvador being forested. The principal forest reserves cloak the mountains and skirting lowlands of the Caribbean slope, but the deciduous woodlands and the forests of the Pacific also constitute a source area for many products. Timber, cabinet and dyewood, gums (notably chicle) and resins, medicinal products and tannins are cut or gathered in Central America. Among the more important Caribbean lowland wood products historically are mahogany, Spanish cedar, lignum vitae and logwood. Exploitation has always been hampered by the heterogeneous nature of the tropical forests and the difficulty of penetration. However, where the rivers are navigable to small craft and rafts lumbering has occurred. By the mid-20th century pine from the forests of British Honduras, eastern Honduras and northeastern Nicaragua had supplanted the tropical hardwoods in the export trade. Plywood is manufactured in eastern Guatemala and northern Honduras. In general, the forest industry production methods and equipment are old. The activity, most important to British Honduras, Honduras, Nicaragua and Panamá, accounts for a small share of the value of regional foreign trade. In all areas, but most apparent in the Pacific lowlands, there has been considerable destruction of forests by charcoal producers, lumbermen, farmers and livestock raisers.

3. Industries.—Manufacturing in Central America is concerned with the processing of agricultural commodities for export and the production of consumer goods and construction materials for domestic use. The establishments that process for export include coffee mills, cotton gins, hard fibre mills, tanneries and sawmills. The industrial facilities which serve the small national markets usually manufacture foodstuffs, beverages, tobacco products, textiles, footwear and apparel, pharmaceuticals and chemicals. Industry is fostered by customs protection and other incentive legislation; transportation costs or the perishable nature of the product may also create an advantage for the local manufacturer. Factories are small.

Among the republics, industrialization probably is most advanced in densely populated El Salvador, and least developed in Honduras. San Pedro Sula vies with the capital, Tegucigalpa, for leadership in manufacturing. Elsewhere the capitals tend to be the chief industrial centres. British Honduras has little industry. (J. T.)

III. ANTHROPOLOGY

The great diversity in cultural and physical types in Central America stems from three basic factors: (1) the Indian cultures before the Spanish conquests were diverse; (2) the various indigenous groups reacted differently to conquest and colonization; (3) four centuries of culture contact, immigration and intermixture resulted in local differences in cultural and racial blending. Any single locality, therefore, may be occupied by several groups of different cultural and ethnic origins or degrees of blending.

A. Ethnology

Richard N. Adams (1956) proposed a classification of culture types based upon eight major traditions that entered into the Central American culture scheme. The three most important, in terms of their total contribution, are the Spanish-American, the Meso-American and the South American. The first is predominantly Spanish, the second is Indian or mixed Indian-Spanish and the third is Indian, but of a different origin from the second. Other traditions, derived from Africa, the Antilles, China, Europe-North America and India, are represented by such groups as the Black Carib of Honduras, the widely scattered Antillean Negroes of Panamá and offshore islands of Honduras, and various European and North American urban dwellers.

1. Spanish-American Tradition.—Local varieties of this tradition have been referred to as creole or Ladino. Adams distinguishes three regional variants, each having developed in relative isolation under the influence of different aboriginal populations. These are (1) the Europeanized Ladinos of Guatemala, El Salvador, Honduras, Nicaragua and the Guanacaste peninsula of Costa Rica; (2) the predominantly white peoples of the Meseta Central (highlands) of Costa Rica; and (3) the Panamanian interior dwellers. There is a general cultural similarity among the three stemming from their common Spanish origins and speech. Each includes urban classes, rural labourers and peasantry.

A stable peasantry is found dispersed throughout Central America, comprising between 40% and 90% of the national agricultural populations. Farms vary greatly in size, and land holdings may be privately owned, rented or sharecropped. Many Spanish-American peasants practise a subsistence agriculture much like that of their Indian neighbours, although with more stress on cash crops and participation in a regional market economy. They also differ from the Indians in their greater use of advanced cultivation equipment and methods, such as steel plows, irrigation and fertilization. Many employ Indians or landless peasants as seasonal labour. There is considerable local specialization in such crafts as pottery, weaving and basketry, or in such industries as sugar production, tilemaking, clothing manufacture, tanning, candlemaking and carpentry. These specialties usually take the form of home industries, although small-scale factories are common in highland Guatemala. Small town dwellers, in addition to agricultural activities, very commonly engage in small-scale commerce. They are the usual proprietors of small stores, taverns and pharmacies.

The family throughout Central America is the basic unit of social organization. Family organization is especially stable where members are a landowning group. Regionally, nearly one-half of the families may originate in common-law marriage, even where civil or church weddings are the ideal. The *compadrazgo* (a formal relationship between the godfather and the father of a child) is found everywhere, and godparents are sought for baptism, marriage and confirmation. This *compadre* relationship is one of great mutual respect. It is possible in most communities to distinguish at least two social classes on the basis of wealth, land ownership or the age and importance of one's family. The names of these classes vary locally—*e.g., la primera* or *la sociedad* for upper classes and *los pobres, la segunda* or *gente humilde* for lower classes. There is little social intercourse or intermarriage between classes.

Spanish-Americans are predominantly Roman Catholic. Orthodox practice with regard to baptism, confirmation, marriage and funeral customs may be affected, however, according to whether or not a priest is readily available. Many small communities are visited by a priest only three or four times annually. The following religious customs are observed widely: the novena, or nine nights of prayer, following a death; prayer in the home to the house saint; pilgrimages to shrines, *e.g.*, to Esquipulas in Guatemala; and observance of a child's death with a *fiesta*. Holy Week, All Saints day and Christmas are important celebrations, but the titular *fiesta* to the village patron saint is everywhere the principal annual religious event. Financing and organizing this event is frequently done by a permanent society such as a *cofradia* ("religious brotherhood") that is devoted to the town saint. *Fiestas* may include Masses, processions and novenas, as well as dancing, fireworks, games and sports events.

Spanish-American peasants share with their Indian neighbours many folk beliefs concerning sickness and curing. This is especially true in areas isolated from modern medical aid. These notions include a belief in witchcraft, *mal de ojo* ("evil eye"), *susto* (loss of soul through fright) and *hijillo* (an emanation of human corpses that causes sickness). There are well-defined cures for many of these, and the *curandero* ("lay curer") may specialize in one or more of them, using herbs, medicines and massage, or magical techniques.

2. Meso-American Tradition.—This complex of historically related cultures, primarily Maya Indian in origin, in preconquest times extended over much of Chiapas, the Yucatán peninsula, Guatemala, British Honduras and the western parts of Honduras and El Salvador. Adams subdivided this tradition into three components, according to the degree of assimilation to Spanish-American cultures. The least modified groups he calls "traditional Indians." The "modified Indians" represent an intermediate stage and the most thoroughly assimilated are the "Ladinoized Indians."

PETER SUSCHITZKY—PIX FROM PUBLIX

INDIAN FUNERAL PROCESSION AT THE BURIAL OF A CHILD IN A GUATEMALAN VILLAGE. MUCH OF MESO-AMERICAN RELIGION IS A BLEND OF ROMAN CATHOLICISM AND PAGANISM

Traditional Indians speak one or more native languages or dialects, but not Spanish, and they preserve their distinctive local costumes. They are best represented by such conservative communities in highland Guatemala as Todos los Santos, Chichicastenango and the villages surrounding Lake Atitlán. Each of these communities centres in a small political unit called a *municipio*. The *municipio* is, in general, culturally isolated from neighbouring groups, and the occupants of each are distinguishable by their colourful costumes, dialect and perhaps economic specialty. These Indians practise a family-based subsistence economy, growing maize, beans and squash with the use of age-old techniques. Almost the only concession to modern technology is the use of the steel hoe, machete, axe and rarely the ancient wooden plow. The lake villages often specialize in such European introductions as onions, beets, cabbages and carrots. But the traditional attitude toward maize as sacred is widely preserved. All of these Indians participate to some degree in a regional market economy, selling local specialties such as pottery, blankets, woodcraft products or vegetables to acquire the cash needed for small purchases. Typically, local affairs are regulated by a combined political-religious hierarchy, whose officials hold office alternately in the church and in civil administration. These two functions are regarded by the Indian as inseparable. Indian religion is an interesting combination of Roman Catholic and Maya elements. Church festivals are frequently the occasion for rites directed to ancient images; but the Indian sees no conflict, and regards himself as a devout Catholic. Aboriginal attitudes toward disease and witchcraft are especially prominent, but even these areas are influenced by Spanish-American folk beliefs. The Indians have wholeheartedly adopted the cult of the saints, and the annual celebration of the patron saint's day is the outstanding event in each village. Indians tend to be weak in the observances of orthodox Catholicism, and church weddings, confirmation and communion are the exception rather than the rule. The *compadrazgo* system is strong, as it is among Spanish-Americans. Indians frequently seek out Ladinos to act as *compadres*.

Those Meso-Americans classified as modified Indian and Ladinoized Indian represent further degrees of assimilation to the Spanish-American tradition. Modified Indians are bilingual, speaking Spanish as well as an Indian tongue, and the men have given up the distinctive costume of the community. Communities retain certain features of Indian social organization, but communication with outsiders is more frequent, and older religious elements tend to pass out of existence.

The Ladinoized Indian speaks only Spanish, and may be almost indistinguishable from his Spanish-American neighbour. Some regard themselves as Indians, others not. Groups representing these extremes are found scattered throughout Guatemala, as well as in parts of Honduras and Nicaragua, often living in close proximity to traditional Indian communities.

3. South American Tradition.—Indians in this category are distributed from Honduras and El Salvador to the Colombian border of Panamá. Contemporary groups are survivors of aboriginal populations that were generally of a less developed cultural level than the Meso-Americans. They stem from various groups, some of which were culturally unrelated, and there is no simple way of classifying them on the basis of historical relationships. Adams recognizes several regional subtraditions, but the resemblances within each are largely the result of common environment and postconquest developments. These regional traditions are: (1) Talamanca—including small enclaves of Bribri, Boruca, Cabecar and Terraba in Costa Rica; (2) Jicaque—the Torrupan in central Honduras and the Yoro Jicaque of Yoro, Honduras; (3) Atlantic Lowland—the Paya of Honduras, the Mosquito and Sumo of Honduras and Nicaragua, the Rama of Rama Cay, Nic., and a very few Guatuso in northern Costa Rica; (4) Matagalpa—a few restricted groups in Matagalpa, Nic.; (5) Guaymí—a series of communities in Bocas del Toro and Chiriquí, Pan.; (6) Cuna—comprising the Cuna Indians of the Atlantic coast and San Blas Islands of Panamá; and (7) Choco—scattered groups in central Darién, Pan.

Because of the extensive displacement of peoples following the conquest, few of these groups can be regarded as direct descendants of aboriginal tribes. Some may comprise remnants of several earlier tribes. Nearly all have undergone serious deterioration of their former cultural patterns, and few can be regarded as traditional Indians (*see* above). Often the Indian group is so nearly like the neighbouring Spanish-American in physical type and culture that its definition as Indian is purely a social matter.

Few of these groups have been the subject of study by anthropologists, and little is known of general cultural similarities. In most cases the family is an independent subsistence unit, and practises a slash-and-burn type of agriculture, using primitive tools and techniques. They plant a wide variety of crops of both American and European origin—maize, cassava, yams, rice, sugar cane and many more. Nearly all families keep pigs and chickens, but larger animals are scarce. Hunting and fishing, employing the gun, bow and arrow, spear or blowgun, vary locally in economic importance. Dugout canoes are widely used for fishing and transportation.

The family is usually monogamous, but a few groups, such as the Guaymí, Bribri and Cuna practise a limited polygyny. Social groups intermediate between the family and the community, such as clans or lineages, have been reported for the Guaymí, Bribri and Choco. Many communities enjoy a measure of political autonomy within a national political structure.

In their religious organization the Indians of Honduras, El Salvador and Nicaragua resemble the traditional and modified Indians of the Meso-American area. The Sumo and Mosquito Indians have been exposed to Protestant missionary activities, but still retain many aboriginal religious elements. The Jicaque of Montaña del Flor, Honduras, and the Guaymí, Cuna and Choco have been influenced by Roman Catholicism, but have considerably modified borrowed beliefs. The Christian God, for example, may be interwoven into aboriginal myths. Ancient shamanistic practices are also common, but among all groups the aboriginal belief systems seem to be deteriorating.

B. LANGUAGE

Few regions of comparable size can match the linguistic diversity of Central America. Over 100 Indian languages and many more dialects are spoken. Classifications are highly tentative, since modern studies of single languages are scarce. According to Norman A. McQuown, who has modified an earlier classification by J. Alden Mason, 5 of the 17 major language families found in Latin America are represented in Central America. The two dominant families, in terms of area covered and number of speakers, are the Macro-Penutian and the Macro-Chibchan.

Macro-Penutian, with affiliates extending far northward into the United States, is represented in Central America by several subfamilies, or stocks. The Mayan stock is the largest in total number of speakers, and includes the Mame, Chol, Lacandon, Itza, Jacalteco, Chuj, Kanjobal, Aguacateco, Ixil, Kekchi, Quiche, Cakchiquel and Pokomam of Guatemala; the Cholti and Chorti of Guatemala and Honduras; and the Achi and Poton of El Salvador. The only other Macro-Penutian stock represented in Central America is the Uto-Aztecan, which includes scattered small enclaves such as the Pipil in Guatemala, El Salvador and Honduras, the Alaguilac in eastern Guatemala, the Nahuatlate in the northwest of Nicaragua, the Nicarao of western Nicaragua, the Bagaz and Desaguadero of Costa Rica and Sigua of western Panamá.

Macro-Chibchan, which is distributed widely in northwestern South America, is the dominant language family in the southern part of Central America (*see* South American Languages). The major stocks are (1) the Misumalpan, including the Mosquitoan and Sumoan languages of the Atlantic lowlands of Honduras and Nicaragua, and possibly the Matagalpan of western Honduras; and (2) the Chibchan, including the Western Chibchan languages of Costa Rica, the Pacific Chibchan languages of Panamá (Move, Murire, Valiente) and the Eastern Chibchan of southern Nicaragua.

Of the remaining families, the Macro-Oto-Manguean is sparsely represented by the Mazateco of the Petén, Guat., the Choluteca in western Honduras and scattered groups along the Pacific coast of Nicaragua and Costa Rica. Hokan-Siouan languages are even fewer—the Maribichicoa in El Salvador and the Subtiaba in Nicaragua. Cariban is confined to perhaps a single language, the Paparo of eastern Panamá. A broad band of unclassified or poorly classified languages extends across Honduras and Costa Rica, and includes the Paya, Lenca, Xinca and Jicaque. Some linguists believe, however, that these four may be affiliated with the Macro-Penutian languages. Numerous widely scattered and nearly extinct languages also remain unclassified.

The northern part of Central America, then, is linguistically part of the North American continent, whereas the southern part is linked with South America. The dividing line appears to run somewhat north of the Honduras-Nicaraguan boundary line, thereby including parts of El Salvador in the Chibchan area. It has been suggested that some of the unclassified (possibly Macro-Penutian) languages along this border entered the area very early, with only scattered groups remaining. Somewhat later intrusives included the Mayan and some Uto-Aztecan languages. The main Uto-Aztecan entry, however, probably corresponded with the late movement of Nahuatl tribes, ultimately extending as far south as Costa Rica. There was evidently some northward movement of South American languages at the time of the conquest.

C. Physical Anthropology

The wide range of physical types in Central America is the product of four centuries of admixture between aboriginal populations and postconquest immigrants. Of the latter the Spanish Caucasoid types are the dominant element, with Negroes and mixed Indian-Negro (Black Carib) rating second. Small groups, which have mixed little with native populations, include non-Spanish Europeans, Chinese and near eastern peoples. The last-named may be known locally as *Turcos*, or *Árabes*.

The dominant Indian-Spanish physical component ranges from nearly unmixed Indian through every degree of blending to typical Spanish types. The dominance of one element over the other in any one locality stems from the same historical factors discussed above (see *Ethnology*). The Meseta Central, which is culturally Spanish-American, is predominantly Caucasoid. Guatemala, El Salvador and Honduras show the highest proportion of Indian admixture.

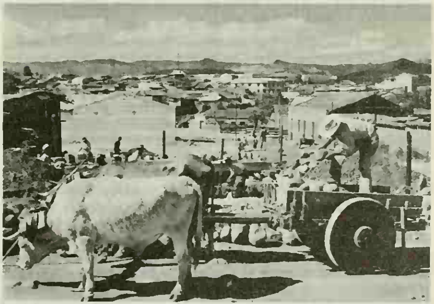
It is virtually impossible, however, to state with certainty the proportion of Indians to non-Indians in any Central American country. National census figures are not reliable guides because such terms as Indian, Ladino or mestizo have social and cultural as well as biological significance. Many individuals classified as Indians are physically indistinguishable from Ladinos.

Terms such as zambo, mulatto or *chombo* reflect a similarly confused situation for areas of Negro admixture. Many gradations of colour receive social recognition locally, and the significance of the term Negro is not everywhere the same. The highest known percentages of Negro admixture are to be found in Panamá and Honduras.

The Maya Indians of Meso-America represent a fairly distinctive physical type. They are described as short—5 ft. to 5 ft. 4 in. for the men, and somewhat shorter for the women. The body build is slight, with medium musculature, although leg and neck muscles may be overdeveloped from carrying heavy burdens. Head hair is straight and black, baldness is rare, and body hair is sparse. The forehead is low, and cheekbones high and broad. A slight epicanthic fold gives the eyes a Mongoloid appearance. In profile the rather striking Maya Indian type closely resembles the ancient Mayas as represented in painting and sculpture—sloping forehead and chin, long, convex nose and full lips, with the lower lip drooping slightly. Skin colour varies from light to dark brown with a reddish tinge.

The few existing blood group studies show that Central American Indians share with most North and South American Indians the high frequencies of blood types O and M.

Outside the Meso-American area the Indians appear to be somewhat less uniform in physical type, attesting perhaps to their highly diverse origins. Existing descriptions vary considerably in designating skin colour, hair form and stature. Skin colour is most commonly described as dark brown. Studies of the Mosquito, Sumo, Paya and Cuna list statures ranging from just under 5 ft. to 5 ft. 2 in., apparently somewhat less than the averages for Maya Indians. Hair is usually black and may be straight or wavy. Body build is generally heavier than among Mayas. Lips may be full, but not thick. The Mongoloid eye fold and sacral spot (a temporary bluish spot at the base of the spine in infants) are widely reported.



EWING GALLOWAY

CONSTRUCTION WORKERS UNLOADING AN OXCART IN TEGUCIGALPA, HONDURAS

See Indian, Latin-American; American Aboriginal Languages; Central and North American Languages; and articles on the individual countries.

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IV. HISTORY

The Mayas, one of the most highly developed Indian civilizations, flourished in Central America for centuries before the arrival of the Spaniards, who first sighted the area probably in 1501, and who were in the Panamá region constantly after 1509. The remainder of Central America was overrun in the early 1520s from Panamá and Mexico.

All Central America, except Panamá, was included in the captaincy general of Guatemala, a part of the viceroyalty of Nueva España, with its capital in Mexico City. Considerable gold was found during the years immediately following the conquest, but the settlers of present-day Guatemala, Honduras, Nicaragua and El Salvador soon turned to agriculture based upon Indian labour. In Costa Rica the standard pattern became independent smaller farmers of European origins who worked family plots. Throughout the colonial period Panamá was important as the link between the mineral-rich viceroyalty of Peru (Nueva Andalucía) and Spain.

PHILIP GENDREAU

PORTERS ON WAY TO MARKET WITH POTTERY AND OTHER WARES WAITING TO BOARD BOAT ON LAKE ATITLAN, GUATEMALA

The captaincy general of Guatemala won its independence from Spain in 1821, without resort to costly military action. The short-lived Mexican empire of Agustín de Iturbide (*q.v.*) assumed jurisdiction over Central America for several months in 1822–23. Following the downfall of Iturbide, a Central American confederation was formed. Separatism, old disputes and conflicting political theories led to the dissolution of the confederation in 1839, and the five constituent states of Guatemala, El Salvador, Nicaragua, Honduras and Costa Rica became independent republics. Panamá, which won its independence along with Colombia, Venezuela and Ecuador, formed a part of Colombia until 1903. British Honduras (Belize), dating from 1638, is the only European colony on the Central American mainland.

For over a century, following the winning of independence, the republics were highly unstable, and wars between them were common—these conditions were factors in U.S. intervention in the area. By the mid-20th century the leadership of the republics had shown a growing tendency to settle differences by arbitration. For more detailed treatment, *see* LATIN AMERICA; MAYA INDIANS; AZTEC; and the various countries. (J. J. J.)

V. POPULATION

1. Number and Distribution.—Censuses taken during 1950 in all parts of Central America except British Honduras showed a total of almost 9,000,000 persons in the area, or the equivalent of 42.2 inhabitants per square mile (*see* Table). In the early 1960s this figure had risen to approximately 12,000,000, and thereafter continued to increase by about 180,000 annually.

The population of Central America is highly concentrated in the valleys and on the slopes of the chain of mountains which parallel the Pacific coast, at no great distance inland, from Guatemala to Panamá. Especially high is the density of population along the chain of active and extinct volcanoes that runs through the central portion of El Salvador and in the uplands of Guatemala. The lowlands in which Managua (capital of Nicaragua) is located, the Meseta Central in Costa Rica and the parts of Panamá which adjoin each end of the Canal Zone likewise are heavily populated. There also are densely inhabited areas in the highland portions of Honduras.

By the mid-20th century the main towns and cities of Central America had shown a rapid growth and development: Guatemala City had over 500,000 inhabitants, while San Salvador (capital of El Salvador), Panamá city and Managua had populations of well over 200,000; San José (capital of Costa Rica) had over 100,000; Tegucigalpa (capital of Honduras) had more than 130,000; and Belize (capital of British Honduras) over 30,000. Nevertheless, the population throughout most parts of Central America remains rural to a very high degree. In 1950 percentages of the inhabitants living outside places of 2,500 or more were as follows: Costa Rica, 66.5; El Salvador, 74.2; Guatemala, 76.8; Honduras, 82.8; Nicaragua, 72.6; and Panamá, 70.2.

2. Composition.—The racial composition of the population in Central America is extremely varied. Guatemala's 1950 census classified 53.6% of its population as indigenous or Indian, and persons of mixed Indian and white ancestry (Ladinos) undoubtedly constitute all but a small fraction of the remainder. Mestizos make up the overwhelming proportion of the population in both Honduras and El Salvador. In the former, 89.9% of the population was classified as mestizo and 6.7% as Indian by the 1950 census; and in the latter, 92.3% was classed as of mixed Indian and white descent by the 1930 census. A native non-Indian of predominantly European culture traits is called a Ladino, which is usually, though not necessarily, synonymous with mestizo. A person of pure Indian blood, by adopting a predominance of traits derived from Europe, may become a Ladino.

Negroes and mulattoes form a considerable share of the inhabitants of the extensive and sparsely populated Atlantic coastal plain of Honduras and Nicaragua—the so-called Mosquito Coast—and of adjacent British Honduras. They are the descendants of fairly recent arrivals who reached Central America from the British possessions in the Caribbean, and they have mixed to a considerable extent with the native Indians who formerly occupied the area. Their presence in Honduras is responsible for 2.1% of that country's inhabitants being classified as Negroes in 1950, and for the fact that the 1946 census of British Honduras indicated that 68.3% of its inhabitants were Negroes or mulattoes.

Probably about 20% of Nicaragua's population is white and 10% Negro, with mestizos and mulattoes accounting for the remainder. Practically no full-blooded Indians remain in Nicaragua. However, in the population of mixed blood, mestizos greatly outnumber mulattoes.

The population of Costa Rica is almost exclusively white. In the 1950 census 97.7% of the population was so classified. Only a few thousand Indians remain. Negroes and mulattoes make up only about 2% of the population, and nearly all of them are located in the lowlands along the Atlantic coast.

Panamá's 1940 census classified 11.1% of the country's population as white, 13.3% as Negro, 9.0% as indigenous or Indian, 65.3% as mestizo (which includes mulattoes), and 1.3% as belonging to other races. The proportion of Indians in the population was considerably understated, since the figure given included only those in tribal groups, such as the San Blas, whose location on islands off the coast and in the most remote parts of the mountains had enabled them to preserve their racial purity, their native tongues and their customary ways of life. These groups were not considered as part of the civil population. On the other hand, large numbers of Indians or cholos who no longer had a tribal organization, who spoke Spanish and who professed Christianity

Area and Population Statistics in Countries of Central America

Political unit	Area (sq.mi.)	Population (1960 census)	Persons per sq.mi.	Increase in inhabitants since 1950 census	Average annual rate of increase (%)
Republics . .	196,378	12,609,932	64.2	3,931,359	...
Costa Rica . .	19,652	1,336,274*	67.9	535,399	5.1
El Salvador .	8,260	2,510,984†	304.0	655,067	3.2
Guatemala . .	42,042	4,278,341‡	101.8	1,487,473	3.8
Honduras . .	43,277	1,884,765†	43.6	516,160	3.4
Nicaragua . .	53,938	1,524,027	28.3	467,004	4.4
Panamá . .	29,209	1,075,541	36.8	270,256	3.4
Dependent areas .	9,425	132,243	14.0	20,201	...
British Honduras	8,867	90,121	10.2	30,901§	3.7
Canal Zone .	558	42,122	113.2‖	−10,700	...
Total . . .	205,803	12,742,175	61.9¶	3,951,560	...

*1963 census. †1961 census. ‡1964 census. §Increase over 1946 census. ‖Computed on a basis of 372 sq.mi. land area. ¶Average.

were considered as part of the civil population and classified as mestizos.

The sexes are fairly equally represented in the populations of most of the major civil divisions throughout Central America. However, males are considerably fewer than females in British Honduras and in the Panama Canal Zone, where a heavy excess of men among the foreign born exerts a significant effect. In 1950 the number of males per 100 females in each of the political divisions was as follows: Costa Rica, 99.7; El Salvador, 98.0; Guatemala, 102.3; Honduras, 100.5; Nicaragua, 97.1; Panamá, 103.5; British Honduras, 94.2; and the Canal Zone, 139.1.

Because both birth and death rates are high throughout most of Central America, the population is heavily concentrated in the younger ages and those in the advanced ages are relatively few in number. In fact by 1950 in all the political divisions, except the Canal Zone, more than 40% of the population was less than 15 years of age, and the proportion of those 65 and over ranged from 2% to 4%.

3. Growth of Population.—The population of Central America is increasing rapidly, probably at an annual rate of over 3.5%. Between 1950 and 1960 the rate for the area as a whole averaged 3.3%, and since that time a continued fall in the death rate with little or no change in the birth rate no doubt has speeded up substantially the rate of population increase.

Natural increase accounts for all except a minute fraction of the population increase in the area as a whole. Only in Panamá, which attracts many immigrants from Jamaica and other British possessions in the West Indies, and from neighbouring Colombia and smaller numbers from places throughout the world, is immigration from outside the area a significant factor in the population growth. However, a large flow of population from El Salvador to Honduras and from Nicaragua to Costa Rica affects substantially the rates of growth in those specific countries.

In Costa Rica, El Salvador and Guatemala, where nearly all the births are registered, the birth rate varies between 45 and 50 per 1,000 population. In the other countries, in which the birth statistics are less reliable, the ratio of children under 5 years of age to women aged 15–44 shows rather conclusively that the rates of reproduction are equally high.

The mortality statistics for most of the area are so incomplete and unreliable that few sound conclusions may be based upon them. It is known in a general way, however, that the death rates in most of the countries had been high (probably at an annual rate of 25 deaths per 1,000 population); and that after 1940 these rates were falling sharply. As a result, unless there is a sharp reduction in the birth rate, by the 1970s the population in many parts of Central America is likely to have increased by more than 3% per year.

See also references under "Central America" in the Index.

(T. L. Sh.)

CENTRAL AMERICAN FEDERATION (Organization of Central American States), a union composed of the republics of Guatemala, El Salvador, Honduras, Nicaragua and Costa Rica. From the 1520s until 1821 they were small provinces of the Spanish empire and were normally ruled by a captain-general in Guatemala. In 1821 the provinces gained independence from Spain without warfare. For about 15 months thereafter Central America was part of the ill-fated Mexican empire of Agustín de Iturbide (*q.v.*), but separated upon his overthrow in 1823. The following year the Federal Republic of Central America was created, with a constitution that permitted a great amount of state autonomy and gave the federal government supreme authority only in foreign affairs. This weak central government, although directed by the notable statesman, Francisco Morazán, had almost no income and lacked the military force to subdue the frequent disorders among the states. Poor communications, jealousy of the power of Guatemala and inexperience in self-government led to secessions and the end of the federation about 1839.

Since 1842 about 25 formal attempts have been made to reconstitute a Central American nation. For example, in 1885 Justo Rufino Barrios attempted to unite the nations by force. In 1896 three of the states created the Greater Republic of Central America, which gained diplomatic recognition from many nations. But invariably the efforts failed. In spite of many similarities among the peoples, old fears, meddling in one another's affairs and continued localism have prevailed. After World War II the endeavours became less political and more economic in nature and enjoyed some success. Agreement on a charter for the Organization of Central American States was reached in Oct. 1951 but because of disputes among the members the organization did not begin to function until 1955. Concrete measures were taken in the 1950s to establish a customs union and common markets, and to facilitate travel and educational opportunities. To many Central Americans the unity of the five nations remains an unfulfilled but desirable dream. They feel that a new federation would bring greater prosperity and stability. (T. L. K.)

CENTRAL AND NORTH AMERICAN LANGUAGES. The aboriginal languages of Central and North America are extremely numerous and highly diverse, a fact which complicates the problem of their classification. (For a general discussion of the languages of the Americas, *see* American Aboriginal Languages.) The problem is further complicated by lack of data; for a great many of the languages of this region there were in the early 1960s too little lexical data (texts and vocabularies) on which to base an adequate classification.

Linguistic stocks or families are set up by intensive and detailed comparison of languages in respect to sound feature, grammar and vocabulary. When such comparison, in the case of two or more languages, reveals systematic resemblances among them in sound feature, grammar and vocabulary, these languages are said to belong to a single stock, which means, in historical terms, that they are derived from a common ancestral or protolanguage.

It is relatively easy for linguists to make preliminary classifications of this sort, and linguists are in agreement in respect to most of the smaller groups of Central and North America, the members of which are as obviously related as English and German or Spanish and Portuguese. Further research has suggested that some of these smaller groups may be more remotely related, so replacing the numerous small linguistic stocks by relatively few larger ones. In the early 1960s the evidence for the larger groupings was not in all cases incontestable, and more work had to be done before any but a tentative statement of the more remote relationships could be demonstrated.

Languages North of Mexico.—The first comprehensive classification of the languages north of Mexico was published by J. W. Powell in 1891. He recognized no less than 56 stocks, later revised to 55 (*see* the 1915 map issued by the Bureau of American Ethnology). The revised list is given below with modifications in nomenclature to bring it into harmony with current usage.

The distribution of these 55 stocks is uneven; 37 of them were either entirely or largely in territory draining into the Pacific, and 22 of these had a coast line on the Pacific. Only seven linguistic stocks bordered the Atlantic coast and languages of 10 stocks (apart from Arawak) the coast of the Gulf of Mexico. The most widely distributed stocks were: Eskimoan, which included Eskimo dialects ranging from east Greenland west to southern Alaska and East cape, Siberia, as well as the Aleut of the Alaska peninsula and the Aleutian Islands (*see* Eskimo-Aleut Languages); Algonkian, which embraces a large number of languages spoken along the Atlantic coast from eastern Quebec and Cape Breton Island south to the coast of North Carolina, in the interior of Labrador, in the northern part of the drainage of the St. Lawrence, in the country of the three upper Great Lakes and the upper Mississippi, and west into the plains of the Saskatchewan and the upper Missouri; Iroquoian, which consists of languages originally spoken in three disconnected areas—the region of Lakes Erie and Ontario and the St. Lawrence, eastern Virginia and North Carolina, and the southern Allegheny country (Cherokee); Muskogian (including Natchez), which occupied the Gulf region from the mouth of the Mississippi east into Florida and Georgia and north into Tennessee and Kentucky; Siouan, divided into four geographically distinct groups—an eastern group in Virginia and North and South Carolina, a small southern contingent (Biloxi) in southern Mississippi, the main group in the valley of the Missouri (eastern Montana and Saskatchewan southeast through Arkansas), and a colony of the main group (Winnebago) in the region of Green Bay, Wis.; Caddoan, spoken in the southern plains (from Nebraska south into Texas and Louisiana) and in an isolated enclave (Arikara) along the Missouri in North and South Dakota; Shoshonean, which occupied the greater part of the Great Basin area and contiguous territory in southern California and the southwestern plains (Texas), also, disconnected from this vast stretch, three mesas in the Pueblo region of northern Arizona (Hopi); Athapaskan, divided into three geographically distinct groups of languages—Northern (the valleys of the Mackenzie and Yukon, from just short of Hudson bay west to Cook inlet, Alaska, and from Great Bear lake and the Mackenzie delta south to the headwaters of the Saskatchewan), Pacific (two disconnected areas, one in southwestern Oregon and northwestern California, the other a little south of this in California), and Southern (large parts of Arizona and New Mexico, with adjoining regions of Utah, Texas and Mexico)—besides isolated enclaves in southern British Columbia, Washington and northern Oregon; and Salishan, in southern British Columbia, most of Washington, and northern Idaho and Montana, with two isolated offshoots, one (Bella Coola) to the north on the British Columbia coast, the other (Tillamook) to the south in northwestern Oregon.

The remaining 46 stocks, according to Powell's classification, in alphabetical order, were: Atakapa (Gulf coast of Louisiana and Texas); Beothuk (Newfoundland; extinct); Chimakuan (northwestern Washington); Chimariko (northwestern California); Chinook (lower Columbia river, in Washington and Oregon); Chitimacha (southern Louisiana); Chumash (southwestern California); Coahuiltecan (lower Rio Grande, in Texas and Mexico); Coos (Oregon coast); Costanoan (western California south of San Francisco bay); Esselen (southwestern California; extinct); Haida (Queen Charlotte Islands and part of southern Alaska); Kalapuya (northwestern Oregon); Karankawa (Texas coast); Karok (northwestern California); Keres (certain Rio Grande pueblos, New Mexico); Kiowa (southern plains, in Kansas, Colorado, Oklahoma and Texas); Kootenay (upper Columbia river, in British Columbia and adjoining parts of Idaho and Montana); Lutuami, consisting of Klamath and Modoc (southern Oregon and northeastern California); Maidu (eastern part of Sacramento valley, California); Miwok (central California); Piman or Sonoran (southern Arizona and south into Mexico as far as the state of Jalisco); Pomo (western California north of San Francisco bay); Sahaptin (middle Columbia river valley, in Washington, Oregon and Idaho); Salinan (southwestern California); Shastan or Shasta-Achomawi (northern California and southern Oregon); Takelma (southwestern Oregon); Tanoan (certain pueblos in New Mexico, Arizona and originally also in Chihuahua, Mex.); Timuqua (Florida; extinct); Tlingit (southern Alaska); Tonkawa (Texas); Tsimshian (western British Columbia); Tunica (Mississippi river, in Louisiana and Mississippi); Waiilatpuan, consisting of Molala and Cayuse (northern Oregon); Wakashan, consisting of Kwakiutl and Nootka (coast of British Columbia); Washo (western Nevada and eastern California); Wintun (north central California); Wiyot (northwestern California); Yakonan (Oregon coast); Yana (northern California); Yokuts (south central California); Yuchi (Savannah river, in Georgia and South Carolina); Yuki (western California); Yuman (lower Colorado river valley, in Arizona, southern California and south into all or most of Lower California); Yurok (northwestern California); Zuñi (pueblo of New Mexico). To these was later added, as distinct from Yakonan, Siuslaw (Oregon coast).

This complex classification of native languages in North America was very probably only a first approximation to the historic truth. There were clearly far-reaching resemblances in both structure and vocabulary among linguistic stocks classified by Powell as genetically distinct.

Certain resemblances in vocabulary and phonetics were undoubtedly due to borrowing of one language from another, but the more deep-lying resemblances, such as could be demonstrated, for instance, for Shoshonean, Piman and Nahuatl (Mexico) or for Athapaskan and Tlingit, were doubtless due to a common origin greatly obscured by the subsequent operation of phonetic laws, grammatical developments and losses, analogical disturbances and borrowing of elements from alien sources.

It was impossible to say at mid-century what was the irreducible number of linguistic stocks that should be recognized for America north of Mexico, as scientific comparative work on these difficult languages was still in its infancy. The following reductions of linguistic stocks which were proposed may be looked upon as either probable or very possible: (1) Wiyot and Yurok, to which might have to be added Algonkian (of which Beothuk may be a very divergent member; (2) Iroquoian and Caddoan; (3) Uto-Aztecan, consisting of Shoshonean, Piman and Nahuatl; (4) Athapaskan and Tlingit, with Haida as a more distant relative; (5) Mosan, consisting of Salish, Chimakuan and Wakashan; (6) Atakapa, Tunica and Chitimacha; (7) Coahuiltecan, Tonkawa and Karankawa; (8) Kiowa and Tanoan; (9) Takelma, Kalapuya and Coos-Siuslaw-Yakonan; (10) Sahaptin, Waiilatpuan and Lutuami; (11) a large group known as Hokan, consisting of Karok, Chimariko, Shastan, Yana, Pomo, Washo, Esselen, Yuman, Salinan, Chumash and, in Mexico, Seri and Chontal; (12) Penutian, consisting of Miwok-Costanoan, Yokuts, Maidu and Wintun. (E. SA.)

Edward Sapir, in 1929, proposed that all of the languages north of Mexico (plus a number in Mexico and Central America) might be put into six major divisions, often called superstocks or phyla. (*See* INDIAN, NORTH AMERICAN: *Language;* INDIAN, LATIN-AMERICAN.)

Sapir called this grouping "suggestive but not demonstrable in all its features"; he clearly meant it to serve more as a guide to future historical research than as a completed classificatory scheme. Research after 1929 had not by the early 1960s verified all aspects of the Sapir classification. The Eskimo-Aleut, Nadene and Aztec-Tanoan divisions appeared to be fairly well substantiated but there was still much to be done before the remaining three superstocks could be said to be proven.

Languages of Mexico and Central America.—The classification of the languages of Mexico and Central America was not nearly so advanced as for America north of Mexico. Most authorities agreed on the following list of 24 linguistic stocks, but there was little agreement on the more remote relationships suggested for some of them.

(1) The Yuman languages of Lower California (clearly related to languages of the same designation spoken in the United States), (2) Serian (northwestern Mexico), (3) Tequistlacecan (Oaxaca state) and (4) Supanecan (Subtiaba in Nicaragua and Tlappanec in Guerrero state) probably belong to Sapir's Hokan-Siouan: no. 1–3 to Hokan proper and no. 4 to the larger Hokan-Coahuiltecan subdivision. Also included here, but with less certainty, were four extinct language groups of Mexico: Coahuiltecan, Tamaulipecan and Janambrian of northeastern Mexico, and Waicurian of the southern portion of Lower California.

(5) Tarascan, a small group of languages spoken in Michoacán, was not included in any larger grouping.

(6) Otomian (central Mexico), (7) Popolocan (Puebla and Oaxaca), (8) Mazatecan (Oaxaca), (9) Triquean (Oaxaca) and (10) Chorotegan (Chiapas) were often grouped together in the larger Otomanguean family.

(11) Mixtecan (Guerrero, Puebla and western Oaxaca), (12)

Proposed Classification of American Indian Languages North of Mexico (and Certain Languages of Mexico and Central America)

I. *Eskimo-Aleut*

II. *Algonkin-Wakashan*

- A. Algonkin-Ritwan
  - 1. Algonkin
  - 2. Beothuk
  - 3. Ritwan
    - *a.* Wiyot
    - *b.* Yurok
- B. Kootenay
- C. Mosan (Wakashan-Salish)
  - 1. Wakashan (Kwakiutl-Nootka)
  - 2. Chimakuan
  - 3. Salish

III. *Nadene*

- A. Haida
- B. Continental Nadene
  - 1. Tlingit
  - 2. Athapaskan

IV. *Penutian*

- A. Californian Penutian
  - 1. Miwok-Costanoan
  - 2. Yokuts
  - 3. Maidu
  - 4. Wintun
- B. Oregon Penutian
  - 1. Takelma
  - 2. Coast Oregon Penutian
    - *a.* Coos
    - *b.* Siuslaw
    - *c.* Yakonan
  - 3. Kalapuya
- C. Chinook
- D. Tsimshian
- E. Plateau Penutian
  - 1. Sahaptin
  - 2. Waiilatpuan (Molala-Cayuse)
  - 3. Lutuami (Klamath-Modoc)
- F. Mexican Penutian
  - 1. Mixe-Zoque
  - 2. Huave

V. *Hokan-Siouan*

- A. Hokan-Coahuiltecan
  - 1. Hokan
    - *a.* Northern Hokan
      - (1) Karok, Chimariko, Shasta-Achomawai
      - (2) Yana
      - (3) Pomo
    - *b.* Washo
    - *c.* Esselen-Yuman
      - (1) Esselen
      - (2) Yuman
    - *d.* Salinan-Seri
      - (1) Salinan
      - (2) Chumash
      - (3) Seri
    - *e.* Tequistlatecan (Chontal)
  - 2. Subtiaba-Tlappanec
  - 3. Coahuiltecan
    - *a.* Tonkawa
    - *b.* Coahuilteco
      - (1) Coahuilteco proper
      - (2) Cotoname
      - (3) Comecrudo
    - *c.* Karankawa
- B. Yuki
- C. Keres
- D. Tunican
  - 1. Tunica-Atakapa
  - 2. Chitimacha
- E. Iroquois-Caddoan
  - 1. Iroquoian
  - 2. Caddoan
- F. Eastern group
  - 1. Siouan-Yuchi
    - *a.* Siouan
    - *b.* Yuchi
  - 2. Natchez-Muskogian
    - *a.* Natchez
    - *b.* Muskogian
    - *c.* Timucua (?)

VI. *Aztec-Tanoan*

- A. Uto-Aztecan
  - 1. Nahuatl
  - 2. Piman
  - 3. Shoshonean
- B. Tanoan-Kiowa
  - 1. Tanoan
  - 2. Kiowa
- C. Zuñi (?)

Chinantecan (Oaxaca and western Veracruz) and (13) Zapotecan (Oaxaca) were said by some to be related and to form, with Otomanguean, a Macro-Otomanguean stock. The evidence for this relationship was weak.

(14) Taracahitian (northwestern Mexico), (15) Aztecoidan (Coran and Nahuatlan of central Mexico; Nahuatlan languages were also found in a number of isolated southern enclaves, in Oaxaca state, Salvador, Guatemala, Nicaragua and Costa Rica) and (16) Piman (northern Mexico and southwestern United States) were clearly related and formed, with the Shoshonean languages of the United States, the Uto-Aztecan subdivision of Sapir's Aztec-Tanoan.

(17) Mayoid included Huastecan of the northeastern coast region of Mexico and Mayan of Yucatan and neighbouring states of southern Mexico, British Honduras, western Honduras and Guatemala.

(18) Mizocuavean, a small group of languages, including Mixe-Zoque (or Zoquean) of Oaxaca, Veracruz, Chiapas and Tabasco, and, with less certainty, Huave of the coast of Oaxaca. Two extinct languages, of which some small record remains, were also included: Tapachultec of southeastern Chiapas and Aguatec of Guatemala.

(19) Totonacan of Hidalgo, Puebla and the coast of Veracruz. Sapir, in 1929, included no. 18 (which he called Mexican Penutian) in his Penutian superstock; subsequently others suggested that no. 17, 18, 19 and Macro-Otomanguean (no. 6–13) were possibly members of a still larger Macro-Penutian stock. The evidence for this hypothesis was very slight, and it should also be noted that neither Sapir's Mexican Penutian nor the proposed Macro-Oto-Manguean were clearly established.

(20) Xincan of southeastern Guatemala, (21) Lencan of Honduras and Salvador, (22) Jicaquean of northern Honduras and (23) Payan of Honduras were as yet unrelated to any other languages of Mexico or elsewhere.

The same was true of (24) Misumalpan, made up of Mosquitoan (coast of Nicaragua and Honduras), Sumoan (eastern Nicaragua and southern Honduras) and Matagalpan (Nicaragua), although it was suggested that these languages bore a remote relation to Chibchan in South America (*see* SOUTH AMERICAN LANGUAGES).

Languages belonging to two South American stocks were spoken in Central America: Cariban, spoken in one or two dialects on the coast of Honduras and British Honduras (these came there in post-conquest times from the West Indies) and Chibchan, spoken in Costa Rica, Panamá and Nicaragua.

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CENTRAL BANK, an institution such as the Bank of England or the U.S. federal reserve system that is charged with responsibility for regulating the size of a nation's money supply and the availability and cost of credit. Regulation of the availability and cost of credit may be nonselective or may be designed to influence the distribution of credit among competing uses. The objective of a central bank in peacetime is to promote monetary stability and sound economic growth; in wartime, its objective is to promote the use of the nation's productive and financial resources in the war effort. Central banks also have other important responsibilities. Generally these include acting as fiscal agents and financial advisers to the government, overseeing the operation of the banking system, clearing checks and serving as correspondents for foreign central banks. Central banks are operated for the public welfare and not for maximum profit.

The modern central bank has had a long evolution, dating back to the establishment of the Bank of England (*q.v.*) in 1694. In the process central banks have become varied in authority, autonomy, functions and instruments of action. Virtually everywhere, however, there has been a vast broadening of central bank responsibility for promoting economic stability and growth. There has also been increasing emphasis on the interdependence of monetary and other national economic policies, especially fiscal and debt-management policies.

The broadened responsibilities of central banks have led to growing government influence in their affairs. This increased influence has taken a variety of forms in different countries: among them have been outright nationalization, representation of the minister of finance on the central bank's board of directors, greater government influence in the selection of the other members of the board, and the establishment of procedures for settling conflicts between the central bank and the government, and to ensure that the government's point of view prevails.

The responsibility of central banks for promoting economic stability and growth arose mainly from the depression of the 1930s. At that time the view developed that central banks in the past had devoted too much attention to prevention of overissuance of their bank notes and to the preservation of unlimited convertibility of these notes into gold at a fixed rate of exchange, and that too little attention had been given to maintaining total economic activity at high levels. In nearly all countries, the powers of central banks to extend credit were liberalized in order to free them from the need to pursue deflationary policies during recessions. Nevertheless, reliance on monetary policy diminished and there was increased emphasis on the potentialities of government spending, taxation and debt management. In many countries, elaborate systems of foreign exchange controls, frequently administered wholly or partly by the central bank, replaced the earlier systems of unrestricted convertibility of the currency into gold and foreign currencies.

During World War II the principal concerns of central banks in warring nations were the financing of the nations' war efforts and restricting the availability of credit for civilian use. In other countries, the problem was to prevent scarcity of imports from causing serious inflation. In the immediate postwar period, the problem in war-damaged nations was to facilitate reconstruction of viable patterns of production and consumption. In the United States, it was to prevent the huge wartime accumulations of liquid assets from generating rampant inflation while the economy was shifting to peacetime production. In the raw-material-producing countries, especially in Latin America, the problem was to avert wartime-accumulated foreign exchange from being dissipated on imports of foreign goods of little value to economic development. The nature of monetary problems during the war and immediate postwar periods led to greater governmental influence in the making of central bank policy and to the development of a variety of new instruments for regulating the availability of credit.

After adjustments to peacetime conditions were made, the primary concern of central banks became, and has continued to be, the maintenance of high levels of output and employment without inflation and deterioration in the nation's international balance of payments. Anti-inflationary monetary policies were adopted by governments in many countries, notably in Germany. Another important development in central banking during the 1950s was the great progress made toward restoring the unrestricted external convertibility of European currencies and toward reducing exchange restrictions in Latin America and the far east. The International Monetary fund (*q.v.*), which may be described as a "central bank for central banks," played a leading role in promoting the removal of international currency restrictions and in bringing about a system of international consultation and co-operation on monetary and foreign exchange problems, and a renewed confidence in the importance of sound monetary policies.

Central banks regulate the money supply primarily by expanding and contracting their assets. An increase in a central bank's assets causes a corresponding increase in its deposit liabilities (or note issue), and these, in turn, provide the funds that serve as the cash reserves of the commercial banks—reserves that commercial banks, by law or by custom, must maintain, and generally in a prescribed proportion of their own deposit liabilities. As banks acquire larger cash balances with the central bank, they are in a position to expand their own credit operations and deposit liabilities to a point where the new, larger cash reserves no longer produce a reserve ratio greater than the minimum set by law or custom. A reverse process occurs when the central bank contracts the volume of its assets and liabilities.

The typical operations by which central banks alter the volume of their assets may be summarized as follows:

Open-Market Operations.—These consist mainly of purchases and sales of government securities, but operations in bankers' acceptances and in certain other types of paper often are permissible. Open-market operations are an effective instrument of monetary regulation only in countries with well-developed securities markets. Open-market sales of securities by the central bank, by draining off cash reserves from the commercial banks, can be used to force these banks to borrow from the central bank and, in conjunction with a high discount rate, can compel them to tighten their lending policies. Open-market sales, by reducing the capacity of the banking system to extend credit and by tending to drive down the prices of the securities sold, also tend to raise interest rates generally. The rise in interest rates forces other financial institutions to offer a higher rate of return on their obligations and, given the reduced availability of bank credit, enables them, like banks, to command a higher rate of return on their loans and investments. Thus, the impact of open-market sales is not limited to the banking system. It is diffused throughout the economy; however, the impact tends to be greatest on banks, because they are more directly affected via the loss of cash reserves. Conversely, purchases of securities by the central bank tend to lead to credit expansion by the financial system and to lower interest rates.

Open-market operations also can be used to stabilize government security prices, thereby assisting the treasury in the management of the national debt; however, the effect on bank reserves may conflict with the central bank's existing credit policy. This situation existed in the United States in the postwar period, until the Treasury-Federal Reserve accord of March 4, 1951.

Loans to Banks.—Such loans, generally called "discounts" or "rediscounts," are short-term advances against commercial paper or government securities to enable banks to meet seasonal or other special temporary needs for funds. The Bank of England deals with discount houses rather than directly with banks, but the effect on bank reserves is similar. The provision of such funds is one of the most important functions of central banks. The rate of interest charged is known as the "discount rate" or "rediscount rate." By raising or lowering the rate, the central bank can regulate the cost of such borrowing. The level of and changes in the rate also indicate the views of the central bank on the desirability of greater tightness or ease in credit conditions.

Some central banks, especially in countries which lack a broad capital market, extend medium- and long-term credit to banks and to government development corporations in order to facilitate the financing of domestic economic development expenditures and to alleviate the deficiency of savings. Such longer-term lending is not regarded as an appropriate central bank activity by most authorities, however, and is regarded as a dangerous source of inflationary pressures.

Other Loans.—Direct government borrowing from central banks generally is frowned upon and commonly is subject to statutory limitations; nevertheless, in many countries the central bank is the only large source of credit for the government and is used extensively. Some central banks make loans to private business but such loans are considered to be commercial banking rather than central banking operations.

Purchases and Sales of Gold and Foreign Exchange.—Central banks buy and sell gold and foreign exchange to stabilize the international value of their own currency and to provide an international reserve for use in periods of need. Prior to the 1930s, the authority of most central banks to issue currency and (less commonly) to incur deposit liabilities was limited by statutory requirements fixing the maximum amount of these obligations in relation to the international reserve. Such requirements have been lowered or eliminated by many countries, however, either because they blocked expansions of the money supply considered essential to domestic stability and development or because they "locked up" gold or foreign exchange needed for payments abroad.

Other Types of Central-Bank Credit Control.—Many central banks have authority to fix and to vary, within limits, the minimum cash reserves that banks must hold against their deposit liabilities. Changes in reserve requirements are an effective instrument both to offset and to substitute for large changes in the supply of reserves. The U.S. federal reserve system was the first central bank to obtain this power as a normal means of credit control (1935), but most other central banks later were given such authority. In some countries, the reserve requirements against deposits provide for the maintenance of certain assets in addition to cash; such requirements are sometimes called "minimum liquidity ratios." Most commonly, the other assets are government securities. Generally, the purpose is to encourage or require banks to invest in such assets to a greater extent than they otherwise would be inclined to do, and thus to limit the extension of credit for other purposes. In Europe, such minimum liquidity ratios were used extensively following World War II and the Korean conflict to prevent banks from disposing of large holdings of government securities in order to expand their loans to private borrowers. During and after World War II many countries felt a need to regulate the availability of credit for particular purposes, such as the purchase of consumer durables, houses and imports of nonessential goods. Their central banks were therefore empowered to impose various selective credit controls. Such controls may apply to nonbank as well as to bank lenders. The federal reserve board in the United States, for example, has had authority to control stock market credit since 1934. Sometimes selective measures, such as specially low discount rates or permission to include certain assets as part of required reserves, are used to encourage specific types of credit.

Relations With the Government.—Notwithstanding a trend toward government ownership of central banks and of co-ordination of their policies with governmental fiscal and economic policies, central banks—even when nationalized—generally have a large measure of autonomy. Because governments are under constant political pressures to increase their spending without increasing taxes in proportion, they tend to follow inflationary policies which a central bank, somewhat removed from such pressures, can help to moderate. A recognition of the value of such a check on their inflationary propensities is the principal reason why governments in most countries permit central banks to have some degree of autonomy and freedom in determining and implementing monetary policy. Ultimately, however, the preservation of such freedom depends on strong public support of the central bank at times of disagreement with the government; otherwise, the government may be subject to no deterrence from revoking the bank's freedom whenever its exercise is an irritation to the government. *See* also BANKING; BANK OF ENGLAND; BANQUE DE FRANCE; FEDERAL RESERVE SYSTEM; JAPAN, BANK OF; MONEY MARKET.

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CENTRAL FALLS, a city of Providence county, with a land area of 1.2 sq.mi., is the smallest municipality in Rhode Island, U.S. On the Blackstone river north of Pawtucket, Central Falls was separated from the town of Smithfield in 1871 and was incorporated as a city Feb. 21, 1895. It produces a variety of manufactured goods. Historically, it is known as one of the places where the Indian leader King Philip wreaked vengeance upon the white settlers. A tablet at High and Aigan streets marks the spot where a company of Plymouth soldiers was ambushed by Indians on March 26, 1676. Points of interest are Jenks park and the Adams Memorial library. For comparative population figures *see* table in RHODE ISLAND: *Population*. (J. O. S.)

CENTRALIA, a city of southern Illinois, U.S., about 60 mi. E of St. Louis, Mo., in Marion and Clinton counties, is near the centre of population of the United States. The village was founded in 1853 by the Illinois Central Railroad company, and was chartered as a city in 1859. It is in a fertile fruit-growing and dairying region, and there are coal mines and oil wells in the vicinity. The city has a large wholesale trade. Two railroads have division repair shops there, and there are several manufacturing industries. For comparative population figures, *see* table in ILLINOIS: *Population*.

CENTRAL MASSIF: *see* MASSIF CENTRAL.

CENTRAL PROVINCE, CEYLON, covers 2,290 sq mi. of mainly hilly country renowned for its fine scenery. The larger part of the province lies to the west of the north-south axis of Ceylon's highland mass; it is drained from that axis by the upper Mahaweli Ganga and its tributaries, but a smaller area drains northward to the Kala Oya. It is well watered, with rain at most seasons of the year although the northward-draining valleys lie in part in the dry zone, which has pronounced seasonal drought during the southwest monsoon. The remainder of the province lies to the east of the highland axis and falls precipitously from an altitude of over 6,000 ft. in the Knuckles range and over 8,000 ft. near Nuwara Eliya to under 100 ft. along the middle Mahaweli Ganga; the lower areas there have a dry zone climate, modified by altitude as the slopes are scaled. The province as a whole thus has a very varied pattern of relief and climate; within a few miles around Kandy (*q.v.*), the provincial capital, one can pass from the greenest of wet zone gardens to the brown aridity of dry zone slopes. (*See* also CEYLON: *Physical Geography*.)

Mixed evergreen and deciduous forest survives over much of the dry zone parts of the province; elsewhere forest has been replaced by cultivation, or has degenerated into poor grassland.

The lowland dry zone parts of the Central province were in ancient times the scene of considerable activity and settlement: the remains of this period may still be seen in such places as Sigiriya, a famous hilltop fortress-palace built by Kasyapa I (A.D. 478–496); Elahera and Minipe (ancient irrigation works); and Dambulla (cave-temples). Gradually, under pressure from Tamils from the north, the centre of gravity shifted to the hills, where, for example, Gampola was the capital of a kingdom (14th century) and Kandy the seat of the last independent Sinhalese kings. The British took over in 1815.

The population of the Central province in 1953 was 1,366,685, with Kandyan Sinhalese in an over-all majority, though locally (as for example in Nuwara Eliya district) Indian Tamil estate workers predominate. The chief towns (1953 pop.) are Kandy, 57,200; Matale, 17,244; Nuwara Eliya, 14,405, the three district capitals; and Gampola, 10,773; Nawalapitiya, 9,862; and Hatton-Dickoya, 10,242, the last-named entirely a creation of the planting industry.

Agriculture of two main types occupies most of the people of the Central province. The first type is that of the Sinhalese peasantry, who grow rice (in the dry zone by irrigation), coconut, areca palm and tea. The second type is that of estates, with European or Ceylonese managers and Indian Tamil or Sinhalese labourers, who produce tea and to a lesser extent rubber and cocoa for export. It was largely to assist the plantations that the skilfully engineered railway and the good road network were developed.

For bibliography *see* CEYLON. (B. H. F.)

CENTRAL REGION, GHANA, was created in 1960 from the eastern part of the former Western region. Pop. (1960) 751,392. Area 3,815 sq.mi. It has a 90-mi. coast line along the Gulf of Guinea, west Africa, approximately between the mouths of the Pra and Densu rivers. Northward it is bordered by the Pra and its tributary the Ofin. The region occupies the southeast corner of the dissected peneplain of southern Ghana. A markedly undulating surface, mostly below 500 ft., is produced by the predominant Pre-Cambrian granites; drainage is by short streams (Ayensu, Nakwa, Ochi) often terminating in lagoons. Patches of Pre-Cambrian metamorphic rocks among Paleozoic and more recent sedimentaries form a coast of picturesque bays and promontories.

Except in the drier littoral zone, where the vegetation is mostly scrub and grass, the rainfall is 40–60 in. annually and supports semideciduous tropical forest on "ochrosols," or fertile loams, suitable for cocoa and forest staples. In the drier coastal zones less fertile lateritic soils predominate.

Historically the region is one of the most interesting in the republic. The strongholds of early European trading are seen in coastal settlements with old forts such as Elmina (Portuguese, 1482) and Cape Coast, once the British capital, crowning the rocky headlands. Later developments in other parts of Ghana greatly reduced the importance of the coastal settlements.

Population is densest in three zones: along the coast, encouraged by the coastal main road linking Takoradi and Accra; in the rich northern agricultural zone served by the Central railway; and around Dunkwa and the routes radiating from it. The largest town is the regional capital, Cape Coast (*q.v.*), with a population in 1960 of 41,230. The headquarters of the five administrative districts are Cape Coast, Dunkwa, Swedru and the coast towns of Winneba and Saltpond. Other centres are Nyakrom, Senya Beraku and Elmina.

Coastal fisheries are widespread and the roadstead ports of Cape Coast and Winneba attract some commerce, but the chief significance of the coastal section lies in the production of copra and limes around Cape Coast and the extraction of salt at Elmina. By the 1960s the real wealth of the region lay in the cocoa, bananas and other food staples of the northern forested zone. In the northwest, where the region forms a panhandle between the Ashanti and Western regions, a gold-dredging industry is centred on Dunkwa, which is also the focus of an important production of forest timber and of a small rubber industry. (Er. A. B.)

CENTRAL REGION, KENYA, established at the beginning of 1963 following a reorganization of administrative units in Kenya (*q.v.*), comprises Nyeri and Fort Hall districts and part of the former Kiambu, Thika, Embu, Nanyuki, Laikipia and Naivasha districts, all of which except Naivasha and Laikipia previously belonged to the larger Central province. The region is bounded north, west and south by Rift Valley region and east by Eastern region. Area about 5,173 sq.mi. Pop. (1962) 1,323,600. Most of the region lies more than 5,000 ft. above sea level and it is dominated by Mt. Kenya in the extreme east and the Aberdare range in the west. Much of the area was formerly forested and has been cleared for agriculture, the soil being generally very fertile. Of the African tribes which inhabit the region, the Kikuyu live especially in Kiambu, Fort Hall and Nyeri districts and the Embu in Embu district. Europeans have settled in Nanyuki and Thika. The chief town is Nyeri (pop. [1962] 7,857). The Africans grow coffee, tea, wattle and pineapples as cash crops and the Europeans coffee, tea and sisal.

CENTRAL SCHOOL (GREAT BRITAIN), a special kind of senior elementary school established in some areas of England and Wales during the second and third decades of the 20th century to provide three or four years of postprimary (terminal) education, usually with a practical bias, for pupils of 11 and upward. There were two main types: selective (usually by examination), introduced in London in 1911, and nonselective to which the older children were drafted from contributory schools in the district. With the institution of secondary education for all by the Education act, 1944, central schools ceased to exist as such, most of them developing as secondary schools. *See* Secondary Education; Education, History of.

CENTRIFUGE is commonly defined as a machine using centrifugal force for separating materials of different densities, but has the broader connotation of any machine designed for the specific purpose of subjecting materials to a sustained centrifugal force. Being of essentially the same nature as gravitational force, centrifugal force can be employed to accelerate or greatly accentuate many processes otherwise dependent on the comparatively meagre attraction of gravity. Apparently this fact was early recognized, for it is known that centrifugal machines were used in the 10th century A.D. for extracting tung oil.

Centrifugal Force.—As enunciated by Sir Isaac Newton in his famous laws of force and motion, a freely moving body tends to travel in a straight line, and if directed along a curved path, it will exert a force against the directing or restraining object in its continual effort to "fly off" onto a straight tangential course. For example, it is a familiar observation that an object revolving in a circle exerts a force away from the centre of rotation. Also, there is general appreciation of the fact that the amount of this force can be increased by increasing either the angular velocity of rotation (S), the mass of the object (M) or the radius (R) of the circle through which the object moves. Perhaps not so generally appreciated is the fact that whereas the centrifugal force is directly proportional to the radius and to the mass, it is, as examination of the formula below will show, proportional to the square of the angular velocity. For example, doubling the number of revolutions per minute will increase the centrifugal force by a factor of 4 (equals 2 times 2); increasing the speed by a factor of 10 will increase the force by a factor of 100 (equals 10 times 10).

The actual amount of centrifugal force (F), expressed in dynes (1 gram of force = 980 dynes), is given by:

$$F = \frac{\pi^2 S^2 MR}{900}$$

where S is in revolutions per minute, M is in grams and R is in centimetres.

In order that a clearer concept of the amount of centrifugal force acting on an object may be provided, the force is often compared directly with the weight (pull of gravity) of the object and the amount of force is stated as so many "times gravity" or so many "g's."

For example, an object revolving at the rate of 600 r.p.m. in a circle having a radius of 10 cm. (equivalent to 3.94 in.) generates a centrifugal force which is 41 times gravity. Through the use of special research apparatus, forces greater than 5,000,000 times gravity have been produced by spinning small metal rotors of about pea size at speeds exceeding 1,000,000 r.p.m.

The rotating element of a centrifuge is usually driven about a fixed axis by an electric motor, or by an air turbine in some high-speed machines, and is variously known as a rotor, rotator, bowl, drum or centrifugal. For the minimizing of vibration and strain on the shaft and bearings, it is essential that a loaded rotor be well balanced; *i.e.*, that the total mass be so distributed about the axis of rotation that the resultant of all the elemental forces is zero. If the bearings are suited to high speeds and if ample power is available to overcome the frictional resistance of the bearings and the surrounding air, the only limitation to the speed of a well-balanced rotor is the strength against rupture of the material from which it is made.

For example, a 15-cm.(6-in.)-diameter Duralumin rotor used in certain biological studies and designed especially for high speeds has a limiting speed for routine operation of about 60,000 r.p.m. In a rotor of given design, the maximum angular velocity obtainable before rupture is to a close approximation inversely proportional to the rotor's diameter. Thus, a small rotor having only one-half the diameter of a larger one can be as safely rotated at twice the angular velocity and with the production at the periphery of twice the centrifugal force.

Effect on Liquids.—Of special importance is the centrifugal behaviour of liquids, particularly those in which is suspended solid particulate matter of small size or globules of an immiscible fluid; *e.g.*, the suspended particles in a water-oil emulsion. The net force acting on any portion of the liquid is the vector resultant of both the centrifugal force and the force of gravity. However, in general the force of gravity is so small in comparison with the centrifugal force generated during operation that its effect may be neglected in the present discussion of principles. In the centrifugal field of force, the liquid tries to distribute itself as far as possible from the axis of rotation, filling the outer portions of the container and forming a free surface which is everywhere equidistant from the axis and hence cylindrical in shape.

Any suspended particles which are more dense than the suspending liquid tend to migrate toward the periphery, while any having a lower specific gravity move toward the surface. The rapidity with which this migration proceeds is dependent on the intensity of the centrifugal force, the difference between the density of the particle and that of the suspending liquid, the viscosity of the liquid, the size and shape of the particle and to some extent the concentration of the particles and the degree to which they are electrically charged. The net motivating force exerted on the particle is the difference between the centrifugal force acting on it and the opposing buoyancy of the liquid, the buoyancy being equivalent to the centrifugal force acting on the volume of liquid displaced by the particle. In a steady state of migration, this net motivating force must be equal to the viscous drag of the liquid. For spherical, electrically neutral particles in dilute suspensions this resistance has been shown by G. G. Stokes to be given by the following relationship:

$$f = 6\pi\eta r s$$

where f is the resistance in dynes, η is the viscosity in poises, r is the radius of the particle in centimetres and s is the speed of migration in centimetres per second.

Equating the expressions for the resistive and the net motivating forces and solving for s, one finds that the rate of movement is proportional to the square of the particle's radius:

$$s = \frac{\pi^2 S^2 R\,(\delta-\rho)\,r^2}{4050\eta}$$

where δ and ρ are the densities of the particle and the suspending fluid respectively. Thus, all other things being equal, a particle having a diameter 10 times that of a given particle will require only 1/100 as much average centrifugal force to move a given distance in a given time. The table, though somewhat oversimplified for the sake of clarity, gives some idea of actual requirements for particles of various sizes, the assumption being made that no remixing occurs within the fluids. Actually, remixing is a definite problem in the centrifugation of small particles at high speeds and is discussed in the next section.

From the foregoing discussion, it is clear that a practically complete separation of the suspending medium and the suspended phase can be produced if the centrifugation is allowed to continue until all particles have collected against the outer wall of the rotor. It should also be noted that a partial separation of two groups of suspended particles of different size can be effected by allowing centrifugation to continue only long enough for all of the larger particles to be completely packed into the sediment, since then many of the small particles will still be suspended in the fluid. If purification of the larger, as well as the smaller particles is desired, the supernatant fluid can be drawn off and the sediment resuspended in some suitable liquid and subsequently centrifuged again to effect further separation. This process may be repeated any number of times.

*Sedimentation of Spherical Particles Suspended in Aqueous Media**

Assumed diameter of particle, in cm. (1 cm. = 0.39 in.)	Examples of particles in size range of same order	Average centrifugal force necessary to produce sedimentation of 1 cm. in 10 min., expressed as number times gravity	Approx. no. of r.p.m. required, assuming average distance of liquid from axis of rotation to be 10 cm.
1/1,000 . . .	Red blood cells	1.8	120
1/10,000 . . .	Typhus rickettsia	180	1,200
1/100,000 . . .	Influenza virus	18,000	12,000
1/1,000,000 . . .	Protein molecules	1,800,000	120,000†

*Assuming viscosity equal to that of water, specific gravity of medium equal to 1 and the average specific gravity of particles equal to 1.3 (order of magnitude for many biological materials).

†Because of the limited strength of materials, speeds above approximately 50,000 r.p.m. are not feasible with rotors of the assumed size. At this speed, an hour or more would be required to produce the indicated sedimentation of animal proteins.

Industrial Centrifuges.—There are numerous industrial applications of centrifugal force. Thick-walled metal pipe and tubing are cast by pouring the molten metal into cylindrical molds which are then rotated while the metal sets into the solid state. Perforated rotating drums or baskets are used for extracting fluids from various natural products after crushing, for throwing off the excess water from washed clothes and for retaining sugar crystals while the liquor in which the crystallization took place is drained off under the action of centrifugal force. However, the greatest advantage of the centrifugal method is realized in fractionating fine suspensions of solid or liquid material. The cream separator is a familiar example.

Though variously modified to suit the particular application, most machines employed for such purposes are of the continuous-flow type, as illustrated by (A) in fig. 1. The bowl or rotor, generally cylindrical in shape, is provided with a central opening to permit the continuous introduction of liquid during operation, and with one or more exit ports from which the centrifuged fluid can overflow and be thrown into collectors.

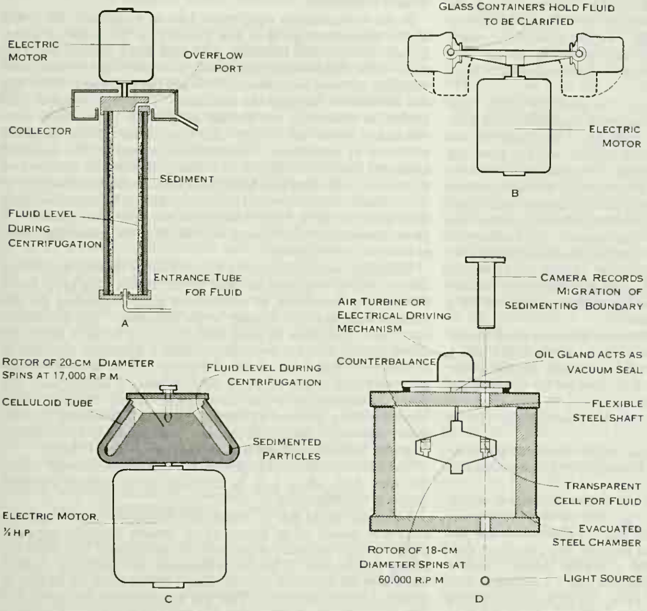
ELECTRIC MOTOR
OVERFLOW PORT
COLLECTOR
SEDIMENT
FLUID LEVEL DURING CENTRIFUGATION
ENTRANCE TUBE FOR FLUID
A
GLASS CONTAINERS HOLD FLUID TO BE CLARIFIED
ELECTRIC MOTOR
B
ROTOR OF 20-CM DIAMETER SPINS AT 17,000 R P M
FLUID LEVEL DURING CENTRIFUGATION
CELLULOID TUBE
SEDIMENTED PARTICLES
ELECTRIC MOTOR, ¼ H P
C
CAMERA RECORDS MIGRATION OF SEDIMENTING BOUNDARY
AIR TURBINE OR ELECTRICAL DRIVING MECHANISM
COUNTERBALANCE
OIL GLAND ACTS AS VACUUM SEAL
FLEXIBLE STEEL SHAFT
TRANSPARENT CELL FOR FLUID
EVACUATED STEEL CHAMBER
ROTOR OF 18-CM DIAMETER SPINS AT 60,000 R.P.M
LIGHT SOURCE
D

FIG. 1.—PRIMARY CENTRIFUGAL METHODS: (A) INDUSTRIAL CENTRIFUGE OF CONTINUOUS-FLOW TYPE; (B) LOW-SPEED LABORATORY CENTRIFUGE WITH SWINGING BUCKETS; (C) LABORATORY CENTRIFUGE WITH INCLINED TUBES; (D) OPTICAL ULTRACENTRIFUGE FOR MEASUREMENT OF SEDIMENTATION RATES AND DETERMINATION OF PARTICLE SIZES

In the simplest type of machine, only one exit port is provided for the supernatant fluid, the sedimented particles being collected in the precipitated form after the rotation has been stopped. In other machines two overflow passages are used, one being at the level of the supernatant fluid and the other leading from the peripheral section of the fluid to an exit port located at a slightly greater radial distance than the overflow for the supernatant fluid. With this arrangement both a "light" fraction (supernatant) and a "heavy" fraction (of increased density because of increased concentration of heavier material or loss of lighter material) of fluid can be continually collected, the flow being kept sufficiently rapid to prevent complete sedimentation of the particles if they are of such a nature as to pack easily into a semisolid sediment.

In many cases, centrifugal bowls are provided with a series of laminations, usually conical in shape and known as separators. Subdividing the fluid into thin layers generally has the effect of speeding up the separating process by reducing the distance through which a particle has to move before its effective removal from the main body of fluid. As soon as a particle reaches the wall of a separator, it can collect with other particles into larger groups that will slide along the wall into the heavy fraction at the periphery, or toward the surface if the particles are of low density. Such an arrangement also minimizes stirring and remixing as the fluid flows through the centrifuge.

Laboratory Centrifuges.—Centrifuges are used extensively in biological and chemical laboratories for the clarification of fluids and for the concentration and purification of various biological and chemical agents.

Most laboratory centrifuges are of the swinging-bucket type (B in fig. 1) or, for work at higher speeds especially, of the inclined-tube type (C in fig. 1).

Submicroscopic disease agents such as influenza virus, smallpox virus, yellow fever virus and the virus of infantile paralysis are nearly always obtained in the presence of considerable extraneous material of both larger and smaller particle size. They might be found in the excreta, blood or other body fluids of an animal, or they might be recovered from ground extracts of certain tissues such as those of the brain or the lungs. Through the process of differential centrifugation already described, these biological agents can be partially purified for further study or for practical purposes such as the manufacture of vaccines.

Laboratory centrifuges of proper design may be used not only for preparative purposes but for semiquantitative investigation as well. As a matter of fact, such a study in various degrees of refinement is usually a preliminary step in selecting appropriate rotational speeds and centrifugation times for a desired purification procedure. If excessive convective disturbances and remixing within the fluid can be avoided, the approximate size of the sedimenting particles can be computed by determining the minimum time required at a given speed for a definite amount of sedimentation and applying the previously discussed formula for spherical particles. The method depends on the sampling of the centrifuged column of fluid at various levels and the determination, by specific biological, physical or chemical tests, of the amount of the respective agent present in each sample. In less quantitative work, almost all of the supernatant fluid may be drawn off into one sample and compared with the sediment after resuspension in fresh fluid.

Two practical difficulties often limit the efficiency of the sedimentation process and make quantitative determinations of sedimentation rate uncertain if not impossible. One involves the remixing caused by the tendency of the fluid to continue revolving as the centrifuge is decelerated to rest. The other involves convection currents caused by slight differences in the temperature of the liquid at different levels, and it is most serious with small particles which require long periods of centrifugation. Since convection is essentially a buoyancy phenomenon, its intensity is stepped up almost directly in proportion to the amount of centrifugal force, and hence convection can be caused by extremely small temperature differences, such as might arise from the difference in the amount of frictional air resistance suffered by a rotor at its periphery and at its centre.

The first difficulty can largely be avoided by using small centrifuge containers and by packing the particles under study into a semisolid sediment before stopping the centrifuge. Air resistance, and hence almost all convection, can be avoided by spinning the rotor within an evacuated chamber according to a method developed by E. G. Pickels and J. W. Beams, illustrated by (D) in fig. 1.

The elimination of air resistance also makes possible the attaining of high rotational speeds with relatively little expenditure of energy.

For small volumes of solution a very fast preparative centrifuge was constructed in 1951 by K. Beyerle and co-workers in Germany. Unlike all other centrifuges, in which the tubes are evenly distributed around the axis of rotation, this centrifuge contains only a single tube in a holder of special design. With a 7.5-c.c. tube the solution could be subjected to a centrifugal field of 500,000 times gravity at 84,000 r.p.m. With a 1.5-c.c. tube a field of 900,000 times gravity has been obtained at a speed of 120,000 r.p.m.

The Analytical Ultracentrifuge.—More precise determinations of particle size and weight can be made by centrifuging the suspension in a cell fitted with transparent windows and recording photographically the progress of the sedimentation (*see* D in fig. 1). This method was first used by T. Svedberg and J. B. Nichols in 1923 and was widely applied thereafter to determine the sedimentation rates and sizes of many submicroscopic particles, particularly protein molecules and viruses. Svedberg and H. Rinde proposed for the first optical centrifuge the name ultracentrifuge, denoting an instrument suitable for quantitative measurement. However, it became general practice to associate the term ultracentrifuge with any type of centrifuge operating at speeds of more than about 20,000 r.p.m.

Two different types of measurements may be carried out in the ultracentrifuge, viz., sedimentation velocity and sedimentation equilibrium. In the first instance when all of the suspended particles are of the same size, as might be the case with a solution of hemoglobin molecules, for example, the particles within any elemental zone of fluid, and hence within the same field of force, will migrate through the liquid at the same rate. Thus, the particles originally at the inner surface of the fluid will form a "rear line of march," or moving boundary, which demarcates the supernatant fluid and the sedimenting solute. It is by photographic recording of the continually changing position of this boundary at repeated intervals that precise determinations of sedimentation rate are made. From the sedimentation rate, in turn, the size or molecular weight of the particles can be determined if the shape factor is eliminated by a measurement of the diffusion constant. If particle groups of differing size are present, each group will form a separate boundary which sediments at a rate characteristic of the particle size. From a study of such multiple boundaries, the composition (from the standpoint of size) of the suspended matter in various biological fluids can be determined and reinvestigated following various treatments.

In the sedimentation equilibrium type of experiment the speed of the ultracentrifuge is so low (usually of the order of 6,000 r.p.m.) that no sharp boundary is formed, but a gradual displacement of the dissolved material takes place until equilibrium is established between sedimentation toward the periphery of the cell and diffusion in the opposite direction. Typically, a higher concentration obtains at the bottom of the cell and a lower concentration at the top. From the distribution of the dissolved substance at equilibrium, the molecular weight of the dissolved molecules may be calculated, or if this is known, the variation of its activity coefficient (*see* SOLUTIONS) with concentration may be determined. By this method substances having molecular weights from about 50 up to more than 50,000,000 have been studied. A great advantage of this type of experiment is that small quantities of material are required.

Migrating boundaries may be detected either through the absorption of visible or ultraviolet light by the sedimenting particles or through the refraction of transmitted light occasioned by the concentration gradient existing at the boundary. The first ultracentrifuges to operate at more than 50,000 r.p.m. were driven by an oil turbine about a horizontal axis in a hydrogen atmosphere at reduced pressure. As illustrated in fig. 1, most ultracentrifugal rotors are spun in an evacuated chamber about a vertical axis, and power is supplied by an air turbine or a special electric motor. For supporting the load at high speeds with a minimum of frictional resistance, successful use has been made of air bearings, magnetic bearings and mechanical bearings of novel design.

The rotor is connected to the driving mechanism through a flexible steel shaft, about $\frac{1}{8}$ in. in diameter, which permits a limited degree of self-balancing.

Following World War II, electrically driven ultracentrifuges operating at speeds up to 60,000 r.p.m. became available for both analytical and preparative purposes in biochemical and other research laboratories. Through refinements the analytical method was made applicable in certain cases even to small molecules of simple chemical structure. This was accomplished through a layering of clear solvent above the solution during acceleration of the ultracentrifuge. An initially sharp sedimentation boundary was thus formed away from the meniscus and its rate measured in spite of the slow sedimentation and rapid diffusion, which otherwise would prevent the formation of a measurable boundary by such small particles.

In some cases it is important to know whether a certain biological activity sediments at the same rate as one of the known components in a naturally occurring fluid. For this purpose various separation cells have been devised. In these, the cell content is subdivided and the re-mixing, usually occurring when the rotor is stopped, is prevented. After the conclusion of the experiment the content in the different sections may be analyzed and the rate of sedimentation for the active substance may be calculated from the distribution of the activity.

The ultracentrifuge has played an important role in the development of modern biochemistry and biophysics. By means of this apparatus it was shown in the early 1930s that most of the soluble proteins in solution exist as well-defined molecular units. At that time, this was contrary to the general view of the nature of protein molecules and gave a new impetus to the study of these substances.

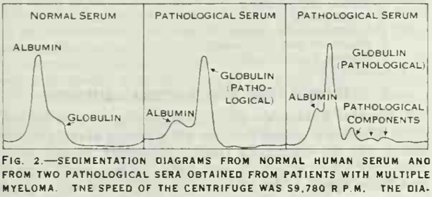

FIG. 2.—SEDIMENTATION DIAGRAMS FROM NORMAL HUMAN SERUM AND FROM TWO PATHOLOGICAL SERA OBTAINED FROM PATIENTS WITH MULTIPLE MYELOMA. THE SPEED OF THE CENTRIFUGE WAS 59,780 R.P.M. THE DIAGRAMS SHOW CONDITIONS AFTER ONE HOUR OF ULTRACENTRIFUGATION. THE AREA UNDER A PEAK IS PROPORTIONAL TO THE CONCENTRATION OF THE CORRESPONDING COMPONENT

In the preparation and purification of proteins and biologically active substances from naturally occurring biological fluids the ultracentrifuge has been of great help in deciding how to conduct a number of fractionations. Several hitherto unknown proteins have been discovered by this method. It has been used also in the study of the purity of protein preparations. Combined with electrophoretic analyses it is generally the most direct way to test the purity of a sample of a soluble protein.

In clinical research it has been used as an instrument for characterizing the serum proteins in various types of diseases accompanied by marked change in serum protein composition. The sedimentation diagram for a normal human serum and for two pathological sera from two cases of multiple myeloma is shown in fig. 2. It is seen that the relative amount of albumin is much reduced in the pathological sera, whereas the globulin is increased. Fig. 2 also shows the presence of some faster sedimenting components. In the case of a certain rare disease, Waldenströms macroglobulinemia, the final diagnosis for many years could be made only on the basis of the sedimentation diagram.

Beginning about 1950 hundreds of thousands of ultracentrifuge experiments were made on human sera in order to study the correlation between the lipoproteins in serum and arteriosclerosis.

Sedimentation studies of high molecular weight materials other than proteins have also yielded important results. The particle size distribution of synthetic high polymers and various plasma substitutes has been determined and attempts have been made to relate various properties of those materials to their particle size distribution.

See T. Svedberg and K. O. Pedersen, *The Ultracentrifuge* (1940); E. G. Pickels, "Ultracentrifugation," *Methods in Medical Research* (1952). (E. G. P.; K. O. P.)

CENTRING, a term applied to the temporary construction built to support arches, etc., while they are setting. Thus, in the case of an arch, the carpenter forms a "turning piece," shaped to take the bricks or masonry and properly tied and braced. This is strutted in position when the arch is completed by the bricklayer or mason. As soon as the work is set, the centring is carefully removed, which is called striking the centring. The same method is used in building brick sewers. The origin of the word centring is obvious from the primary use in centred arches, but the same term is applied to the use of scaffold boards to support concrete floors while they are setting hard. *See* ARCH AND VAULT; BRICKWORK; CARPENTRY.

CENTUMVIRI, a court of civil jurisdiction in ancient Rome (from Lat. *centum*, "hundred," and *vir*, "man"), which was probably instituted after 241 B.C., perhaps about 150. The judges originally numbered 105, 3 from each of the 35 tribes, but increased under the emperor Augustus until they later numbered 180. Elected in the 1st century B.C. by the *comitia tributa* (*see* COMITIA), they were selected by lot during the empire, and met in the Basilica Julia. Ex-quaestors (*see* QUAESTOR) were the presiding officers at the end of the 1st century B.C. but later were replaced by *decemviri stlitibus judicandis* ("board of ten for the trial of lawsuits"). They functioned only as *judices* since the *praetor urbanus* or *peregrinus* (*see* PRAETOR) conducted the proceedings *in jure* (preliminary hearing), and decided the choice between this court and a single *judex*. The *centumviri* judged a wide range of civil claims (*vindicationes*), especially inheritance claims, through which they influenced the law of succession.

See A. H. J. Greenidge, *Legal Procedure of Cicero's Time* (1901); H. F. Jolowicz, *Historical Introduction to the Study of Roman Law*, 2nd ed., pp. 203–205 (1952); A. Berger, *Encyclopaedic Dictionary of Roman Law*, p. 387 (1953). (T. R. S. B.)

CENTURION, in the ancient Roman army, the commander of a *centuria*, the 60th part of a legion. The 60 centurions in a legion were arranged in a complicated order of rank with wide variation in authority and responsibility from top to bottom. The senior centurion in each legion, the *primipilus*, participated in councils of war with the tribunes and *legati*. The senior centurion of a maniple or cohort was the commanding officer of those tactical units. Since the centurion was of plebeian origin and was promoted from the ranks, he is usually considered a noncommissioned officer. The duties of senior centurions, however, resembled those of modern company officers and battalion commanders. The ratio of centurions to men in the ranks (60 centurions to 4,200 men) was much less than the analogous ratio in modern armies. *See* also ARMY; LEGION. (Do. A.)

CENTURIPE, a town of Sicily, in the province of Enna, is situated 54 km. (33 mi.) W. of Catania by road, 2,380 ft. above sea level. Pop. (1961) 9,529 (commune). Until 1863 it was called Centorbi (anc. Centuripae). It is surrounded by deep ravines caused by erosion. Its chief features are the remains of the classical city including Hellenistic houses with wall paintings, baths and cisterns and a number of substruction walls on the steep slopes, mostly of the Roman period. Hellenistic terra cottas (including especially some small molded female figures) and finely painted vases of local manufacture were discovered and a large number of tombs excavated. The civic museum and the Palazzo Communale have exhibits of local antiquities. The chief industries are the cultivation of cereals and the extraction of chalk from the numerous caves. There are mineral springs.

Thucydides called Centuripae a Sicel city. It allied itself with Athens against Syracuse and remained independent (apart from the Syracusan tyrant Agathocles' domination) until the First Punic War. Cicero, perhaps exaggerating, called it the largest and richest city in Sicily. It appears to have suffered considerably in the war against Sextus Pompeius and not to have regained its prosperity under the empire. Frederick II partly destroyed it in 1232 and its ruin was completed by Charles of Anjou. It was later rebuilt by Francesco Moncada, count of Adernò, and his descendants ruled it as a county until 1813.

In 1860 Centuripe passed to the kingdom of Italy. In World War II it was captured by the Allies, after heavy fighting, on Aug. 3, 1943. (M. T. A. N.)

CENTURY PLANT. The century plant is a name given to *Agave americana* from the erroneous supposition that it flowers only when 100 years old. *See* AGAVE.

CEPHALIC INDEX, the percentage of breadth to length in any skull. The longer diameter of a skull, the antero-posterior diameter, is taken as 100; if the shorter or transverse diameter exceeds 80 the skull is broad (brachycephalic), if between 80 and

75 it is mesaticephalic, and if below 75 dolichocephalic (*see* RACES OF MANKIND; SKULL).

CEPHALOCHORDA, a subphylum of the animal phylum Chordata; these fishlike animals, represented by *Amphioxus* and its allies, are of interest because of their primitive chordate features.

See AMPHIOXUS; CHORDATE.

CEPHALONIA (Lat. CEPHALLENIA; Gr. KEFALLINIA), the largest of the Ionian Islands on the west of the Greek mainland. Pop. (1961) 46,302. Its length is 32 mi. and its breadth varies from about 27 mi. in the south to less than 3 mi. in the promontory opposite Ithaca. Area is 297 sq.mi. The whole island is mountainous, the main range running from northwest to southeast. Cephalonia (anc. Mt. Aenos; 5,341 ft.) frequently has snow for several months. There are few permanent streams except the Rakli, and springs are likely to fail in dry summers. In the west a gulf runs up from the south, a distance of about 7 mi.; on its east side is the chief town, Argostolion (*q.v.*), and on its west the rival city of Lixourion. About 5 mi. from Argostolion is the Venetian castle of S. Giorgio. The ruins of Crane are close to Argostolion, those of Pale to Lixourion. On the other side of the island the remains of Same are on the bay of Samis, those of Pronni farther south above the vale of the Rakli. Near the village of Skala is a nameless site with Roman baths and tessellated pavements, a brick temple and rock tombs. Many Mycenaean tombs were found near Mazarata and Diakata. Only a small proportion of the soil is under cultivation, and the grain production is meagre. The chief crop is the currant, in which Cephalonia surpasses Zante. The fruit is smaller than that of the Peloponnesus, and has a peculiar flavour. Grapes are grown for wine. The olive crop is of importance, and cotton is grown on the low ground.

Manufactures are few: lace from aloe fibre, Turkey carpets and basketwork in the villages and boatbuilding at both the principal towns. Of all the seven Ionian Islands Cephalonia and Zante (*q.v.*) are the most purely Greek.

History.—The island was an important Mycenaean centre, and was known to Homer as Same. It took little part in the Persian War; in the Peloponnesian War it sided with the Athenians. The town of Pale supported the Aetolian cause and was vainly besieged by Philip V of Macedonia in 218 B.C. In 189 B.C. all the cities surrendered to the Romans, but Same afterward revolted and was reduced only after a siege of four months. The island was presented by Hadrian to Athens, but it appears again later as "free and autonomous." After the division of the Roman empire it was attached to Byzantium till 1082, when it was captured by Robert Guiscard, who died, however, during the revolt of 1085. In 1204 it was assigned to Gaius, prince of Tarentum, who accepted the protection of Venice in 1215. After 1225 it was held with Santa Maura (mod. Leukas) and Zante by the Tocco family at Naples. Formally made over to Venice in 1350 by the prince of Tarentum, it fell to the Turks from 1479 to 1500, but Venice held it again till the fall of the republic.

For some time it was administered for the French government. In 1809 it was taken by the British, under whom it advanced in material prosperity, but was several times the scene of political disturbances. After its annexation to Greece in 1864 it was broken up into 20 demarchies, each with its separate jurisdiction and revenues, and the police system was abolished. In 1941 it was occupied by Italy, and was liberated in 1944. In 1953 it suffered a severe earthquake.

See also CORFU; IONIAN ISLANDS. (J. Bo.)

CEPHALOPODA, a small group of highly organized invertebrate animals of exclusively marine distribution constituting a class of the phylum Mollusca. About 130 genera and 650 species of living cephalopods are known, of which the octopus, squid and cuttlefish (*qq.v.*) are the most familiar representatives. The extinct forms, however, outnumber the living, the class having attained very great diversity in late Paleozoic and Mesozoic times (ranging from 70,000,000 to 235,000,000 years ago). Of extinct cephalopods the ammonites (*q.v.*) and belemnites are the best known examples.

This article is divided into the following sections:

- I. Introduction and Natural History
  - 1. General Features
  - 2. Economic Uses
  - 3. Distribution
  - 4. Nutrition
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- II. Form and Function
  - 1. Body Plan
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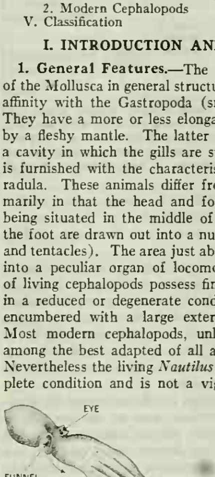
I. INTRODUCTION AND NATURAL HISTORY

1. General Features.—The Cephalopoda agree with the rest of the Mollusca in general structure and appear to have the closest affinity with the Gastropoda (snails, periwinkles, limpets, etc.). They have a more or less elongate body (visceral mass) covered by a fleshy mantle. The latter may secrete a shell and encloses a cavity in which the gills are suspended. The alimentary canal is furnished with the characteristic molluscan rasping tongue or radula. These animals differ from the rest of the Mollusca primarily in that the head and foot are approximated, the mouth being situated in the middle of the foot, and that the edges of the foot are drawn out into a number of fleshy appendages (arms and tentacles). The area just above the edge of the foot is formed into a peculiar organ of locomotion, the funnel. The majority of living cephalopods possess fins, and their shell is internal and in a reduced or degenerate condition. Many fossil cephalopods, encumbered with a large external shell, were poor swimmers. Most modern cephalopods, unhampered by a large shell, are among the best adapted of all animals for active life in the sea. Nevertheless the living *Nautilus* (*q.v.*) retains the shell in a complete condition and is not a vigorous swimmer.



FROM A LANG, "LEHRBUCK DER VERGLEICH. ANAT." 1892

FIG. 1.—AN OCTOPUS (OCTOPUS VULGARIS): (TOP) SWIMMING BY MEANS OF WATER EXPELLED THROUGH FUNNEL: (BOTTOM) AT REST

For invertebrate animals the Cephalopoda attain a large average size. The giant squids (*Architeuthis* species) are actually the largest living invertebrates, the Atlantic species *Architeuthis princeps* attaining a total length of more than 60 ft., including the extended tentacles. Some squids and octopuses, however, are no more than an inch long; the average-sized octopus usually has arms no longer than 12 in., and rarely longer than 36 in. The shell of the fossil ammonite *Pachydiscus seppenradensis,* from Cretaceous rocks in Westphalia, measures 6 ft. 8 in. in diameter; it is considered the largest shelled mollusk. Although not such a flourishing group as they were in earlier geologic time, the Cephalopoda are still one of the major groups of marine animals. They are relentless enemies of Crustacea and small fishes, and are, in turn, the principal prey of toothed whales and other marine carnivores. The bizarre appearance of Cephalopoda, the sinister eyes and the secretive habits of some of the shore-living forms have made them a subject of legend among imaginative peoples. Authors have not hesitated to exaggerate the horrors of the attack of a giant squid or an octopus.

Denis de Montfort and Victor Hugo have invested them with a melodramatic violence that has taken root in popular fancy. Nor is this reputation for ferocity entirely unmerited, especially among the giant squids, insofar as attacks on human subjects are concerned.

2. Economic Uses.—Cephalopods occur in very large numbers in the sea and form one of the greatest potential food resources of the oceans. They are eaten by man in many parts of the world, although they never have been accepted generally in North America or northern Europe. Besides being a direct source of food for mankind, they are indirectly important since they furnish a large part of the diet of the sperm whale and some of the smaller whales and seals which are economically important. In Nova Scotia the squid *Illex* supports an important bait fishery, the catch of codfish being in direct relation to the squid catch. Squids, cuttlefishes and octopuses are eaten and highly prized along the shores of the Mediterranean, in India, Indochina, Malaysia, China, Japan and the Pacific islands.

China and Japan lead in consumption of cephalopods. Japan, one of the leading fisheries nations of the world, lands about 600,000 tons of squid annually, the greater part being *Todarodes pacificus,* in some sections amounting to about 60% of the total landings. The catch in China is also high but statistics are inadequate, only cuttlefish with an annual catch of about 80,000 tons being reported. In Europe Italy leads with a catch of about 22,000 tons. In North America about 11,000 tons are landed, of which nearly one-half are landed in eastern Canada.

Cephalopods are taken in a variety of ways, the squids usually by nets at night after they have been attracted by powerful electric lights. They also are caught by jigging with hand lines and by trolling. Octopuses are taken in fish traps, in earthen pots strung together in long lines or by searching them out in their lairs and spearing them.

Cephalopods are prepared in many ways. In Japan they are largely split and sun-dried, but are often canned in the U.S. and in Spain and Portugal, being put up in the last two mentioned countries in olive oil. The fresh product is either boiled or more often fried, and when well prepared somewhat resembles scallops in flavour.

3. Distribution.—The Cephalopoda are exclusively marine animals. There are numerous littoral species, but few have been reported from even slightly brackish water and one from the mouth of a fresh-water stream (Hoyle, 1907). The squid *Lolliguncula brevis* occurs along the Florida coast in several areas having a salinity of 15–17 parts per thousand or per mille $(^0/_{00})$. Cephalopods are eliminated, except as wanderers, from the Baltic sea because of lowered salinities. On the other hand, they have been found in certain areas of the Suez canal where salinities are higher than in the oceans. There is some evidence that in parts of the open sea that differ only slightly in salinity there may be a varying cephalopod fauna.

Geographical Distribution.—The geographical distribution of the Cephalopoda is still incompletely known. In general the open ocean pelagic and bathypelagic forms are cosmopolitan in warm and temperate waters; for example, *Ommastrephes bartrami, Onychoteuthis banksi, Cranchia scabra, Liocranchia reinhardti,* etc. On the other hand, the ommastrephids in general are limited by genera to particular oceans or to continental waters. Even some species of bathypelagic habitat are limited to one ocean. This is undoubtedly due in part to the type of larvae that they have. The Octopoda, as a result of their bottom dwelling habits, show stronger restrictions in their distribution, but *Octopus vulgaris* and *O. macropus,* both species with small eggs and hence planktonic larvae, have gained world-wide distribution. Several species, including *Bathypolypus arcticus,* are known to occur along both sides of the North Atlantic. *Illex illecebrosus,* the common northern American squid, has its southern boundary in Europe at about the English channel, replaced to the southward by *I. coindeti.* In general, the pelagic and planktonic cephalopods conform in their distribution to the other pelagic animals. They are limited by the salinity and temperature barriers of certain of the major ocean currents such as the Canaries current that segregates a northeastern Atlantic fauna and the Agulhas current that separates the temperate fauna of the Atlantic and the Indo-Pacific. Although these currents are barriers to the surface fauna, they undoubtedly have much less effect upon the bathypelagic species. It should be pointed out that knowledge of the geographical distribution of the cephalopods is still limited by the status of their systematics; finer differences may show more segregation than is presently known.

Vertical Distribution.—The vertical distribution of cephalopods, like the geographical distribution, is also incompletely known. Some general conclusions can be drawn, however. *Nautilus* moves vertically through the water, living near the bottom, and has been obtained at a depth of about 550 m. It is fished in the Philippines, however, when it comes into shallow water. In the Sepioidea the Sepiidae (*Sepia*) are littoral, whereas the Sepiolidae (*Heteroteuthis, Sepiola*) dwell on or near the bottom down to considerable depths. In the Teuthoidea, the Myopsida (*Loligo*) are coastal forms, whereas the Oegopsida are oceanic, living from the surface to depths in excess of 5,450 m.

In general the oceanic species may be grouped by families according to their depth range. The Lycoteuthidae, Enoploteuthidae, and Ommastrephidae normally occur from the surface to about 500 m.; the Onychoteuthidae from the surface to 150–200 m.; and the Histioteuthidae and Chiroteuthidae range from the surface to over 1,500 m. *Chiroteuthis lacertosa* has been taken at a depth of about 5,400 m. The Cranchiidae are planktonic animals, drifting more or less at the mercy of the currents, although certain forms such as *Mesonychoteuthis hamiltoni* and *Liocranchia reinhardti* in the adult stage may be active predatory species.

The larvae of both octopuses and squids are usually planktonic in the surface layers. The Octopoda occur from the surface of the open ocean (*Tremoctopus*) to the deep bathypelagic layers (*Eledonella* at about 5,300 m.); most are bottom-dwelling forms restricted to the continental shelf and its slope. One group, the Cirrata, are deep-sea in habitat, showing many adaptations for this mode of life.

Schooling.—Alcide d'Orbigny, in his account of the Mollusca of South America, asserted that the Cephalopoda are in general sociable, *i.e.,* gregarious, and this statement is certainly true of *Nautilus,* which are found together in droves (A. Willey, 1902). Nevertheless, Jatta, who made a special study of the Mediterranean forms, was of the opinion that only certain pelagic forms are gregarious (*Todarodes, Ocythoe*). W. Rees and G. Maul have also reported schools of the large oceanic squid *Thysanoteuthis rhombis* at Madeira. Although there is no proof that numbers constitute gregariousness, octopus "villages" also have been reported and A. E. Verrill adduced evidence that the shoaling of young *Loligo pealei* off the coast of New England is not accidental.

The breeding season also has a marked effect on the local distribution of certain Cephalopoda. The common cuttlefish (*Sepia officinalis*) comes into shallow water in the spring and summer to breed, and migrations of a similar nature have been observed in other forms (*Loligo, Alloteuthis*).

4. Nutrition.—The majority of living Cephalopoda are carnivorous and live principally on Crustacea. They also feed on small fishes. A food cycle has been shown in the New England *Illex,* in which the adults feed upon young mackerel and the adult mackerel in turn feed upon the young squid. *Octopus vulgaris* feeds also upon bivalve mollusks and sometimes causes severe losses in the lobster industry. Squid are also cannibalistic, feeding upon their own kind and other related species. The smaller oceanic squid probably feed primarily upon small fish, copepods, heteropods and caridean shrimp. The Cirrata, which have reduced musculature and radula, indicating a loss of activity and of masticatory power, probably feed on bottom debris or minute plankton. G. C. Robson, from a study of the anatomy of the giant squid, *Architeuthis,* decided that this animal, despite its size and reputed ferocity, probably is a bottom scavenger living along the continental slope.

The Cephalopoda are fed upon by the toothed whales, porpoises, dolphins, large fish, seals and sea birds. The stomachs of sperm whales are often found to contain whole small to giant squids and fragments of arms, mandibles and sucker rings.

5. Colour, Luminescence and Behaviour.—*Colour Changes.*—Colour in the Cephalopoda is determined by a cutaneous system of contractile cells (chromatophores) containing pigment and an underlying layer of iridescent or reflecting cells (iridocytes). The iridocytes are closely packed beneath the skin in the Decapoda, giving these animals their iridescent hues, but in the Octopoda they are deeper and more diffused. The chromatophores, innervated by certain nerves, can be widely expanded to reveal the colours of the pigment or tightly contracted to the point of disappearance. The pigments are brown, black, red, yellow or orange-red, but there are variations. No cephalopod contains all these colours, but is limited usually to only three. By combinations of these three colours, a variety of other colours can be produced. E. V. Cowdry has studied colour changes in the common octopus, and J. Z. Young and others have studied them in other species.

E. V. Cowdry has described the colour patterns of *Octopus vulgaris* at Bermuda, and other species have been studied at Naples. While certain colour patterns are protective, resembling the background on which the animal rests, others appear to indicate emotion, varying from fear to rage, and whole series of colours may pass over the animal in rapid successive waves.

Skin Changes.—The skin itself may be changed from smooth to rough to papillae or even arborescent projections. *Octopus arborescens* from the Indo-Pacific possesses sculpture of the last type, whereas *O. hummelincki* from the West Indies possesses straplike papillae that blend with the background of marine plants of the coral reefs.

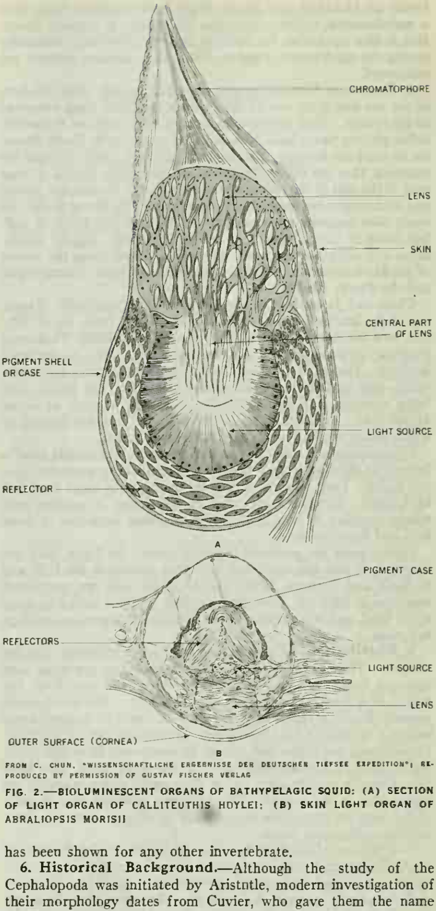
"Ink" Ejection.—One of the chief aids in escaping from enemies, however, is the ink that all but some of the deep sea octopods can eject when in danger. This has commonly been likened to a smoke screen behind which the animal may escape. While this is true for the octopods, it also may serve to deaden temporarily the organs of smell and sight in fishes like the moray eel that prey upon octopods. In the squids, however, the ink is ejected as a cigar-shaped body about the size of the squid itself, the ink coagulating in the water. With this "dummy" left behind, the squid contracts its chromatophores, becomes colourless and speeds away.

Luminescence.—In certain of the Decapoda, notably those that live in the intermediate depths, special light organs (photophores) are developed on and within the mantle, arms and head. No light organs are known in *Nautilus* or the Octopoda, but they are found in the Vampyromorpha and in numerous groups of the Sepioidea and Teuthoidea. In most of the Teuthoidea the light is produced by a luciferin-luciferase reaction (*see* BIOLUMINESCENCE). In many of the Sepioidea, especially those in which the light organ is associated with the ink sac, the light is said to be produced by symbiotic luminescent bacteria. In some of the Sepioidea that dwell in deep water, luminescent ink is produced.

The value of bioluminescent organs in the Cephalopoda is still a matter of conjecture. It has been thought that in certain of the smaller squids they are used in mating play. While this may be true of some of the shore squids, it is unlikely that such is the case in the deep-water forms such as *Pyroteuthis* or *Calliteuthis*. In these animals bioluminescent organs are more likely of value for species recognition by the two sexes. These organs may also be used for attracting planktonic prey, as has been shown for certain light producing fishes. This may be the case in *Chiroteuthis lacertosa*, which is equipped with a large light organ at the end of the tentacular club that is surrounded by a cluster of dangling hooks.

In *Calliteuthis* a remarkable asymmetry is found in the head: one eye is nearly twice the diameter of the other. It has been suggested that the large eye is functional in deep water, where the only light is that produced by luminous animals, and the small eye functions near the surface in increased illumination.

Behaviour.—The behaviour of *Octopus* has been studied by many workers at the Zoological station at Naples. These animals have been credited with behaviour approaching true intelligence. J. Z. Young and his colleagues have demonstrated that they are capable of remembering and learning to a much higher degree than has been shown for any other invertebrate.



FROM C. CHUN, "WISSENSCHAFTLICHE ERGEBNISSE DER DEUTSCHEN TIEFSEE EXPEDITION"; REPRODUCED BY PERMISSION OF GUSTAV FISCHER VERLAG

FIG. 2.—BIOLUMINESCENT ORGANS OF BATHYPELAGIC SQUID: (A) SECTION OF LIGHT ORGAN OF CALLITEUTHIS HOYLEI; (B) SKIN LIGHT ORGAN OF ABRALIOPSIS MORISII

6. Historical Background.—Although the study of the Cephalopoda was initiated by Aristotle, modern investigation of their morphology dates from Cuvier, who gave them the name by which they are now known. H. de Blainville (1777–1850) and Alcide d'Orbigny (1802–57) laid the foundation of cephalopod systematics. The great monograph of d'Orbigny, *Histoire Naturelle, générale et particulaire, des Cephalopodes acetabulifères, vivants et fossile,* is a landmark in systematic zoology; it included descriptions of fossil as well as living species. R. Owen contributed substantially to the knowledge of the morphology of the class. R. A. von Kölliker may be said to have founded the embryological study of cephalopods (1843), and Alpheus Hyatt (1868) led the way in early paleontological studies.

The first great modern teuthologist, J. Steenstrup of Copenhagen, in a long series of papers placed the modern systematic study of cephalopods on a firm foundation. A. E. Verrill led the study of the group in America and first made known (1882) the complexity and richness of the rare deep-sea fauna from his studies of the waters off the New England coast.

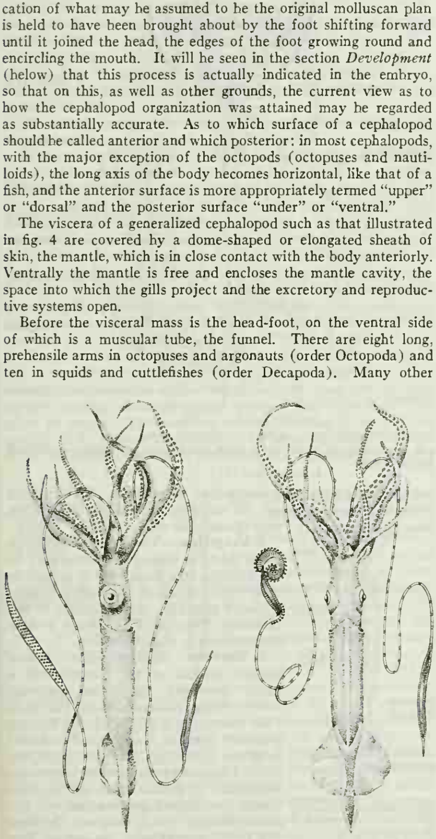
W. E. Hoyle described (1886) the rich collections obtained by the "Challenger" expedition. Since then many investigators have contributed to our knowledge of the living and fossil forms. Particular mention must be made of A. Naef, who subjected the living and fossil forms to a synthetic treatment. The monumental work by Robson on the octopods has been followed by a modern statistical treatment by Grace Pickford. W. Adam has cleared away much of the confusion in the cuttlefish. The systematic treatment of the cephalopods is now turning toward monographic studies and revisions, although many new species remain to be described. The study of the habits, ecology and bathymetric distribution of cephalopods are rewarding fields still awaiting investigation.

II. FORM AND FUNCTION

1. Body Plan.—The view has been widely accepted that in the Cephalopoda the surface of the foot has become very much shortened as compared with that of other mollusks. The length of the body has been reduced, while its height increased. This modification of what may be assumed to be the original molluscan plan is held to have been brought about by the foot shifting forward until it joined the head, the edges of the foot growing round and encircling the mouth. It will be seen in the section *Development* (below) that this process is actually indicated in the embryo, so that on this, as well as other grounds, the current view as to how the cephalopod organization was attained may be regarded as substantially accurate. As to which surface of a cephalopod should be called anterior and which posterior: in most cephalopods, with the major exception of the octopods (octopuses and nautiloids), the long axis of the body becomes horizontal, like that of a fish, and the anterior surface is more appropriately termed "upper" or "dorsal" and the posterior surface "under" or "ventral."

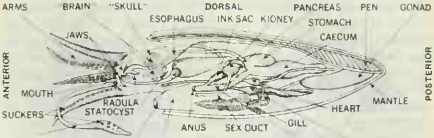
The viscera of a generalized cephalopod such as that illustrated in fig. 4 are covered by a dome-shaped or elongated sheath of skin, the mantle, which is in close contact with the body anteriorly. Ventrally the mantle is free and encloses the mantle cavity, the space into which the gills project and the excretory and reproductive systems open.

Before the visceral mass is the head-foot, on the ventral side of which is a muscular tube, the funnel. There are eight long, prehensile arms in octopuses and argonauts (order Octopoda) and ten in squids and cuttlefishes (order Decapoda). Many other smaller cephalopods may have numerous small and comparatively weak appendages: *Nautilus* has about 90. The circlet of arms encircles the mouth.



FROM C. CHUN, "WISSENSCHAFTLICHE ERGEBNISSE DER DEUTSCHEN TIEFSEE EXPEDITION"; REPRODUCED BY PERMISSION OF GUSTAV FISCHER VERLAG

FIG. 3.—CHIROTEUTHIS IMPERATOR (ABOUT ONE-FOURTH NATURAL SIZE), SHOWING LONG TENTACLES AND SHORTER ARMS



FROM T. I. STORER & R. L. USINGER, "GENERAL ZOOLOGY"; REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO. (1957)

FIG. 4.—INTERNAL STRUCTURE OF A SQUID (LOLIGO); LEFT SIDE OF BODY AND FIVE ARMS REMOVED

2. Relation to Life Habits.—The main divergences of structure are indicated in the section *Classification* (below); but, for the sake of rendering clear the importance of some of the details that follow, it is necessary to introduce two important facts: (1) *Nautilus* with its external, coiled shell represents a more primitive and less specialized group, the subclass Tetrabranchia; and (2) the subclass Dibranchia (including octopuses, squids, etc.) have acquired a more active and vigorous mode of life that has led to certain marked departures in structure and function from the type represented by *Nautilus* and (it is assumed) the fossil ammonites. Among the Dibranchia themselves certain important habitudinal divergences are established, and hand in hand with these are associated certain structural and physiological adaptations, *e.g.*, to a sluggish life spent in the great depths of the sea, to a floating life in the mid-waters or to a more active and aggressive existence near the surface. The following account attempts to present the main structural and physiological features of the cephalopods in relation to their mode of life.

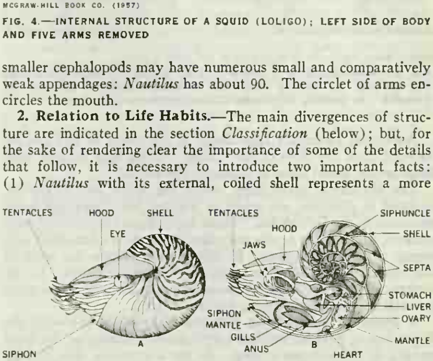


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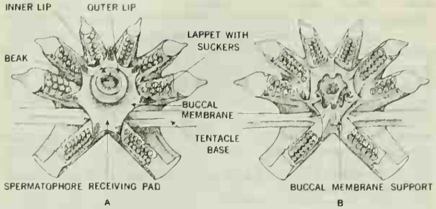
FIG. 5.—PEARLY NAUTILUS (NAUTILUS POMPILIUS): (A) EXTERNAL FEATURES; (B) SECTION SHOWING INTERNAL FEATURES

The fossil nautiloids and ammonites were in all probability mainly shallow-water animals living near the bottom. They relied for protection on a calcareous external shell and their speed of movement was probably inconsiderable. The modern *Nautilus* represents this mode of life very closely.

The Dibranchia are, on the whole, more active, and swimming or floating has become their characteristic mode of locomotion.

Associated with their active life, the dibranchians show the following features in their external organizations. The mantle, which in the majority of mollusks and in the Tetrabranchia has a passive role, merely containing the viscera and secreting the shell, has become involved in the mechanism of locomotion. It has almost entirely lost the rigid shell and has become highly muscular. Its expansion and contraction produce a locomotory water current by drawing water into the mantle cavity and expelling it through the funnel. The rapid ejection of this jet of water enables the animal to execute quick backward movements. A locking mechanism seals the mantle opening while the locomotory jet is under compression: a cartilaginous stud or ridge on each side of the edge of the mantle fits securely into a pair of corresponding sockets on the head.

The funnel, which in *Nautilus* is represented by two muscular folds that meet in the middle line, is, in the Dibranchia, completely fused forming a tube.



FROM A. NAEF, "FAUNA UND FLORA DES GOLFES VON NEAPEL" (1923)

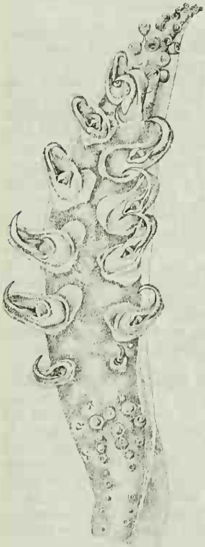
FIG. 6.—MOUTHFIELD OF A SQUID (LOLIGO VULGARIS) WITH OUTSPREAD ARM STUMPS: (A) BUCCAL MEMBRANE OUTSPREAD SHOWING SUCKERS ON LAPPETS; (B) BUCCAL MEMBRANE CLOSED SHOWING SUPPORTS

Additional locomotor appendages in the shape of fins are developed from the sides of the mantle. These may become very large and no doubt assist in balancing the animal.

The circumoral appendages, which are many and feebly developed in *Nautilus*, are fewer in number but larger and more muscular in the Dibranchia. These appendages are provided with suckers, which in the squids and other decapods are furnished with horny, often toothed rims. In certain dibranchians the teeth of the suckers are modified as large and formidable hooks. In the decapods two of the arms are specially modified as longer and more powerful tentacles used in the capture of prey.

3. Internal Supporting Structures and Viscera.—All the Cephalopoda have an internal cartilaginous covering of the main ganglia of the nervous system. In the Dibranchia this is more complete than it is in *Nautilus*. It encircles the ganglia and constitutes a kind of skull. Besides this structure various Dibranchia are secured by skeletal supports of the muscles that are found at the base of the fins and in the "neck," gills and arms.

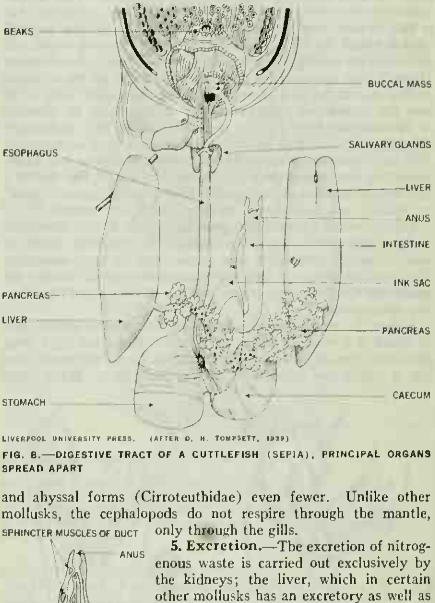
The alimentary system of the Cephalopoda consists of a muscular buccal mass, furnished with a pair of jaws (mandibles) and a rasping tongue (radula); esophagus; salivary glands; stomach; caecum; liver; and intestine. Efficient mastication is secured by the powerful mandibles and sharp-pointed teeth of the radula. In the Octopoda the esophagus is expanded to form a crop. In the deep-sea Cirrata, which apparently feed on bottom debris, the radula is frequently degenerate or absent and there is a "second stomach," a capacious dilatation of the intestine. In the Dibranchia the pancreatic element of the liver is partly separated from the latter. Nearly all the members of this subclass have near the anus an intestinal pouch into which is secreted a dark fluid, the sepia, or ink. This ink can be forcibly discharged, the dark cloud thus formed in the water often serving as a means of escape from enemies (see *Distribution and Natural History*). This so-called ink sac is absent in *Nautilus* and in certain deep-sea Octopoda.



FROM C. CHUN "WISSENSCHAFTLICHE ERGEBNISSE DER DEUTSCHEN TIEFSEE EXPEDITION"; REPRODUCED BY PERMISSION OF GUSTAV FISCHER VERLAG

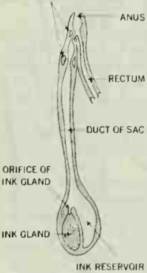
FIG. 7.—TENTACULAR CLUB OF A SQUID (GALITEUTHIS ARMATA)

4. Circulatory and Respiratory Systems.—The Cephalopoda, in contrast to the other mollusks, possess a closed circulatory system of blood vessels, with the exception of *Nautilus* in which it is partly lacunar. The blood of cephalopods contains a blue respiratory pigment, hemocyanin, a copper compound dissolved in the plasma. The circulatory system has three hearts, one systemic and two branchial, one at the base of each gill. These modifications all are associated with the highly mobile and energetic life of the cephalopods in contrast to the sedentary habit of the rest of the mollusks. The mechanism of respiration is likewise more efficient in the Dibranchia, the rhythmical contractions and expansions of the mantle musculature causing a circulation of water over the gills. The featherlike gills, each consisting of a central axis with a row of lamellae on either side, are suspended freely in the mantle cavity. In the Decapoda the gill may possess as many as 40 lamellae per side; however, that number is reduced in the Octopoda, the common octopus possessing only 9–11 and abyssal forms (Cirroteuthidae) even fewer. Unlike other mollusks, the cephalopods do not respire through the mantle, only through the gills.



LIVERPOOL UNIVERSITY PRESS. (AFTER D. H. TOMPSETT, 1939)

FIG. 8.—DIGESTIVE TRACT OF A CUTTLEFISH (SEPIA), PRINCIPAL ORGANS SPREAD APART



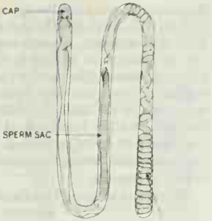
FROM "CAMBRIDGE NATURAL HISTORY," VOL. III, MACMILLAN & CO. LTD. (1898)

FIG. 9.—INK SAC OF A CUTTLEFISH (SEPIA), SHOWING ITS RELATIONSHIP TO THE RECTUM

5. Excretion.—The excretion of nitrogenous waste is carried out exclusively by the kidneys; the liver, which in certain other mollusks has an excretory as well as digestive role, does not participate in this function. There are four kidneys in *Nautilus* and two in the Dibranchia.

6. Nervous System.—The central nervous system of the Cephalopoda is highly developed, the major ganglionic centres being concentrated in the head. This condensation of the central nervous system is found in *Nautilus* and perfected in certain Dibranchia. In some of the cuttlefish (Sepioidea) the cerebral centres are subdivided for specialization and the pedal ganglia are divided into brachial and epipodial elements which innervate the arms and funnel respectively. In certain Teuthoidea the mantle is innervated by giant paired dorsal axons, the largest nerve fibres known. Such axons are found in all of the powerful swimming squids but are absent in feeble swimmers such as the giant squid, *Architeuthis*. The sense organs of the Cephalopoda are eyes, rhinophores (olfactory organs), statocysts (organs of equilibrium) and tactile organs. In *Nautilus* the eyes are open pits without lenses. In the Dibranchia the eyes are very complex and approach those of the vertebrates in efficiency.

7. Reproductive System.—The sexes are usually separate in the Cephalopoda, but G. E. Pickford has reported a case of hermaphroditism in a specimen of *Octopus vulgaris* from Trinidad. Sexual dimorphism is common but is usually expressed in slight differences of size and in the proportion of various parts. In some species there is a preponderance of males and in others a preponderance of females. In the paper nautilus (*see* NAUTILUS) the males are much smaller than the females; they exhibit one of the greatest size discrepancies in the animal kingdom.



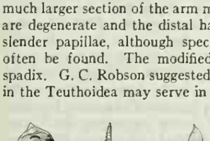
FROM "BULLETIN OF MARINE SCIENCE OF THE GULF AND CARIBBEAN," VOL. 1

FIG. 10.—SPERMATOPHORE STRUCTURE OF AN OCTOPUS (OCTOPUS BURRYI)

The female reproductive system is simple, consisting usually only of posterior gonads and paired oviducts.

In the males the system is complicated by a series of chambers or sacs along the course of the *vas deferens;* these sacs produce long tubes (spermatophores) to contain the spermatozoa, the final sac (Needham's organ) also being used for their storage. The spermatophores are complicated structures containing a sperm reservoir, mid-part, horn, cap and delicate triggering mechanism for the release of the spermatozoa. Since spermatophores vary from species to species they are important taxonomic characters.

During courtships (see *Reproduction and Development*) the spermatophores are deposited on the female either within the mantle cavity or on a pad below the mouth by means of a specially modified arm termed the hectocotylus. The hectocotylized arm in *Octopus* bears a spoonlike terminal organ. In the Teuthoidea a much larger section of the arm may be modified; often the suckers are degenerate and the distal half of the arm bears rows of long slender papillae, although special pouches and large flaps may often be found. The modified arm of *Nautilus* is termed the spadix. G. C. Robson suggested that the modifications of the arm in the Teuthoidea may serve in exciting the female and termed it the nuptial arm.



(A) FROM A. E. VERRILL, "REPORT U.S FISH COMMISSION, 1879"; (B) FROM G. E. PICKFORD, "TRANSACTIONS OF THE CONNECTICUT ACADEMY OF ARTS AND SCIENCES" (1946); (C) FROM "BULLETIN OF MARINE SCIENCE OF THE GULF AND CARIBBEAN," 4(2); (D) FROM C. CHUN, "WISSENSCHAFTLICHE ERGEBNISSE DER DEUTSCHEN TIEFSEE EXPEDITION"; REPRODUCED BY PERMISSION OF GUSTAV FISCHER VERLAG; (E) FROM A. NAEF, "FAUNA UND FLORA DES GOLFES VON NEAPEL" (1923)

FIG. 11.—TYPES OF HECTOCOTYLIZED (NUPTIAL) ARMS

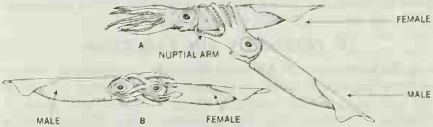
Right third arm of: (A) *Bathypolypus arcticus;* (B) *Octopus vulgaris;* (E) *Tremoctopus violaceus.* Left ventral arm of: (C) *Lolliguncula brevis;* (D) *Pterygioteuthis giardi*

III. REPRODUCTION AND DEVELOPMENT

1. Mating and Spawning.—Little is known about the mating habits of cephalopods. E. Racovitza has described in general outline the mating behaviour of the common octopus. The male and female remained some distance apart while the male first caressed the female with the tip of the hectocotylized arm. The male then inserted the tip of his arm into the mantle cavity of the female, remaining for over an hour, during which time the sperm bundles traveled down the longitudinal groove of the arm. In the cuttlefish, according to L. Tinbergen, the pair of *Sepia* swim side by side, the male indulging in some "love play" with his arms. Eventually, mating takes place by the pair intertwining their arms and remaining together while the spermatophores are placed on the inner side of the female's mouth membrane. A somewhat similar type of mating has been shown for the Pacific coast squid, *Loligo opalascens*, which however do not pair off. In octopuses and cuttlefishes the life span is not known but it probably includes several spawning seasons. In the smaller squids such as *Loligo*, however, the males usually die after mating and the females after spawning.

The eggs of most coastal species are laid inshore and are attached singly or in clusters to floating material, or more frequently to bottom objects, coral fragments, algae, etc. Practically nothing is known about the spawn or spawning of the oceanic squids, but G. Pickford has found eggs of the Vampyromorpha and has correlated their vertical distribution with water density. Parental care is exhibited only by octopuses in which the female broods over the eggs. In all the others known, with the exception of *Argonauta*, which broods its eggs in her egg-case shell, the eggs are left to the mercy of predators. Those squids that attach their eggs to the bottom engulf them in a gelatinous mass that protects them from fungus attack and at the same time deters such predators as fish.

2. Development.—The embryological development of *Nautilus*, unfortunately not yet known, may hold clues to the phylogeny of the cephalopods. The eggs of all cephalopods are provided with a remarkable amount of yolk so that, unlike that of the rest of the Mollusca, the segmentation is incomplete and restricted to one end of the egg. The embryo is likewise localized at this end, and the ectoderm appears stretched out over a large mass of yolk. Later on, a sheet of cells is developed below the ectoderm, commencing from that edge of the ectoderm at which the anus is subsequently developed; after this, cells migrating inward from the ectoderm give rise to the mesendoderm.

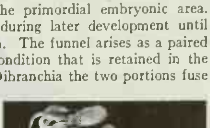


FROM J. A. MCGOWAN, "CALIFORNIA FISH AND GAME" (1954)

FIG. 12.—COPULATING SQUID (LOLIGO VULGARIS): (A) POSITION WHEN SPERMATOPHORES ARE TRANSFERRED TO MANTLE CAVITY; (B) POSITION WHEN SPERMATOPHORES ARE TRANSFERRED TO BUCCAL SPERM RECEPTACLE

The mouth in the early stage of development is not surrounded by the arm rudiments. The latter arise as outgrowths of the lateral and posterior edges of the primordial embryonic area. These outgrowths pass forward during later development until they reach and encircle the mouth. The funnel arises as a paired outgrowth of the same area, a condition that is retained in the adult *Nautilus;* however, in the Dibranchia the two portions fuse together in the median line. The further development of the Cephalopoda varies somewhat after the germ layers have been developed, depending on whether there is a yolk-sac or not.

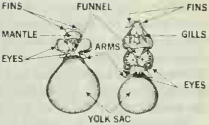
The embryo of *Sepia, Loligo* and *Octopus* is provided with a yolk-sac that may become partly internal. In certain Decapoda presumed to be archaic there is less yolk, and the yolk-sac is practically absent ("oigopsid embryo" of Grenacher). Nevertheless, although the latter mode of development may be regarded as less specialized than that of the heavily yolked egg, *e.g.*, of *Sepia*, there is no certain indication in the development of any known cephalopod of those larval phases



BY COURTESY OF GENERAL BIOLOGICAL SUPPLY HOUSE, INC.

FIG. 13.—CLUSTER OF OCTOPUS (OCTOPUS VULGARIS) EGGS, SHOWING THE DEVELOPING EMBRYOS WITHIN, AND TWO YOUNG OCTOPUSES

that characterize the development of other Mollusca. The embryological history of the members of the Cephalopoda reveals as much specialization and differentiation from the more primitive molluscan type of development as does the structure of the adult.



FROM "CAMBRIDGE NATURAL HISTORY," VOL. III, MACMILLAN & CO., LTD. (1895)

FIG. 14.—TWO STAGES IN DEVELOPMENT OF EMBRYO OF A SQUID (LOLIGO VULGARIS): (LEFT) EARLY; (RIGHT) MORE ADVANCED

At hatching from the egg, the animal may closely resemble the adult and take up its definitive habitat or it may go through a larval stage, differing widely from the adult, and spend a considerable time in the plankton as part of the drifting life of the sea. In those octopods with small eggs (*Octopus vulgaris*) the larvae are planktonic, spending upwards of several weeks in the plankton, and the *Macrotritopus* stage of *Scaeurgus* may greatly prolong its larval life until a favourable bottom is found. In those octopods with large eggs (*Octopus briareus*) the young resemble the adult and immediately assume a bottom life.

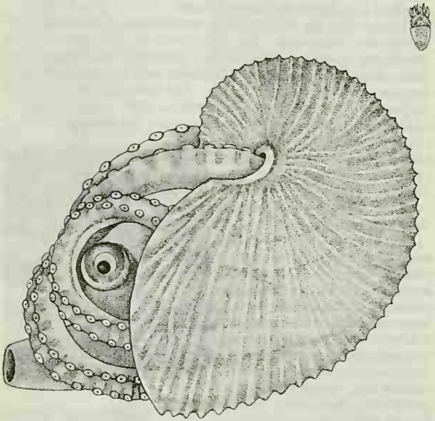
In the Sepioidea the young closely resemble the adults and spend only a short interval in the passive stage. In the Teuthoidea, however, especially among the Oegopsida, the larvae differ widely from the adult, *e.g.*, the *Rhynchoteuthis* stage of the ommastrephids, the *Doratopsis* stage of *Chiroteuthis*, etc.

IV. PHYLOGENY AND EVOLUTION

1. Nautiloids and Ammonoids.—The evolutionary history of the Cephalopoda is complicated by the lack of fossil records of the soft parts. It is assumed—based upon the soft parts of *Nautilus*, the oldest surviving cephalopod—that the Nautiloidea and Ammonoidea shared in the possession of four gills and other anatomical structures. Similarly, knowledge of the evolution of the Octopoda suffers from lack of verifiable fossil remains.

The Nautiloidea, as represented by *Nautilus*, have coiled, chambered shells with a median tube or siphuncle, smooth septa, simple sutures and simple external sculpture. The earliest forms are from the Upper Cambrian.

In *Orthoceras* is found the unmistakable chambered shell and median siphuncle of the nautiloid. The shell, however, is straight, not coiled. Later the shell becomes coiled like that of the true *Nautilus* whose ancestors are found in Triassic rocks. Modern *Nautilus* did not actually appear until the Early Tertiary.

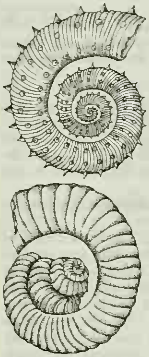


FROM A. NAEF, "FAUNA UND FLORA DES GOLFES VON NEAPEL" (1923)

FIG. 15.—PAPER NAUTILUS (ARGONAUTA): (UPPER RIGHT) MALE (ABOUT FIVE-EIGHTHS INCH IN LONGEST DIMENSION); FEMALE (ABOUT SIX INCHES FROM TIP OF SIPHON TO OUTER CURVE OF SHELL)

From this brief sketch, and assuming that the Mollusca are a homogeneous group, it seems reasonable to suppose that the primitive Mollusca from which the Cephalopoda sprang were provided with a simple, caplike shell not unlike that of a limpet and perhaps similar to the primitive deep-sea gastropod *Neopilina*. With elongation of the shell (by additional shell being secreted around the rim) and the formation of septa or partitions, the primitive nautiloid shell could be formed. The elongate shell of *Orthoceras* would no doubt become unmanageable and coiling would result as in the Gastropoda.

The second order of Tetrabranchia, the Ammonoidea, are ranked as tetrabranches from shell characters, but their anatomy is unknown. In contrast to the nautiloids they have a marginal siphon, a persistent embryonic whorl (protoconch) at the apex of the shell, wrinkled septa and complex sutures and external sculpture. They also have a tendency toward uncoiling. Ammonites are customarily derived from Devonian forms with straight shells such as *Bactrites*, which itself has certain nautiloid traits. Coiled ammonites appear in the Upper Devonian (*Goniatites*), and thereafter follow a great variety of forms. The ammonites became extinct in the Cretaceous after having become the largest class of the Cephalopoda.



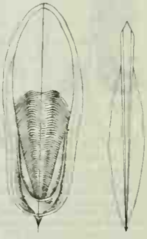
FROM "GUIDE TO FOSSIL INVERTEBRATES" (BRITISH MUSEUM)

FIG. 16.—PARTIALLY COILED CRETACEOUS AMMONITES (ABOUT ¾ NATURAL SIZE). (TOP) CRIOCERAS EMERICIANUM; (BOTTOM) HETEROCERAS EMERICIANUM

2. Modern Cephalopods.—The history of the dibranchiate Cephalopoda is dominated by one main evolutionary theme. Modern squids, cuttlefishes and octopods are distinguished from the nautiloid and ammonoid forms by the possession of an internal and partly degenerate shell that is straight except in *Spirula*, which has a coiled and wholly internal shell. The position and state of the shell in the Dibranchia is due to the progressive overgrowth of the shell by the mantle and the formation round the shell of a secondary sheath, the various parts of which eventually become larger than the shell itself. The loss of the true shell probably occurred with the change to an active swimming life during which period stronger pallial muscles developed. This change also resulted in the shift in position of the shell for stability of the animal in a horizontal swimming position.

There is no direct evidence of forms connecting the Tetrabranchia with the Dibranchia, but A. Naef cites certain orthoceratoid nautiloids that approach the oldest Dibranchia.

It is not until Triassic times that one finds in *Aulacoceras* unmistakable evidence of the modification of the shell. This tendency is seen at its best in the belemnites. The modification consists primarily in the apex of the shell (phragmocone) being enclosed in an external calcified sheath, the guard, and in the development of an accessory plate, the pro-ostracum, at the anterior end of the shell. The animals possessing these features, and having an ink sac and hooks on their suckers, were undoubtedly dibranchiates. Through various lines of descent, mostly shown by modification of the shell, the belemnites gave rise to *Spirula* (with a coiled shell); cuttlefish (with calcified phragmoconal septa forming a thick shell), and the Teuthoidea (with loss of phragmocone and guard and the persistence of the pro-ostracum as a horny "pen"). These forms appeared in

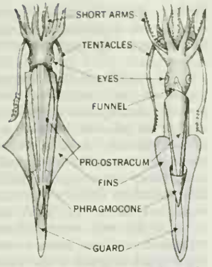


(LEFT) FROM A. LANG "LEHRBUCH DER VERGLEICH. ANAT." (1892); (RIGHT) FROM "BULLETIN OF MARINE SCIENCE OF THE GULF AND CARIBBEAN," 6(2)

FIG. 17.—SHELLS OR PENS OF: (LEFT) A CUTTLEFISH (SEPIA ACULEATA); (RIGHT) A SQUID (LOLIGO PEALEI)

the Jurassic and are probably derived from belemnitelike ancestors. Of living Teuthoidea *Ommastrephes* preserves a trace of the phragmocone.

The shell is greatly reduced in the Octopoda, persisting only as fine cartilaginous stylets or as somewhat better-developed fin supports (in Cirrata), both of which are usually regarded as vestiges of the shell. There is little knowledge of the ancestry of the group. The Vampyromorpha are considered by some to be a possible connecting link between the squids and the Octopoda. *Palaeoctopus newboldi*, from the Cretaceous of Syria, affords no clue to the early stages of the ancestry of the Octopoda. Of the modern forms the Cirrata (*Cirroteuthis*), despite much specialization in relation to the abyssal habitat, are an older group than the true octopods (*Octopus, Eledone* and the Argonautidae).



FROM "GUIDE TO FOSSIL INVERTEBRATES" (BRITISH MUSEUM)

FIG. 18.—RESTORATION OF ANIMAL AND SHELL OF TWO BELEMNITE: (LEFT) DORSAL VIEW; (RIGHT) VENTRAL VIEW

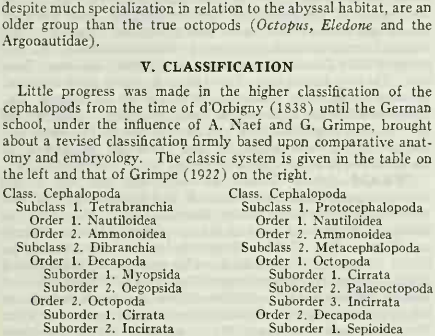
V. CLASSIFICATION

Little progress was made in the higher classification of the cephalopods from the time of d'Orbigny (1838) until the German school, under the influence of A. Naef and G. Grimpe, brought about a revised classification firmly based upon comparative anatomy and embryology. The classic system is given in the table on the left and that of Grimpe (1922) on the right.

Class. Cephalopoda
  Subclass 1. Tetrabranchia
    Order 1. Nautiloidea
    Order 2. Ammonoidea
  Subclass 2. Dibranchia
    Order 1. Decapoda
      Suborder 1. Myopsida
      Suborder 2. Oegopsida
    Order 2. Octopoda
      Suborder 1. Cirrata
      Suborder 2. Incirrata

Class. Cephalopoda
  Subclass 1. Protocephalopoda
    Order 1. Nautiloidea
    Order 2. Ammonoidea
  Subclass 2. Metacephalopoda
    Order 1. Octopoda
      Suborder 1. Cirrata
      Suborder 2. Palaeoctopoda
      Suborder 3. Incirrata
    Order 2. Decapoda
      Suborder 1. Sepioidea
      Suborder 2. Teuthoidea
      Suborder 3. Belemnoidea

In 1940, Pickford proposed a new order of cephalopods, Vampyromorpha, for the archaic but living deep-sea *Vampyroteuthis infernalis*. This order is thought by some to represent a link between the Decapoda and the Octopoda. A somewhat different classification incorporating the new order is given below. This scheme is apparently preferred by the paleontologists and is accepted by most neontologists (taxonomists of recent organisms).



FROM A. LANG, "LEHRBUCH DER VERGLEICH. ANAT." (1892)

FIG. 19.—A BELEMNITE AND ITS DESCENDANTS: (A) SEPIA; (B) BELOSEPIA (FOSSIL); (C) BELEMNITE (FOSSIL); (D) SPIRULIROSTRA (FOSSIL); (E) SPIRULA; (F) OSTRACOTEUTHIS (FOSSIL); (G) OMMASTREPHES; (H) LOLIGOPSIS

Median section through shells showing: (1,2,3) three most recent septa; (a) anterior and (b) posterior walls of siphuncle; (c) pro-ostracum; (d) phragmocone; (e) guard; (f) siphuncular canal

Class. Cephalopoda
  Subclass 1. Nautiloidea
  Subclass 2. Ammonoidea
  Subclass 3. Coleoidea
    Order 1. Belemnoidea
    Order 2. Sepioidea
    Order 3. Teuthoidea
      Suborder 1. Myopsida
      Suborder 2. Oegopsida
    Order 4. Vampyromorpha
    Order 5. Octopoda
      Suborder 1. Palaeoctopoda
      Suborder 2. Cirrata
      Suborder 3. Incirrata

While in both Grimpe's classification and the one shown directly above, the terms Tetrabranchia (nautiloids and ammonoids) and Dibranchia (all living Cephalopoda except *Nautilus*) are abandoned, the names are still conveniently used in general discussions of cephalopod groups. It is presumed that *Nautilus*, with four gills and four kidneys and a lacunar circulatory system, is the most primitive form. Since the fossil nautiloids and ammonoids are known only from their shells, it is unsafe to assume a similar anatomy, such as four gills, etc., although the living and fossil nautiloids and ammonoids undoubtedly represent natural units.

The classification of the Dibranchia proposed by Naef and Grimpe involves a more fundamental change. The primary division into Octopoda and Decapoda follows traditional lines, but it still places too high an emphasis upon the Octopoda as a major group, while lessening the importance of the Sepioidea and the Belemnoidea. The essential relationship of these groups is better shown by placing them as orders under the subclass Coleoidea. The division of the living Decapoda into Sepioidea and Teuthoidea cuts across the heterogeneous Myopsida, dividing them into two unequal but more homogeneous groups.

In the new classification the Myopsida, retained as a suborder under the Teuthoidea, contain the Loliginidae and the new family Pickfordiateuthidae as well as the problematical family Promachoteuthidae. The large families Sepiidae and Sepiolidae, as well as the Sepiadariidae, Idiosepiidae and Spirulidae, form the order Sepioidea. Some authorities may argue that the Sepiidae are more closely related to the Loliginidae than to *Spirula* with its wholly internal coiled shell, but C. Chun has advanced convincing arguments for the relationship of *Spirula* with the Sepiidae. The classification is still probably imperfect, and more information is needed from the fields of anatomy and embryology before a more definitive scheme is evolved.

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CEPHALOTAXACEAE, an old world family of shrubs or small trees in the order Coniferales of the gymnosperms. There are two genera: *Cephalotaxus*, the plum yew, which occurs in Japan, China and India; and *Amentotaxus,* of western China. Two of the five or more species of *Cephalotaxus* are sometimes cultivated as specimen plantings or for hedges, and a fatty oil is reportedly obtained from the seeds of *C. drupacea.* The plants have leaves generally similar to those of the yew, but larger and with a sharper point at the tip. In the Cephalotaxaceae the staminate, or pollen-bearing, cones are in clusters on short axillary peduncles. The cones have about 12 scales, each of which usually bears three pollen sacs. The ovulate, or seed-bearing cones, are rather specialized. They are borne on short peduncles and are composed of several opposite pairs of cup-shaped bracts, each with two erect ovules. Ordinarily only one ovule enlarges to form a large, olivelike, fleshy seed.

Embryogeny in the Cephalotaxaceae is relatively advanced. Only simple polyembryony occurs, but this appears to be a derived condition. The mature embryo has two cotyledons. The Cephalotaxaceae appear to be related to the Taxaceae, but the resemblances may be superficial, since the latter are basically different from the Coniferales. (R. W. H.; X.)

CEPHALUS, the legendary ancestor of an Attic family, was traditionally a great hunter, and his legends are connected with this idea. He was beloved by the Dawn (Aurora or Eos), who carried him off for a time, as she did other great hunters. With his hound Laelaps (Hurricane), he overcame the vixen of Teumessus, which ravaged Boeotia. The vixen was magically incapable of being caught and the hound of failing to catch his prey; Zeus solved the impasse by turning both to stone. But the most popular tale about Cephalus in later Greek and Roman literature concerned his wife Procris. Cephalus' devotion to hunting aroused in her jealous suspicions that he went out to meet a rival. She followed him, and when he called on a cloud or a breeze to cool him, she, thinking that this was the name of his mistress, emerged from a thicket and was fatally struck by her husband who mistook her for his prey. Some versions add such fanciful details as that his spear was magically incapable of missing its mark. Later legends by false etymology made Cephalus the founder of the Ionian island community of Cephalonia and linked him with the ancestry of Odysseus. (H. W. Pa.)

CEPHEUS, in Greek mythology, the father of Andromeda (*q.v.*); in astronomy, a constellation of the northern hemisphere. The class of stars known as Cepheid variables gets its name from δ Cephei, a typical example (*see* Star). This star was discovered by J. Goodricke in 1785. The period is 5.37 days and the range of magnitude is from 3.6 to 4.2. The star β Cephei is also a famous Cepheid variable; although its range of brightness is only 0.05 mag., its variability was detected by Paul Guthnick of Berlin university by photoelectric measurements.

CEPHISODOTUS, the name of two Greek sculptors, one a son and the other a near relative of Praxiteles. The latter must have flourished about 400 B.C. A noted work of his was Peace bearing the infant Wealth, of which a copy exists at Munich. Peace is a Madonnalike figure of a somewhat conservative type. He made certain statues for the city of Megalopolis, founded in 370 B.C. Of the work of the younger Cephisodotus there are no remains; he flourished in the latter part of the 4th century B.C., and was noted for portraits of Menander, of the orator Lycurgus and others.

CER, the Greek name for a destructive spirit. Popular belief attributed death and illness to the action of these impersonal powers, often spoken of in the plural (Ceres). The word is also used of an individual's doom, with a meaning resembling the notion of destiny. In Greek art the Ceres are perhaps the small winged figures often associated with scenes of battle and death, though they can rarely be identified with certainty. In literature they are often described as black and occasionally as possessing fangs and claws. In the Attic festival of the Anthesteria, the spirits of the dead, when they were expelled from the house, were addressed as Ceres, whence some scholars suppose that this was the original meaning of the word. (H. W. Pa.)

CERACCHI, GIUSEPPE (1751–1802), Italian sculptor, whose works are representative of the neoclassic manner, was born on July 4, 1751, either in Rome or in Corsica. After receiving a prize from the Academy of St. Luke (1771) he went to England where he soon secured numerous commissions and, among other things, executed bas-reliefs for the Adams brothers. He became the teacher of the celebrated amateur sculptor Anne Seymour Damer and perhaps his name is now chiefly remembered for his statue of her as the muse of sculpture (British museum). He also designed Lord Chatham's monument in St. Paul's cathedral, London. The only known bust of Sir Joshua Reynolds is by Ceracchi. He went to America, where he did a bust of Washington, but, disappointed in his expectations there, returned to Europe. In 1801 he was implicated in a plot on the life of Napoleon and was executed in Paris on Jan. 30, 1802. It is said that he went to the guillotine in a car of his own design. (A. K. McC.)

CERAM (Seram, Seran), an island, 216 mi. long, in the Moluccas group, Indonesia, lies 3° S. and between 127° 45′ and 131° E. It is due east of Buru, from which it is divided by the Manipa or Buru strait, in which are the islands of Manipa, Kelang and Boano. Pop. (1957 est.) 96,797. Area (with adjacent islands) 7,191 sq.mi. The island, which geologically is composed mostly of eruptive rocks and crystalline schists in the middle and western portions and of crystalline chalk in the east, is very mountainous, a fine range of mountains traversing it from east to west. The highest peak is Binaija (6,798 ft.) in the central part, and four others exceed 6,000 ft. In some places the mountains extend right to the coast bounding the many bays; in others wide stretches of lowland are sometimes fringed with swamps by the seashore.

There are many rivers, running mostly to the north; they are partly navigable for small craft only during the rainy season and often dry up altogether during the period of drought. Comparatively little is known of the interior of the island. With Ceram are included Ceram-Laut, a cluster of islands on a coral reef about 20 mi. long, Geser and Kilwaru, the Gorong (or Goram) Islands (Suruaki, Gorong and Manawoka), the Watubela group and the Tioor Isles, all of which lie southeast of Ceram. The larger islands are of Tertiary (Miocene) formation, and the others of Recent coral. None has hills of over 1,000 ft. and most are thickly wooded, while Suruaki has extensive swamps. Many of the Watubela Islands have rugged hills covered with coconut palms, and some of the Tioor group are entirely waterless as a result of the nature of their coral rock.

Ceram is covered with dense tropical forests which provide excellent timber (ironwood is general) and yield a variety of forest products, including cajuput oil, dammar and wild nutmeg. In the swamps of the coast and valleys the sago palm thrives. Both the flora and the fauna of the island lack variety and characteristic specimens. The cassowary is the outstanding feature of the fauna, which includes deer, cuscus, pig, shrews, cockatoos, lories, hornbills and birds of paradise, and there are many species of fish in the rivers. The climate is hot and moist, the rainfall being heavy, and earthquakes occur.

The people of the interior are of a mixed Malay-Papuan stock. They are largely pagan in religion, wear little in the way of clothing, live in houses built on piles and use as weapons the bow and arrow, parang and lance. They have a patriarchal social system and a form of marriage sometimes endogamic, sometimes exogamic. Women have a good position among them and are well treated. Ceramese, a language without either script or literature (although there are traditional songs which have been handed down orally), is divided into 35 different dialects and is closely related to the indigenous language of Amboina. Malay is used commonly on the coasts. Weaving is known in some parts, and weapons and plaited goods are manufactured. China plates and dishes are considered objects of the highest value and long ceremonial feasts are characteristic. The Ceramese are a strong and muscular people and extremely independent. The inhabitants of the middle and east were far more peaceful in their ways than those of the west, who were fierce head-hunters. However, modern civilization has affected all the groups as a result of increasing trade facilities and the provision of schools in many districts. Along the coast are Muslim and Christian settlements.

Fishing, hunting and the production of sago flour from wild trees are the chief means of existence for the tribes of the interior. The coastal inhabitants grow some rice, maize and root crops, but they, too, have sago as their staple food. They export copra, cajuput oil and some other forest products. There are a few tobacco and coffee plantations. Near Bula bay (east coast) is a small petroleum field. Amanhai, in the south (centre), has a good harbour. Other ports of call are Piru (west), Wahai (north), Tehoru (south) and Bula (east). Roads are nonexistent. There is an airfield at Bula.

In the mid-17th century a fort established at Cambello extended Dutch influence, with help from Ternate, which claimed suzerainty. The power of Amboina later helped the Dutch acquire the whole island, although there was some resistance when they destroyed clove plantations in order to uphold Amboina's monopoly. Expeditions were made against the interior, but the island was quiet after 1910. During World War II Ceram was occupied by the Japanese. In 1950 the Christians joined in the abortive secession attempt of the South Moluccan republic (*see* AMBOINA). Guerrilla warfare continued in some areas of the island. (J. O. M. B.)

CERAMICS: *see* POTTERY AND PORCELAIN.

CERARGYRITE (HORN SILVER), the name usually applied by mineralogists to naturally occurring silver chloride, though sometimes taken to include the bromide and iodide as well, or mixtures of them. Cerargyrite is an important ore of silver, occurring in considerable quantity in the oxidation zone of silver lodes in dry climates, such as Chile, Peru, and Broken Hill in New South Wales, where the surface waters are rich in chlorides, bromides and iodides; it is also found widely in the western mining districts of the United States. It usually forms hornlike masses; it is very soft, being easily cut with a knife, and generally of a dirty gray or yellowish colour. Crystals, though rarely found, usually are cubic. (R. H. RA.)

CERATOSTIGMA, a genus of hardy perennial herbs or shrubs called leadwort, belonging to the Plumbaginaceae family and native to Ethiopia, China and the Himalayas. It is related to *Plumbago* but differs in having flowers in dense clusters rather than in spikes and in other technical characteristics. The only species of note is *Ceratostigma plumbaginoides* (*Plumbago larpentae*), a hardy bedding plant 10 to 12 in. high, producing its deep-blue flowers late in the fall. It will thrive in any fairly good garden soil in a sunny, sheltered location, and may be propagated by root division. In cold regions this plant needs protection during winter. (R. T. V. T.)

CERBERUS, in Greek mythology, the dog who guarded the entrance to the lower world. According to Hesiod in his *Theogony*, Cerberus was a 50-headed monster, the offspring of Typhon and Echidna. He was variously represented with one, two or (usually) three heads, often with the tail of a snake or with snakes growing from his head or twined round his body. One of the tasks imposed upon Hercules was to fetch Cerberus from below to the upper world, a favourite subject of ancient vase paintings.

CERCIDAS (3rd century B.C.) of Megalopolis, Greek poet, philosopher and politician, who wrote satiric poems in the cynic tradition. A family friend and political supporter of Aratus of Sicyon, leader of the Achaean league, he secured the support of Antigonus Doson for the league against Cleomenes III of Sparta and the Aetolians. He commanded 1,000 Megalopolitans at the battle of Sellasia (*c. 222* B.C.) when Cleomenes was finally defeated, and he may have been responsible for the new constitution adopted at Megalopolis in 217 B.C. Only a few quotations from his verses were known until 1911 when parts of a number of new poems were published from papyri found at Oxyrhynchus. These are meliambic, *i.e.*, lyrical in form and metre but satiric in content, and the language is a literary Doric. Cercidas delivers bitter attacks on the wealthy classes and seems to contemplate the redistribution of their wealth to the poor. Yet he had also led the opposition to Cleomenes, the champion of radical social reform in the Peloponnese, and he may have wanted moderate reforms. His satirical comments on social customs may have influenced Lucilius and Horace, but his poems are fragmentary and difficult to interpret.

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CERCIDIPHYLLUM, a genus of plants of the Cercidiphyllaceae family. The only member of the genus (and of the family) is *C. japonicum*, the katsura tree, native to Japan. It is a hardy, ornamental, shrubby tree of pyramidal habit, almost columnar when young, with handsome light green foliage, purplish when unfolding and turning bright yellow or partially scarlet in autumn. Commonly there are several trunks, usually 20–30 ft. in height, but sometimes attaining 100 ft.

C. japonicum var. *sinense*, from western China, usually consists of a single trunk which may exceed 100 ft. It is the largest of all broad-leaved trees known from China; the trunk is often free of branches for nearly 50 ft. above the ground and may attain a girth of 25 ft. or even more. (J. M. BL.; X.)

CERDIC (d. 534), founder of the West Saxon kingdom, is said to have landed at Cerdicesora in 494 or 495. One tradition dates his conquest of Wessex in 500, another in 519. The Anglo-Saxon Chronicle associates his son Cynric with him, and says they captured the Isle of Wight in 530, giving it later to their kinsmen Stuf and Wihtgar. However, the oldest versions of the West Saxon genealogies show that Cynric was Cerdic's grandson, and too much reliance should not be placed in the annals of this early period. The chronicle enters his death in 534. Later Saxon kings derived their right to rule through descent from him. Some scholars consider that his name is Celtic.

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CEREALS. Cereals, or grains, are members of the grass family that are cultivated primarily for their starchy seeds (technically, dry fruits), which are used for human food, feed for livestock, and as a source of industrial starch. Wheat, rice, maize (called corn in the U.S.), rye, oats, barley, sorghum and some of the millets are the common cereals.

Cereals were among the first plants to be domesticated, having been grown long before the beginning of recorded history. Each of the world's great civilizations has depended upon cereals as a major source of food. When ancient man learned to grow cereals he was able to produce more than enough food for his own immediate needs, thus making possible settled communities and the development of the arts and sciences that distinguish civilized man from the savage. Grain storehouses have been found in many excavated ruins: wheat and barley storehouses in Mesopotamia, Egypt, Greece and Italy, and storage places for maize in the ruins and caves of the Mayas, Aztecs, Incas and other peoples of the western hemisphere.

Wheat, rice and rye are grown primarily for consumption as human food, while much of the maize, barley, oats and sorghum grown in North America, Europe and Australia is fed to livestock to produce meat, dairy and poultry products. Countries that have an inadequate supply of all kinds of starchy foods generally consume large quantities of cereal foods, while some other countries with adequate starch supplies convert a larger portion into animal products. Large quantities are shipped from countries having a surplus into areas not producing enough to meet their needs. They are inexpensive foods and can be handled and shipped in bulk without loss or deterioration in quality. Increasing quantities of maize and sorghum are being utilized industrially in surplus-producing countries such as the U.S. A few of the more important products are starches, dextrose, sirups, pastes, edible oils and industrial alcohols.

Types.—Wheat has been an important cultivated crop since prehistoric times. Many scientists believe it originated in southwestern Asia. Varieties now being grown probably are the results of complex hybridization in nature among at least three wild species. Wheat is adapted to a wide range of climatic conditions, with important acreages being grown in over 50 countries. It does best in temperate regions where annual rainfall is between 13 and 35 in. and where there are cool, dry seasons. In some semiarid areas wheat is grown in alternate years, utilizing water accumulated by keeping the soil bare during the year of no crop. Shortage of water limits the yield on much of the wheatland of the world, although warm, dry weather is desirable during the ripening period. High rainfall at this period delays ripening, damages the straw and interferes with harvesting operations. Heavy rainfall also favours the development of wheat diseases and may cause nutrients to be leached from the soil.

Rye is botanically related to wheat and barley, all belonging to the tribe Hordeae. It probably was cultivated first in Turkestan after having grown as a weed for many years in barley and wheat fields. It was unknown during the ancient Egyptian and Greek civilizations. Rye is the most productive grain on poor soils and will survive more severe winters than other cereals. It is the main food grain in parts of Europe and Asia.

Barley is a crop of ancient origin, having been cultivated by Swiss lake dwellers in the Stone Age. It is one of the most widely adapted crops, being produced in temperate regions throughout the world. It is used for livestock feed and malt production and to a lesser extent for human food.

Oats are believed to have been cultivated first in western Europe during the Iron and Bronze Ages. Now they are grown in temperate regions, especially the corn belt of the U.S. and in Canada and northern Europe. Some varieties are adapted to warmer climates, such as those of the Mediterranean regions.

Rice is believed to have originated in the orient more than 5,000 years ago. It is the principal cereal grown for food in the tropics and warmer, humid parts of the temperate zone. Rice requires a large amount of moisture for its growth, and most of it is cultivated with four to eight inches of water on the land. It is the major food crop for about half the people of the world. It responds with high yields to the intensive cultivation practised in the orient, where about 95% of the world crop is produced.

Maize originated in the western hemisphere and was introduced into Europe and Asia by the early explorers. It is a highly domesticated crop that has been cultivated for 5,000 years or longer. Because of its great diversity of types, maize can adapt to environmental conditions ranging from sea level to 10,000-ft. altitudes and from the tropics to latitudes throughout the temperate zones. The development of hybrid maize has greatly improved the crop and given impetus to production in many parts of the world. It is the highest yielding grain crop.

Sorghum is an important grain crop that probably originated in tropical Africa. Its growth requirements and uses are similar to those for maize but its tolerance to heat and drought permits it to be grown in areas where maize is not a successful crop.

Production.—Cereal production is highly mechanized in many of the major producing areas; thus a small proportion of the population provides the world supply. Surplus-producing areas in Canada, the U.S., Australia, Argentina and the Ukraine of the U.S.S.R. ship large quantities to industrialized and densely populated areas.

The cereals are attacked by many diseases and insect pests and are subject to damage by drought, heat, cold and other adverse conditions. Scientific research since about 1900 has contributed much toward overcoming these hazards and increasing and stabilizing production. Plant breeders have produced varieties that resist many diseases and insect pests, are better adapted to growing conditions, are suited for mechanized production, and possess qualities that increase their value to consumers. Entomologists, plant pathologists and chemists have developed pesticides and other means for pest and disease control. Agronomists have devised fertilization and cultural practices that give higher yields per acre. (L. A. Ta.)

CEREALS IN THE DIET

Nutritional Values.—The dietary properties of the entire seed of wheat, rice, barley, rye, maize, oats and millet resemble each other in most respects. They are all deficient in calcium and vitamin A (except yellow maize), and the biological value of their protein moiety is lower than that of the proteins of milk, meats and eggs. When any one of these cereals is supplemented with calcium, vitamin A and a source of proteins of animal origin, it is rendered nutritionally more complete.

Under the chronic conditions of scarcity of foods that prevailed generally in most parts of the world before the invention of modern farm machinery from 1840 on, cereals remained the most important food crop, although the yields were low because of inferiority of varieties and poor cultivation technique. With the development of modern machinery and improved varieties, wheat production has been enormously increased. The price range of cereal products is small compared with prices of foods such as meats, milk, eggs, fruits and vegetables other than the potato. Bread grains and potatoes are the cheapest foods. Whenever economic conditions lower the incomes of families or increase the cost of foods, the tendency has been for people to subsist more largely on bread and potatoes. Since the potato is not constituted so as to supply the essential food elements missing in cereals, such diets are nutritionally inadequate.

Improvements in Flour.—An especially important factor for nutritional considerations in connection with the milling of white flour (as opposed to whole meal) is the removal of the germ and the outer layers of the wheat, which are, with the exception of the outermost or bran layer, the most nutritious parts of the grain. Removal of the outer parts of the wheat grain is facilitated by the use of the roller mill, which, toward the end of the 19th century, superseded the millstones of ancient times as a machine for milling. The fat present in whole meal may become rancid on long storage, but there is only about half as much fat in white flour as there is in whole meal. Modern white flour contains only the protein moiety of the grain that has the lowest nutritive value. In addition, a large proportion of the vitamins and mineral elements are milled out and go into stock feed. Modern white flour is milled to satisfy public taste; experience has shown that demand for brown or whole meal bread does not much exceed 5%, even when attempts are made to publicize its merits. Because of the spoilage problems connected with marketing a more highly nutritious flour for breadmaking, it is clear that there is much to justify modern milling processes from the economic point of view. As a World War II measure Canada introduced a long extraction wheat flour known as Canada Approved flour, which represented about 85% of the wheat berry as compared with ordinary flour, which retains only the least nutritious 70% of the wheat. Later, Great Britain adopted the practice of manufacturing a similar flour. Such flour is superior to ordinary white flour in nutritive value, being superior in vitamin and mineral nutrient values and in the quality of its proteins. In the interest of health it would be advisable to adopt such flour to the maximum extent to which commercial transport and storage of flour permit.

Improved Bread.—The practice of improving the quality of commercially baked bread by the use of nonfat milk solids instead of water in preparing the bread mix became general in the United States after World War I. As much as 6% of nonfat milk solids in bread greatly improves the nutritive value of the loaf by compensating for all of the nutritive deficiencies of white flour except iron. Four to six per cent milk bread becomes stale less rapidly than does bread made without milk, crumbs less on cutting, and otherwise makes a highly desirable bread. This method of improving bread has become popular with bakers.

Following the development of synthetic production of several of the vitamins and consequent lowering of their cost, the British government in 1935 ordered that white flour should be enriched with vitamin B (thiamin), niacin and iron to certain nutrient levels, and with creta praeparata (calcium carbonate). In the United States, enrichment with thiamin, niacin, riboflavin and iron has become general, with calcium and phosphorus additions optional. While it is true that such enrichment of a white flour bread may safeguard the health of people whose diets are of low quality, it is not clear that it is a wise policy to pay for the inclusion of the vitamins and iron in diets of good to high quality, which, there are good reasons for believing, represent those of a large majority of the people in areas where enriched bread is manufactured. An excess of vitamins has not been shown to be of benefit.

It is a wise policy to promote the manufacture of bread of the highest possible nutritive value. It would seem desirable nutritionally to include small percentages of wheat germ, corn (maize) germ, dried brewers' yeast, rice polishings, as well as the maximum amount of nonfat milk solids, in commercial bread. Such a policy would go far toward justifying the milling of highly refined flour of good keeping quality. At the same time the nutritionally superior parts of the grain that have hitherto been used largely for animal feeding would be used to improve human nutrition. For homemade bread *see* Food Preparation.

Nonwheat Food Products.—Maize meal (corn meal) and corn grits are widely used as human food, especially in the southern United States, in parts of Italy, Rumania, Egypt and elsewhere. Since maize contains about one-fifth as much niacin as does wheat, pellagra, which is due to niacin deficiency, has been common only where corn is extensively used as a bread grain or as corn-meal mush (polenta). The milling of maize by modern machinery produces a meal for human consumption that is as much depleted in nutrients as is white flour. Barley and rye are extensively used as human food only in areas where wheat does not yield well.

Rye is milled by a gradual reduction process which, however, differs from the wheat milling system in several respects, but whole meal is often used for rye bread. Where barley is used as bread grain it is not milled refined as is wheat but is employed as essentially whole meal products. Oats are prepared for human consumption by dehulling the kernels, which are then cut, steamed and rolled to produce rolled oats, or ground to make oatmeal and oat flour. Rolled oats and oatmeal represent practically the entire kernel of the oat.

Where wheat or other cereals are marketed for use as breakfast cereals, it is advisable to provide products that represent the entire seed because of their superior food values. But even whole-wheat cereals are deficient in thiamin after toasting.

Rice is second only to wheat in the quantity grown and used as human food. Being the one cereal that grows in swampy land, it forms the principal food of many millions of people in the warmer and wetter areas of the world. The flavour of whole rice is generally less relished than is that of polished rice. Polishing is desirable for the same commercial reason as is the refining of white flour: it improves the keeping qualities. Polishing removes the bran and aleurone layers from the surface of the kernel and also the germ. Polished rice closely resembles highly refined (and unfortified) white wheat flour in dietary properties. Attempts have been made, and some progress achieved, in the distribution of "undermilled" rice and steamed rice. The former product contains some of the outer layers (silverskin) of the grain, and some germ. In the preparation of steamed rice the grain is steeped in water warm enough to facilitate permeation of the grain and gelatinization of the surface starch. These processes, which serve to retain the thiamin content of rice, have been promoted as a means of preventing the disease beriberi, which afflicts people whose diet is too largely derived from polished rice.

Sorghums and the seeds of several grasses, popularly known as millets, are the least palatable of the cereals and are eaten from necessity rather than from choice. The use of these seed grains is most common in semiarid regions of the U.S.S.R., northern Asia and Africa, where other grains cannot be produced.

Proper Dietary Use of Cereals.—Cereals in the early 1960s were the least expensive and most important food sources of calories, thiamin and protein, even though cereal protein is of rather poor quality compared with proteins of animal origin. Because of their dietary deficiencies, especially when refined derivatives of cereals are eaten, the ideal way to use cereals in the diet is in menus in which occur liberal amounts of milk and milk products, meats, eggs, fish, poultry, together with appropriate amounts of green and yellow vegetables and some fresh vegetable foods suitable for eating in the uncooked state for their antiscorbutic properties. The fact is well established that none of the common foods is nutritionally complete when eaten as the sole source of nutriment. The keynote to successful nutrition is the selection of foods that supplement each other and collectively make a complete diet with no nutritional shortcomings. (E. V. M.)

Processed Breakfast Cereals.—Processed breakfast cereals, referred to in the food industry as the R-T-E (ready-to-eat) cereals, have taken their place in the modern diet with a per capita consumption in the U.S. in the early 1960s of seven to eight pounds annually. R-T-E cereals, in the form of flakes, puffs, shreds, biscuits and granules, represented the beginning of a new era in the food industry—convenient prepackaged foods.

The industry had its origin with the vegetarians and food faddists of the 19th century and grew out of a succession of inventions, including graham crackers in 1829 by Sylvester Graham, a temperance lecturer-food faddist, who promised to save souls through the stomach; Granula (forerunner of Grape-Nuts) in 1863 by James C. Jackson of Jackson sanitarium, Danville, N.Y.; Shredded Wheat, by Henry D. Perky (1893); and Puffed Wheat, by Alexander Anderson (1902).

With the formation of the Western Health Reform institute in Battle Creek, Mich., by the Seventh-Day Adventists in 1866, Battle Creek was destined to become the "cereal capital of the world." The institute—later the Battle Creek sanitarium—under the leadership, beginning in 1876, of John Harvey Kellogg, became a world-famous health centre. Kellogg, a physician, surgeon, inventor and writer, exposed many people to his cereal grain foods that were later to form the basis for this new industry.

Sensing the possibilities of the sanitarium's health foods that he ate as a patient, C. W. Post organized the Postum Cereal company in 1897 and began the promotion and sale of Postum, and later Grape-Nuts. The Postum Cereal company was the parent company in the founding of the General Foods corporation.

W. K. Kellogg left his brother, John Harvey Kellogg, and the sanitarium and formed a cereal company in 1906. The growth of the processed cereal industry provided the impetus for the development of a packaging industry, an advertising and promotion industry, and later a whole host of prepackaged convenience foods.

The various flaked, shredded, puffed and granular products were invented and patented by individuals who developed their own equipment and process for manufacturing. These patents and knowledge have been closely held by individual companies. Thus, aside from patent files, there is little common knowledge regarding the manufacture of cereal products. The process involves cooking, forming (flaking, shredding or extruding) and toasting or gun puffing.

Heavy promotion (competitive selling with subsidiary inducements) has been a characteristic of this industry since its inception. The box-top self-liquidating premium, the pack-in premium, and the cutouts have taken their turn as sales inducements for these products. These have been supported by intensive advertising programs using all types of media.

The closely held patents, the requirements for heavy expenditures in equipment development, and the large advertising and promotion requirements have tended to concentrate the industry among a few manufacturers. A handful of companies produce millions of pounds and billions of packages of cereals each year.

The original concept of a crisp, dry product to which milk is added before serving has remained unchanged through the years.

The forms of cereal have also remained unchanged. Variety has been provided by new shapes, vitamin fortification, sugar coating and protein supplementation.

Cereals became identified early as breakfast foods and have maintained this position. They have changed from "health foods" to "high energy foods," and their use has spread to other English-speaking countries, generally through the expansion of American companies.

See GRAIN PRODUCTION AND TRADE and the articles on the various cereals, such as BARLEY; CORN; WHEAT, etc. *See* also references under "Cereals" in the Index volume. (V. D. LU.)

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CEREBELLUM, one of the major divisions of the brain. *See* BRAIN.

CEREBRAL PALSY implies a paralysis (loss of volitional control over a motor function) resulting from some disorder of the brain (cerebrum) suffered either before or at birth or during infancy. The meaning of the term cerebral palsy is broad, including commonly all motor disturbances attributable to a cerebral disorder of early life. In precise medical language the term is shunned. Specifically, however, two types of infantile cerebral palsy are meant: spastic and athetosic. In the spastic type there is a more or less severe paralysis of the voluntary movements, with a spastic contracture of the extremities either on one side of the body (infantile hemiplegia) or on both sides (diplegia). In the latter case, spastic contracture and paralysis are usually more prominent in the lower extremities than in the arms and hand (Little's type of diplegia), or only the legs may be affected (paraplegia). In the athetosic type the voluntary movements may not be actually paralyzed, and spastic contractures may be slight or absent. Instead there are slow, changing, mobile spasms in the face, neck and extremities, either on one side (hemiathetosis) or, more frequently, on both sides (double athetosis), with resulting involuntary movements in the whole body or its parts, with facial grimacing and inarticulate speech (dysarthria), which increase under stress or excitement. In the spastic type, the cerebral damage affects especially the nerve cells and connections of the cerebral cortex (outer gray matter), either of one cerebral hemisphere (contralateral to paralysis) as in infantile hemiplegia, or of both hemispheres as in diplegia. In the athetosic type, damage to the brain affects especially the basal ganglia (deep gray matter) underlying the cerebral cortex.

Cerebral palsy does not necessarily imply mental retardation; many children affected with cerebral palsy grow to be mentally competent adults. However, any cerebral disorder in early life may result in impairment, sometimes severe, of the subsequent intellectual and emotional development. Epileptic attacks in the form of convulsive seizures, especially in the parts affected by the paralysis, occur in many children with cerebral palsy (*see* EPILEPSY). In the spastic type of cerebral palsy, mental retardation and epileptic attacks are particularly frequent. In the athetosic type the incidence of severe mental retardation is much lower, and occurrence of convulsive seizures is exceptional. Children affected with athetosis may be perceptive and intelligent; however, because of the involuntary movements and dysarthria, they are often unable to communicate by intelligible words or signs and so may appear mentally retarded.

The causes of cerebral palsy are multiple and vary from case to case. Heredity plays a role in only a small number of cases. It may manifest itself in neoplastic malformations of nerve cells, interstitial tissues and blood vessels of the brain with tendency to produce tumours, as in tuberous sclerosis, angiomatosis and related congenital defects; or it may express itself in an abnormal chemistry of the brain. Embryonic malformations of the brain, and fetal diseases due to transplacental infections, maternal diabetes, blood dyscrasias and similar affections, with disturbance of placental circulation and fetal metabolism and nutrition, are commoner causes of cerebral palsy than is heredity. Incompatibility of parental blood types, leading to severe jaundice of the newborn, may cause brain damage and cerebral palsy. Embryonic malformations and fetal diseases of any cause predispose to premature birth or to malpresentation and difficult delivery, and hence to asphyxia at birth. Asphyxia at birth is probably the commonest immediate cause of a great majority of cerebral palsies. Postnatal diseases, particularly infections of infancy and childhood, severe head injuries and accidents of poisoning (with heavy metals, such as lead, or with other toxic substances in food, drink or respired air; *e.g.*, carbon monoxide) are other less common causes of cerebral palsy.

Treatment with the so-called muscle-relaxant drugs is at best palliative, temporary in effect and limited in value. In some cases of particularly awkward dislocation of the posture, severing of the tendons of contractured muscles may contribute to improvement in efficiency of motor performance, but usually the benefit gained does not justify the effort. The use of mechanical devices to correct posture or to counteract spasm and contracture may make it possible for the child to stand alone and walk after a fashion, and so may facilitate other volitional movements, provided intellectual faculties are not severely curtailed. In some cases of infantile hemiplegia associated with disturbances of emotional behaviour, with convulsions and with signs of progressive impairment of intellectual development, surgical removal of the affected cerebral hemisphere proved to be of benefit for the further development of the child, provided the operation was performed before puberty. In all cases of cerebral palsy, however, the basic program of treatment should aim at the psychological management, education and training of the child, to develop whatever sensory, motor and intellectual assets are still available to him in order to compensate for the physical liabilities. The child should be exposed to the normal demands and stimulations of his natural social and physical surroundings, care being taken that the challenge is commensurate with his ability to meet these demands and to respond to stimulations adequately, with a reasonable chance for gratification to the child in his attainments. (P. I. Y.)

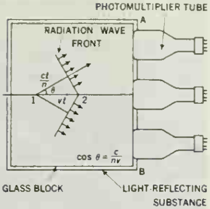
CEREBROSPINAL FLUID: *see* MENINGES AND CEREBROSPINAL FLUID.

CEREMONIALISM: *see* RITES AND CEREMONIES.

CERENKOV, PAVEL ALEKSEEVICH (1904–), Soviet physicist awarded the 1958 Nobel prize for physics, jointly with I. E. Tamm and I. M. Frank, "for the discovery and interpretation of the Cerenkov effect," was born in 1904. The Cerenkov effect is defined as the emission of light waves by electrons or other electrically charged atomic particles moving in a medium at any speed greater than the velocity of light in that medium (*see* CERENKOV RADIATION). This effect is analogous to the formation of an acoustic "bow wave" by a bullet or aircraft moving through air at supersonic velocity.

Cerenkov's contribution to these researches was made in 1934 when he was a research student under S. I. Vavilov at the Institute of Physics of the Academy of Sciences of the U.S.S.R., where he continued to work. His work includes studies on electron radiation carried out jointly with Frank and Tamm, for which all shared the Stalin prize in 1946. (W. J. BP.)

CERENKOV RADIATION, light radiated by a charged particle when the particle passes through an optically transparent medium at a speed greater than the speed of light in the medium. In 1934 P. A. Cerenkov observed that when a beam of high-energy electrons penetrated a transparent liquid, light was emitted. He was able to show that this light was not the usual phosphorescence and fluorescence that is frequently observed when substances are struck by high-energy electrons, but that it was generated only when the velocity of the electrons was greater than the velocity of light in the liquid. He also observed that the light emitted was strongly polarized. In 1937, I. M. Frank and I. E. Tamm developed a theory of the phenomenon. In 1958 the Nobel prize in physics was given to these three men for the discovery and the theoretical explanation of the Cerenkov effect. Since that time Cerenkov light has been observed from gases and solids as well as liquids.



CHARGED PARTICLE WITH VELOCITY v TRAVELS FRON POSITION 1 TO POSITION 2 IN A BLOCK OF GLASS IN TIME t, WHEREAS THE VELOCITY OF LIGHT IN THE GLASS IS c/n. THUS THE WAVE FRONT MOVES AT ANGLE θ. THE LIGHT MAY BE DETECTED BY PHOTOMULTIPLIER TUBES ATTACHED TO FACE OF BLOCK

The theory developed by Frank and Tamm shows that whenever a charged particle traverses a transparent medium with a velocity v which is greater than c/n, where c is the velocity of light in free space and n is the index of refraction of the medium, light will be radiated by the particle. This light is emitted at a characteristic angle θ to the path of the particle such that $\cos\theta = c/nv$. The reason for this relation may be seen in the accompanying figure, where the part of the wave front emitted when the particle is at position 1 advances through the medium with a velocity c/n so that after a time t, it has traveled a distance ct/n, whereas the particle itself has traveled only a distance of vt. Furthermore, it may be shown that the light is polarized, with its electric vector in the plane of the figure, and that its spectrum is continuous and more concentrated at the blue end.

The amount of light emitted by a fast particle in traversing a substance such as water is very small, there being only about 250 photons (quanta of light) emitted in the visible region of the spectrum per centimetre of path. However, an intensely radioactive source such as a nuclear reactor, when surrounded by water, will generate enough high-energy electrons in the water so that the Cerenkov light emitted by them is easily seen. In fact, Marie Curie observed that radium salts emit a pale bluish light when dissolved in distilled water.

Cerenkov radiation in a gas has been demonstrated by observing with photomultiplier tubes the minute flashes of light emitted by extremely high-energy cosmic ray particles as they traverse the earth's atmosphere. Since the velocity of light in gases at atmospheric pressure is very nearly equal to c, the energy that a charged particle must have in order to emit Cerenkov radiation is very high. For instance, protons traveling through air must have an energy greater than about 5.5×10^{10} electron volts before they will radiate.

Cerenkov radiation has been extensively used in high-energy nuclear physics to detect charged particles and to measure their velocity. The general principle of a common form of Cerenkov counter is illustrated in the figure. The particle to be detected travels through the material of index of refraction n and the light radiated is detected by photomultiplier tubes with their cathodes located at the plane AB. The material is surrounded by a light-reflecting substance, except at the points where the photomultipliers are attached. The refractive substance may be glass, liquid, or a gas confined under high pressure in order to adjust its reflective index to a specific value. Such a detector will respond to all particles whose velocity is greater than c/n. More elaborate detectors have been constructed in which only light emitted at a certain angle θ is allowed to fall upon the photomultiplier cathode. Such a detector will respond only to charged particles whose velocity is $v = c/n \cos\theta$. Another form of Cerenkov counter consists of a large cube of lead glass, perhaps 12 in. on a side, with photomultipliers arranged over one face. Such a detector will respond to high-energy photons which generate showers of electron-positron pairs in the lead glass. The total amount of light emitted from such a shower is proportional to the energy of the incoming photon. Hence, with this type of detector it is possible to measure the total energy of the incoming photon.

See J. V. Jelley, *Cerenkov Radiation and Its Applications* (1958); J. Marshall, "Cerenkov Counters," *Ann. Rev. Nuclear Sci.*, 4:141–156 (1954). (A. V. T.)

CERES, goddess of the growth of food plants, worshiped, alone or with the god Cerus, over a considerable part of ancient Italy. Her name, "creatress," may be of Oscan origin. Her cult was early overlaid by that of Demeter (*q.v.*), who was widely worshiped in Sicily and Magna Graecia. On the advice of the Sibylline books, a cult of Ceres, Liber and Libera was introduced into Rome in 496 B.C. to check a famine (*see* also LIBER AND LIBERA). Liber and Libera seem to represent the Iacchos and Kore of the Eleusinian cult, and the ritual of this worship was largely if not wholly Greek. The temple, which was built on the Aventine hill in 493 B.C. and was of Etruscan shape but decorated by Greek artists, became a centre of plebeian activities, religious and political. Ceres was regarded as the patroness of the corn trade, which seems to have been early in plebeian hands.

The chief festivals of this cult were the Ludi Ceriales, introduced before 202 B.C., and ultimately lasting from April 12 to 19; an annual festival, instituted before 217 B.C., celebrated in secret by the women and apparently dealing with the union of Kore and Hades; from 191 B.C. on, a fast (Jejunium Cereris) held at first every five years, but subsequently every year on Oct. 4. All these were on Greek lines.

See G. Wissowa, *Religion und Kultus der Römer*, 2nd ed. (1912).

CERIGNOLA, an episcopal town of southeast Italy, in the region of Puglia, province of Foggia, is situated on high ground marking the southern limit of the Puglia tableland, 124 m. (407 ft.) above sea level. It is 37 km. (23 mi.) S.E. of Foggia by road, on the main railway line from Milan, Ancona and Foggia to Bari and Brindisi. Pop. (1957 est.) 54,205 (commune). The philologist Nicola Zingarelli (1860–1935) was born at Cerignola and Mascagni composed *Cavalleria Rusticana* there in 1890. The annual festival of the Madonna di Ripalta takes place on Sept. 8. Vines, olives, almonds, wheat and oats are cultivated and there is trade in merino and mattress wool. The town suffered damage at the hands of barbarians and Saracens. On April 28, 1503, the Spaniards defeated the French below the town, making the kingdom of Naples a Spanish province. Cerignola later passed to the princely families of Caracciolo and Pignatelli. In World War II it was captured by the Allies in Sept. 1943. (M. T. A. N.)

CERINTHUS (fl. *c.* A.D. 100), a Christian heretic, to confute whose errors, according to Irenaeus, John wrote his Gospel, was probably born a Jew in Egypt. Little is known of his life save that he was a teacher and founded a short-lived sect of Jewish Christians with Gnostic tendencies (*see* GNOSTICISM). He apparently taught that the world was created by angels, from one of whom the Jews received their imperfect Law. The only New Testament writing Cerinthus accepted was the Gospel of Matthew. Jesus, the offspring of Joseph and Mary, received Christ at his baptism as a divine power revealing the unknown Father. This Christ left Jesus before the passion and the resurrection. Cerinthus admitted circumcision and the sabbath, and held a form of millenarianism.

Eusebius in his church history quotes a story that Irenaeus heard from Polycarp: the apostle John, on learning that Cerinthus was in a bathhouse he was entering, rushed out exclaiming that the building would collapse since the enemy of truth was within.

See J. Danièlou, *Théologie du Judéo-Christianisme* (1958). (G. Q.)

CERIUM, the most abundant of the rare-earth group of chemical elements, is a metal of iron-gray colour that is slowly oxidized in air. It reacts rapidly with boiling water, liberating hydrogen, and in wire form burns brilliantly when heated. The symbol for cerium is Ce, the atomic number is 58 and the atomic weight is 140.12. The estimated terrestial abundance is 0.00461%. Four stable isotopes are known: Ce^{136}, Ce^{138}, Ce^{140} and Ce^{142}.

Cerium and its compounds have a number of practical applications. Tetravalent (ceric) salts, which are powerful but stable oxidizing agents, are used in analytical chemistry to determine oxidizable substances such as ferrous iron. The dioxide is employed in the optics industry for fine polishing of glass and as an opacifier in porcelain coatings; cerium nitrate is used in the manufacture of Welsbach incandescent gas mantles; other salts are employed in the ceramic, photographic and textile industries. The metal is an ingredient of the carbon-impregnated arcs used for illumination in the motion-picture, television and related industries. Along with other rare-earth metals, cerium is a constituent of numerous ferrous and nonferrous alloys; a superior high-temperature alloy for jet engines contains about 3% cerium with magnesium. Misch metal (50% cerium, 25% lanthanum, 15% neodymium and the other 10% consisting of other rare earths and iron) is used for lighter flints, as a deoxidizer in various alloys and in vacuum tubes as a getter to remove traces of oxygen.

Cerium was discovered in 1803 by Jons Berzelius and Wilhelm Hisinger working together and independently by M. H. Klaproth. It was named after the asteroid Ceres, which had been discovered in 1801. Cerium occurs in monazite, bastnasite, cerite and many other minerals; monazite is the important commercial ore. Along with praseodymium and terbium, cerium is different from the other rare earths in that it forms compounds in which it is tetravalent; it is unique in that it is the only rare earth that forms solutions containing the tetravalent ion. Procedures for separating and purifying cerium usually are based on the fact that only cerium is easily oxidized in aqueous solution to the plus four oxidation state. One common scheme involves oxidation of the trivalent cerium in a rare-earth nitrate solution of low acidity by potassium bromate; the tetravalent cerium nitrate hydrolyzes to precipitate the insoluble basic nitrate practically free from other rare earths. Solvent extraction of tetravalent cerium is also used.

The nearly white oxide formed by air ignition of cerium salts is CeO_2; it is insoluble in hydrochloric or nitric acids but is soluble in sulfuric acid. Most tetravalent cerium salts are orange to yellow in colour, as are solutions containing the Ce^{4+} ion. In its trivalent oxidation state, cerium behaves as a typical rare earth; its ionic radius is 1.034 Å. Neither the 4+ nor 3+ form produces sharp, discrete lines in the ultraviolet, visible or near-red spectral regions, but certain broad absorption bands have been used for analysis. Tetravalent cerium, with no 4*f* electrons, is diamagnetic, while trivalent cerium, with one unpaired 4*f* electron, is paramagnetic.

Cerium metal is prepared by electrolysis of the anhydrous fused halides or by thermoreduction of the halides with alkali or alkaline earth metals. It is about as soft and ductile as tin and is a powerful reducing agent. The melting point is 804° C.; its density is 6.768 g. per millilitre for the face-centred cubic structure; other forms are known to exist.

See also references under "Cerium" in the Index volume.

(Ld. B. A.)

CEROGRAPHY, the art of painting in wax. *See* ENCAUSTIC PAINTING.

CERRITO, FANNY (FRANCESCA) (1817–1909), Italian ballerina noted for the brilliance, strength and vivacity of her dancing. Born in Naples on May 11, 1817, she worked under Salvatore Taglioni, made her debut in 1832 and sprang into international fame in London, 1840. Her greatest role was in *Ondine*, created for her by Jules Perrot in London, 1843. Two years later she appeared with Marie Taglioni, Carlotta Grisi and Lucile Grahn in Perrot's famous *Pas de Quatre*.

Fanny Cerrito's favourite partner was Arthur Saint-Léon, whom she married in 1845. A noted choreographer, he arranged *La Fille du Marbre* for her Paris Opéra debut in 1847. They separated in 1851. One of the few women to achieve distinction as a choreographer during the 19th century, she staged *Rosida* (London, 1845) and *Gemma* (Paris, 1854). After appearances in Russia, she retired in 1857. She died in Paris on May 6, 1909.

See Ivor F. Guest, *Fanny Cerrito* (1956). (Ln. Me.)

INFORMATION SERVICE, EMBASSY OF VENEZUELA

CERRO BOLÍVAR, A MOUNTAIN OF IRON ORE, VENEZUELA

CERRO BOLÍVAR, a mountain of iron ore 1 mi. wide, 4½ mi. long and 2,631 ft. above the surrounding grasslands just north of the Guiana highlands, Venez., is one of the most important mineral discoveries of the 20th century. It lies 90 mi. S.W. of Puerto Ordaz, a river port at the confluence of the Caroni and Orinoco. The ore is sent by rail to this port for loading into ocean-going vessels which navigate the Orinoco and its distributary on the delta, the Boca Grande, for 187 mi. to the Atlantic. The mountain, which is thought to contain 500,000,000 tons of high-grade ore (a mixture of hematite, limonite and a small percentage of magnetite, with an average 63.5% iron), lies in a region geologists believe to contain reserves of as much as 2,000,000,000 tons. The ore deposits have an average thickness of 230 ft. Cerro Bolívar was discovered in 1947 during the United States Steel corporation's world-wide search for new sources of iron ore. Mining is possible the year round, and millions of tons of ore are shipped annually to the U.S., Europe and Japan for manufacture into pig iron and steel. (L. We.)

CERRO DE PASCO, a mining town in the highlands of central Peru and capital of the department and province of Pasco (*q.v.*), is located 110 mi. N.E. of Lima, to which it is connected by rail and an all-weather highway. Pop. (1958 est.) 26,000. The town, one of the world's highest (elevation 13,973 ft.), owes its location to the discovery of rich silver ores in 1630 and for about two centuries was one of the world's chief sources of silver. In the late 19th century when the silver ores had been almost depleted, Cerro de Pasco declined in population; but in the 20th century its importance was regained as a result of the mining of copper, gold, lead, zinc and bismuth. Nearby are the vanadium mines at Minaragra. Mining is made difficult at the high altitude because of the rarified air, and only the richness of the ores makes continued production possible. The copper is smelted at La Oroya to the southeast. (P. E. J.)

CERRO GORDO, a mountain pass about 60 mi. N.W. of Veracruz, Mex., where the U.S. army under Gen. Winfield Scott first met serious resistance (April 1847) on its march to Mexico City during the war between the United States and Mexico. Advance units of Scott's army reached Plan del Rio, a few miles from Cerro Gordo, on April 11, 1847. There they met detachments from Gen. Santa Anna's Mexican army, which numbered about 12,000 and was entrenched in the pass. The next few days were spent in reconnaissance, during which Scott arrived with the main body of his 8,500-man army. This reconnaissance (conducted in part by Capt. Robert E. Lee and other officers who won fame in the American Civil War) discovered a rough path that passed around the position of the defenders, and Scott decided upon a flanking movement to attack the Mexican forces from the rear. Before this plan could be executed, fighting broke out on the afternoon of April 17 around two hills held by the Mexicans and facing the front lines of the invaders. This fighting was continued on the early morning of the 18th, when the Mexican forces fled in disorder. The battle had been decided while the flanking movement was still in process. The defenders had lost about 1,100 men in killed and wounded and about 3,000 were taken prisoner. U.S. losses were about 400, of whom 63 were killed. The state of Santa Anna's forces precluded further organized defense in that vicinity, and Scott moved on to Puebla, the second city of Mexico, and later to Mexico City. *See* also Mexican War, The.

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CERRO LARGO, a department in northeast Uruguay, established in 1837, bordering Brazil. Its population (1954 est.) was 118,947, of whom 36,000 lived in Melo, the departmental capital. Most of Cerro Largo's 5,317 sq.mi. is ranch country, with more than 700,000 cattle and 1,700,000 sheep counted in the early 1960s. Corn, wheat, rice, grapes, fruit and forage crops are grown. Melo, founded as an outpost against smuggling in 1795, still has a colonial air, but is rapidly becoming modernized. (M. I. V.)

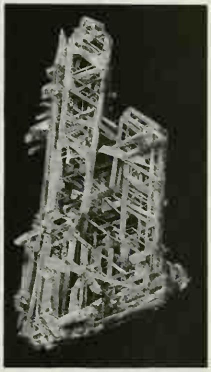
CERTHIIDAE, the creeper family of small songbirds, found in North America, Europe, Asia and Australia. These birds have thin, curved bills, are weak fliers and usually are seen creeping up a tree trunk. *See* Tree Creeper; Brown Creeper.

CERTIFIED CHECK (CHEQUE): *see* Check.

CERTIFIED PUBLIC ACCOUNTANT (C.P.A.), an accountant who has received the certificate of a certified public accountant and who holds a valid permit to practice under the laws of his state. In most cases he has passed a comprehensive examination covering the theory of accounts, accounting practice, auditing and commercial law, and has met certain experience and educational requirements.

The C.P.A. offers services to the public for a fee and adheres to a strict code of professional conduct. He may be called on to perform a variety of services for his clients. As an independent auditor, the C.P.A. expresses an unbiased opinion of his client's financial condition and results of operations. He prepares tax returns and gives advice concerning possible tax consequences of planned business decisions. The management services he performs include consultation on the design and installation of accounting systems and on operations research projects in the field of accounting (*q.v.*). (A. R. Ce.)

CERUSSITE, a mineral consisting of lead carbonate, $PbCO_3$, is an important ore of lead (*q.v.*); it contains 77.5% of the metal. Cerussite occurs in large quantities in the upper oxidized portions of lead deposits and is found in many localities. It is an abundant ore at Leadville, Colo., and in other mining districts of the western United States. The name is derived from the Latin *cerussa*, "white lead." It crystallizes in the orthorhombic system, and often forms pseudohexagonal twins like those of aragonite (*q.v.*), with which it is similar in crystalline form or isomorphous. It also occurs in compact granular or fibrous forms. It is usually colourless or white, sometimes gray or greenish, and is usually more or less transparent; some well-formed crystals have a brilliant lustre. Its hardness is 3 to 3.5 and density 6.5. Unlike anglesite (lead sulfate) it effervesces with dilute nitric acid. (Cl. F.)



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CRYSTAL STRUCTURE OF CERUSSITE FROM BROKEN HILL, NEW SOUTH WALES, AUSTR.

CERUTTI, GIUSEPPE ANTONIO GIOACCHINO (1738–1792), French writer and politician who enjoyed considerable influence as a pamphleteer during the Revolutionary era. Born at Turin on June 13, 1738, he was brought up by Jesuits and became a member of the Society of Jesus, which he vigorously defended in *Apologie générale de l'institut et de la doctrine des jésuites* (1762). Later he became an equally fervent advocate for the claims of the *tiers état* and his pamphlets, including *Mémoire pour le peuple français* (1788), enjoyed great popularity. In 1790 he was one of the founders, with R. Saint-Etiènne and P. Crouvelle, of the weekly news bulletin, *La Feuille villageoise*, designed to inform the rural population of the progress of the Revolution. Though elected a member of the legislative assembly, he was able to address it only once before his death at Paris, on Feb. 3, 1792.

CERVANTES SAAVEDRA, MIGUEL DE (1547–1616), Spanish novelist, playwright and poet, creator of Don Quixote, was born in the university city of Alcalá de Henares, the second son and fourth of seven children of Rodrigo de Cervantes and Leonor de Cortinas. The exact date is not recorded, the choice of name (Miguel = Michael) suggesting Michaelmas (Sept. 29); he was baptized on Oct. 9, 1547. Rodrigo led an unsettled and precarious existence as an apothecary-surgeon. He was apparently resident in Valladolid in 1554 and appears to have moved his family to Madrid when Philip II established that city as his capital in 1561. He is met with in Seville in 1564–65, and again in Madrid from 1566. Somewhere, as a boy, Cervantes saw the famous actor-manager and dramatist Lope de Rueda, of whom he writes enthusiastically in the preface to his plays and who possibly first fired his passion for the drama. He may have had some schooling in Valladolid and again with the Jesuits in Seville. No reference to him is known between baptism and 1569, when Juan López de Hoyos, professor of Latin at the Studium of Madrid, edited a volume of exequies to Philip II's third wife, Elizabeth de Valois. In it appeared a sonnet, four redondillas and an elegy by Cervantes, "our dear and beloved pupil." The term "pupil," at age 21, is perplexing. On Sept. 15, 1569, a warrant was issued for the arrest of one Miguel de Cervantes, missing from the capital, against whom sentence had been pronounced of the loss of his right hand and ten years' exile "for wounds inflicted on Antonio de Sigura in Madrid." This could explain a request from Rome to his father for legal testimony to his legitimate birth and old Christian stock. The certificate to this effect is dated Dec. 22, 1569. Years later, in the dedication of the *Galatea*, he wrote of having been chamberlain in Rome to Giulio Acquaviva, who became cardinal in 1570.

On Sept. 16, 1571, he sailed from Messina as a common soldier on board the "Marquesa" in the armada led by Don John of Austria against the Turks. At the battle of Lepanto (Oct. 7, 1571) the "Marquesa" was in the thick of the conflict. Though ill with fever, Cervantes fought gallantly and received three gunshot wounds, one permanently maiming his left hand—"to the greater glory," as he says, "of the right." By April 1572 he was again fit for duty and, accompanied by his younger brother Rodrigo, he shared in the naval engagement off Navarino on Oct. 7, 1572; in the capture of Tunis on Oct. 10, 1573; and in the unsuccessful expedition to the relief of La Goletta in the fall of 1574, with periods of garrison duty at Palermo and Naples. Anxious for promotion, he procured himself letters of commendation from Don John and the viceroy of Sicily, obtained leave to return to Spain and embarked, again with his brother, on the "Sol" out of Naples on Sept. 20, 1575.

Six days later, off Marseilles, the "Sol" was attacked by three Turkish galleys; Cervantes, his brother and other Spaniards were captured and taken to slavery in Algiers. There he was closely guarded, the letters he carried suggesting him to be a person of consequence worth a high ransom. In 1576 he tried to escape, but a Moor whom he had induced to guide him and other captives to Oran deserted them on the way, and the baffled fugitives had to return to Algiers, where Cervantes was treated with additional severity. Early in 1577, priests of the Order of Mercy arrived with 300 crowns sent by his parents, a sum which was insufficient to free him but which served to ransom his brother. Another attempt at escape in September again failed through betrayal, and Cervantes, brought before the viceroy of Algiers, Hassan Pasha, was threatened with death. His heroic bearing caused Hassan instead to buy the prisoner for his own service. In 1578 he incurred sentence of 2,000 strokes for appealing for help to the Spanish governor of Oran; again punishment was remitted. His family continued its efforts. In March 1578 his father presented a petition to the king setting forth Cervantes' services. His mother obtained in 1579 a licence authorizing the trading from Valencia to Algiers of goods to the value of 2,000 ducats; and she herself raised, with a daughter, 300 ducats toward his ransom, entrusting the money to two Trinitarian monks. Late that year Cervantes plotted to secure a frigate on his own, but was again betrayed. Hassan once more spared his life, declaring that "so long as he had the maimed Spaniard in safe keeping, his Christians, ships and city were secure." The two Trinitarians arrived in Algiers on May 29, 1580, just as Hassan's term of office ended. Their funds fell short of the 500 gold ducats he demanded, but Christian traders in the town made up the balance and, on Sept. 19, when Cervantes, who was to follow Hassan to Constantinople as a slave, was already on board ship, he was granted his freedom. He sailed for Spain late in October, landed at Denia and proceeded to Madrid, where he signed on Dec. 18 a statement concerning his release.

It seems certain that soon after this he visited Portugal, then lately incorporated in the Spanish crown, and in May 1581 he set out from Tomar on a mission to Oran. Returning eventually to Madrid, frustrated in his hopes of official employment, he consorted with writers and turned his hand to the writing of plays. In the *Adjunta al Parnaso* he mentions as "worthy of praise" a number which are ascribed to the years 1582–87: "but the one I esteem and pride myself on most was and is *La Confusa,* which, with all respect to as many cloak-and-sword plays as have been put on the boards up to now, may well stand out as good among the best." Of these "twenty or thirty," all of which, he tells us, were acted, only *El Trato de Argel* and *La Numancia* have survived, in manuscript copies discovered in 1784. In 1584 he obtained licence to print a pastoral novel, *La Galatea.* Published in Alcalá de Henares in 1585 and twice reprinted during his lifetime (Lisbon, 1590; Paris, 1611), it remained his own favourite and for over 30 years, and still on his deathbed, he kept promising a second part.

On Dec. 12, 1584, he married Catalina de Palacios Salazar y Vozmediano of Esquivias, a girl 18 years his junior, who brought him a modest dowry of some vineyards and an orchard, various items of furniture, four beehives, 45 hens and chickens and one rooster. It was probably a year or two earlier that he had a daughter, Isabel de Saavedra, by one Ana Franca de Rojas. By his wife he had no children, and Isabel figured much in his life in later years. His father's death on June 13, 1585, doubtless increased his responsibilities as the man of a household of many women, including his sisters and a niece, and gave new urgency to the search for a livelihood.

In 1587 he went to Seville, presumably alone, to seek employment in the provisioning of the Invincible Armada, this marking the beginning of a 15-year hiatus in his literary career. Excommunication for excessive zeal in requisitioning grain belonging to the dean and chapter of Seville at Ecija initiated a long chapter of mischances and dire financial straits in this new role of commissary to the navy, in which he was retained after the defeat of the Armada. On May 21, 1590, he petitioned the king for one of four posts then vacant in the Indies: an accountantship in New Granada, the governorship of a province in Guatemala, the position of auditor to the galleys at Cartagena, the chief magistracy in La Paz. The petition, referred to the Council for the Indies, was there annotated: "Let him look for something nearer home"; and he continued as commissary. In Nov. 1590 he had to borrow the price of a suit of clothes; in Aug. 1592 his sureties were called on to make good a deficiency in his accounts. Meanwhile his thoughts still ran on the stage; and on Sept. 5, 1592, he contracted with one Rodrigo Osorio of Seville to write six plays at 50 ducats apiece, payment to be withheld were each not to prove, to Osorio's satisfaction, "one of the best ever produced in Spain." Nothing came of the agreement. Within a fortnight Cervantes was for some days in prison at Castro del Río, again on charges of illegal requisitioning at Ecija. Accounting difficulties with the exchequer led him into deeper and deeper water. In mid-1596 he entrusted to a banker in Seville 7,400 reals for payment to the treasury in Madrid. The banker absconded, and not until Jan. 1597 was the money recovered. In Sept. 1597 Cervantes was committed to Seville jail and held for three months for failure to guarantee compliance with an order that he present himself in Madrid within 20 days. With this incident his official employment appears to have terminated, although in 1599 and again in 1601, the government was still summoning him to Madrid to clear up his accounts.

The years 1600–03 are a blank. The possibility that he may have rejoined his wife in the tranquil obscurity of Esquivias is reinforced by the only thing to be inferred with certainty of this period—that he was busily engaged in the writing of *Don Quixote.* Philip III had removed the capital to Valladolid in 1601, and when Cervantes reappeared in Valladolid, in the middle of 1604, it was to see to the publication of a manuscript which was then ready for press. Licence to print was granted for Castile on Sept. 26, and in Jan. 1605 *El Ingenioso Hidalgo Don Quixote de la Mancha* appeared, in Madrid, with a dedication to the duke of Béjar that seems to have brought the author no return in patronage. The book had an immediate success. Within a few weeks of publication three pirated editions were issued at Lisbon. A second authorized edition, with minor revisions, was hurried out in Madrid with a privilege extending now to Aragon and Portugal, and two other reprints appeared in Valencia in the same year. It was reissued in Brussels (1607 and 1611), Madrid (1608) and Milan (1610). With the exception of Mateo Alemán's *Guzmán de Alfarache,* no Spanish book of the period achieved such currency. Thomas Shelton's English version of 1612 was the earliest translation.

A stabbing affray outside Cervantes' first-floor lodging in Valladolid on June 27, 1605, that landed him and his womenfolk in jail for a week on suspicion, shows him to be still living in difficult circumstances. For three years thereafter he is again lost to view, to reappear in 1608 in Madrid, now once more the capital. There he was much harassed by an interminable series of legal squabbles over financial matters in which he was involved by his daughter and her second husband; and when in mid-1610 the count of Lemos was appointed viceroy of Naples, Cervantes sought escape by aspiring to an appointment in his train. The hope did not materialize, but in dedicating to the count the second part of *Don Quixote* Cervantes paid tribute to the generous support received in his last years from him, as also from Bernardo de Sandoval, cardinal-archbishop of Toledo. Earlier, in 1609, he had been received into the newly founded fraternity of Slaves of the Most Blessed Sacrament; about the same time his wife took the habit of the Third Order of St. Francis. In 1612 he joined the Academia Selvaje, a new literary club to which Lope de Vega belonged.

He was now entering on his third period of literary activity. The 12 *Novelas ejemplares* appeared in 1613, dedicated likewise to the count of Lemos. There followed in 1614 the *Viaje del Parnaso,* a burlesque poem on the poets of the day with an admirably whimsical postscript, the *Adjunta al Parnaso,* in prose. He returned to his first enthusiasm with the *Ocho comedias y ocho entremeses nuevos* (1615), genially admitting in the prologue that these, written "some years previously," had found no favour with managers, whence his acceptance of an offer of publication from a bookseller. In the foreword to the *Novelas ejemplares* Cervantes had promised speedy appearance of a sequel to *Don Quixote.* He was at work on the 59th chapter of this when he learned of the publication at Tarragona, 1614, of a spurious *Segundo tomo del ingenioso hidalgo Don Quixote de la Mancha* by one Alonso Fernández de Avellaneda of Tordesillas. The book was not devoid of literary talent and robust humour. What stung most was an insolent preface taunting Cervantes with physical defects and moral infirmities. Cervantes hurried on with his own second part, allowing some bitterness against Avellaneda to creep in, and it appeared toward the end of 1615. It too was speedily reprinted, in Brussels and Valencia (both 1616) and in Lisbon (1617), with a first translation, into French, in 1618. From the Barcelona edition of 1617 onward both parts appeared together.

Los Trabajos de Persiles y Sigismunda, which appeared posthumously in 1617 and ran through eight editions in two years, proved his last work. A long *historia setentrional,* he made bold to claim for it that it would be either the worst or the best work of imagination in the language. The brief dedication to his patron, a most moving and gallant leavetaking, he penned on his deathbed, on April 19, 1616. He had already received extreme unction, and on April 23, in his house in the Calle de León, he died. Next day he was buried in the Trinitarian convent in the Calle de Cantarranas; no stone marked his grave, and no will is known. His wife survived till 1626 and his daughter till 1652, when his line became extinct.

WORKS

Cervantes, once he found himself as a writer, was characterized by a consistent self-confidence allied to much probing of his gifts and limitations, and by a profound preoccupation with the relationship between life and literature. He began with poetry, plays and a pastoral novel, imitation of established literary kinds and of other authors being the accepted mode of entry into literature as a career. When finally convinced of his own inventive faculty, he applied himself not to wringing success from competition in well-trodden fields but to striking out in directions of his own. He set himself to kill the romance of chivalry as then current, and in so doing brought into existence what was in effect a new kind, the modern novel. He was the true creator for Spain of the psychological short story. His last work, a vast allegory of the Catholic faith, he himself held to be his greatest. Esteemed until comparatively recently as an inspired but uninstructed genius who wrote a masterpiece by accident, he is recognized now as having not merely kept abreast of contemporary thought but as one who was notably independent in his own thinking, deliberate in his aims and in his every effect.

His fascinated interest in literary theory, which makes whole chapters of *Don Quixote* read like a running commentary on Aristotle, may date from the years of service in Italy. Though he never makes reference to it, the publication in Madrid in 1596 of Alonso López Pinciano's *Philosophía antigua poética* would seem, however, to have been the decisive influence in his literary career, leading him back to letters after the long hiatus following the *Galatea*, and giving him the sense of purpose and direction he had lacked before. This most penetrating of all the Spanish Renaissance treatises on poetics is concerned no less with aesthetics, and proclaims its derivation from Aristotle, already implicit in the title, in the philosophic approach to literature that informs it throughout. By implication it contains, among much else, a sustained attack on Lope de Vega and the *comedia*, with their open repudiation of classical authority; and this Cervantes echoes in his unwillingness, rather than inability, to write to their pattern, and in his call for some form of dramatic censorship. His claim in 1614 for the lost *La Confusa* of his earliest period (that it could stand with the best cloak-and-sword plays ever written) shows him unpersuaded to the end; and his *Ocho comedias*, printed when they had failed to make their way to the boards, could be reprinted by B. A. Nasarre in 1749, after a century and more of oblivion, as deliberate exercises in absurdity, parodying the established *comedia* as *Don Quixote* had parodied the novel of chivalry. The theory is untenable: Cervantes believed every literary kind good in itself if properly informed, and sought to inform the drama, not with whatever most appealed to the groundling (as did Lope de Vega), but with such reasonableness and relevance to life as would commend it to the cultured minority. He failed, lacking the sense of dramatic tension, just as he lacked skill in the economic contriving and unfolding of plot. Individual scenes in his earliest plays, instinct with lofty patriotism in *La Numancia*, or with grim experience in *El Trato de Argel*, have power to grip, and explain his much greater success in the *entremés* or interlude. Here, in a brief sketch, characters taken from life are caught and pilloried in a revealing situation developed, for the most part, in the raciest of prose (the plays are in verse) and with unfailing *vis comica*.

The *Galatea* was Cervantes' other wrong turning. The pastoral novel, pseudoclassic in lineage and transplanted from Italy to Spain by the Portuguese Jorge de Montemayor (*c.* 1559), had imposed a fashion. Cervantes' characters are no shepherds, but "very discreet courtiers" who discourse endlessly in prose and verse on the nature of true love without ever coming to grips with life. This doubtless explains the author's own dissatisfaction with the work, though again not with the kind, that clearly responded to some deep idealistic strain in his make-up. Hence the constant alluding to a second part. As promised originally, this would have been the mere exploiting of the popular success he had hoped, and failed, to win with the first. As promised early in *Don Quixote*, and often thereafter, it would have reflected his new-found concern with the interrelationship of literature and life; and his failure to discharge the promise suggests that, much as he obviously longed to, he never succeeded in working out in his mind the form that reflection should take within the pastoral framework.

Don Quixote.—In *Don Quixote* Cervantes discovered his true bent. That its initial purpose was to discredit through parody the "false and absurd" romances of chivalry, which for a century had exercised a hypnotic attraction on readers of all classes, cannot be questioned: it is reiterated in the last sentence of the book. Don Quixote, a modest country gentleman so hypnotized, sets out to resurrect the institution of knight-errantry. Admirably sane in everything else, he mistakes inns for castles, windmills for giants, criminals on their way to the galleys for victims of tyranny, and sees at every turn a wrong reserved for him to right. He is brought back to his village at length a prisoner in a cage, believing himself enchanted. A second sally, that takes him much farther afield, ends with his defeat in a duel, the penalty being his abandonment of the profession of chivalry, and he returns home to die of disillusion. But Cervantes makes equally clear—notably through the mouth of the canon in part i, 47–48—that he did not abominate the romance of chivalry as such. Remoteness from life, failure to instruct as well as delight, ignorance of the literary "rules," particularly in the matter of verisimilitude and of the role of the fable in poetic creation: these grosser failings of its practitioners had obscured the true possibilities of the chivalric romance as the modern equivalent of the classical epic, free to range not so much over geographical space as through the whole gamut of society and experience. All this was to be learned or inferred from López Pinciano, as likewise it was to be seen that poetry resided not in the accident of verse but in the conception; that poetic truth was superior to historic and of a more universal validity; and that the epic might not only be cast in prose rather than verse but could dispense with its traditional rooting in historic fact. That it should carry conviction to the reader was what mattered. Don Quixote, the knight-errant brought up against harsh reality and defeated by it every time, even—and most cruelly—when he believes himself triumphant, is sufficient counterblast to the absurdities of an Amadís de Gaula moving in outer space, and is also a figure of mingled fun and pathos in his own right.

But while the knight's adventures are relevant to the book's satirical purpose, Cervantes soon realized the new and constructive possibilities inherent in his design. The discovery can be dated from part i, 4, where he sends Don Quixote back to his village to procure himself a squire. Adventure thereafter serves a second and higher purpose—to provide both a framework and subject matter for two men talking as they travel the roads of Spain. There can be few themes current in the age which the two do not discuss, but it is the abiding themes that recur: the meaning and purpose of existence, the nature of reality and of truth, the relativity of judgment and hence of values, the inner springs of character. And out of this play of mind on mind comes Cervantes' perception of "character in solution," where in earlier fiction it had been essentially static. Not merely do Don Quixote the idealist and Sancho Panza the realist interact almost to the point of exchanging roles; but the reader's interest is subtly transferred from adventure in itself to its effect on the adventurer. In all these respects—the play of dialogue, the interplay of character, a scope coextensive with society and with the mind of man itself, a constant delving beneath the surface of appearances and of experience for their deeper significance—*Don Quixote* may properly be held to be at once the first and still the greatest of modern novels. Its all-pervading humanity makes it also one of the world's most loved books, as it is, after the Bible, the most widely translated.

Novelas Ejemplares.—Five of the 12 *Novelas ejemplares* belong to the Italianate vein of amorous intrigue, perilous adventure and incredible coincidence; in this, as in their innocence of serious intention, they are separated by an abyss from the others and may be held to date from before 1596. Cervantes' claim of originality—"I am the first to write short stories in Spanish"—and of "exemplariness" applies to the seven remaining. These show him exploring the realization that art is not reality but the imitation of reality, fancy-free within the bounds of verisimilitude, and much concerned, as reality is not, with form. The function of experience he sees now as being not to supply the writer with theme, incident or character—that falling to the creative imagination—but to invest these with a meaning and bearing on life. The contrast may be pointed between *El Cautivo,* a much earlier tale, inserted in *Don Quixote,* that is in large part a transcript of the author's years of captivity in Algiers, and *El Coloquio de los perros,* the last and best of the *Novelas ejemplares,* in which two dogs, discovering themselves possessed one night of the power of speech, dissect the follies and absurdities of that strange creature, man. Both are cast autobiographically: one is compact of the facts, the other of the lessons, of experience. It is in this sense, and not in that of conventional morality, that these tales are exemplary. They throw their several lights on human nature and on problems of human relations. The one lesson they would teach is that discretion is the supreme virtue, indispensable to the achieving alike of inner harmony and of the larger harmony with one's fellows and with nature. They are new in the sense that Cervantes, with the same general body of Aristotelian precept before him as in *Don Quixote,* is seeking to forge for himself a set of rules for this minor type of literature which had hitherto been ignored by the lawmakers. The seven tales can be seen as a succession of experiments, and if achievement is relative (for Cervantes, with his tendency to discursiveness, hankered instinctively after the larger canvas of the novel), he does establish the pre-eminence of character over incident, of form over content: "Some tales are pleasing in themselves, others in the mode of telling."

Persiles y Sigismunda.—*Persiles y Sigismunda* is commonly considered an enigmatic aberration in the unfolding of Cervantes' genius. The author's own opinion of it has been stated, and no other of his works enjoyed the same immediate popularity. It was inspired by the *Aethiopian History* of Heliodorus, exalted by López Pinciano both as a true epic and as great poetry, and specifically linked by him with the romance of chivalry. Here was, in fact, a romance of chivalry written to the rules, and Cervantes set himself to the writing of another such, his confidence deriving from the fact that at last he had before him both a body of precept and an example. Where he parted company from Heliodorus, again with warrant from his mentor, was in giving to his work an allegorical and deeply religious purpose. Knights and ladies are pilgrims now in search of truth, not the Platonic, philosophical truth of *Don Quixote* but the revealed truth of the Catholic faith. The pilgrimage, begun in the errant north, ends in Rome. Cervantes' closing years showed an increasing concern with religion, and this had come to seem to him the noblest, most chivalrous enterprise of all. In placing his talents at the service of a cause, he knowingly forfeited the universal appeal of *Don Quixote,* just as in placing so much of the action in lands unknown to him, he jeopardized his cardinal principle of verisimilitude. He remained to the end, and remains, the supreme master of the Spanish tongue.

That mastery derives in part from wide reading—how wide is revealed in the "scrutiny of the books" in *Don Quixote* part i, 6—and from an ear sensitive to every nuance of a language just then come to maturity. The constant concern, as his powers developed, to distil experience into dialogue, allied to a repugnance for pedantry and affectation, gives his style the flexibility and naturalness of conversation at its best. Sancho Panza, drawing so effectively from the bottomless well of Spanish proverbs, is as good a talker as his master, and an effective foil to the latter's gravity and eloquence. And informing the whole is the sweet reasonableness, the infinite charity and humanity of Cervantes' own mind, always more concerned to understand than to judge. In this, too, reside his abiding greatness and the universality of his appeal.

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CESALPINO, ANDREA (CAESALPINUS, ANDREAS) (1519–1603), Italian botanist and physician famous for his classification of plants based essentially on fruit and seed characters, was born in Arezzo in Tuscany on June 6, 1519. He studied anatomy and medicine at the University of Pisa, where he took his doctor's degree in 1551, and in 1555 became professor of materia medica and director of the botanical garden. Appointed physician to Pope Clement VIII, he removed in 1592 to Rome, becoming professor at the Sapienza. He died in Rome on Feb. 23, 1603.

Cesalpino was perhaps the most distinguished botanist of his time. His work, *De Plantis libri xvi* (1583), was the source from which various subsequent writers, and especially Robert Morison (1620–83), derived their ideas of botanical arrangement. Linnaeus himself gratefully avowed his obligations to Cesalpino. Cesalpino was also distinguished as a physiologist, and it has been claimed that he had a clear idea of the circulation of the blood. His other works include *Daemonum investigatio peripatetica* (1580), *Quaestionum medicarum libri ii* (1593), *De Metallicis* (1596) and *Quaestionum peripateticarum libri v* (1571).

See L. C. Miall, *The Early Naturalists* (1912) and V. Viviani, *Vita ed Opere di Andrea Cesalpino* (1922).

CESARI, GIUSEPPE (1568?–1640), called CAVALIERE D'ARPINO, also IL GIUSEPPINO, Italian painter and architect, was born in Rome. Under papal patronage he enjoyed extensive commissions and widespread fame, but his art was often the centre of great controversy. He stood between Annibale Carracci's theoretical eclecticism, and Caravaggio's antitheoretical naturalism, and was publicly reproached by both. Cesari was said to have corrupted taste in painting as Giambatista Marino had in poetry. He died in Rome in 1640. His brother Bernardino assisted in many of his works.

CESAROTTI, MELCHIORRE (1730–1808), Italian poet and literary critic whose translations of Ossian influenced the development of Italian romanticism, was born at Padua on May 15, 1730. He was educated in the seminary of his native city, where he later taught rhetoric (1751–60). In 1761 he entered the household of the Grimani family in Venice as a tutor; and in 1768 he was appointed to the professorship of Greek and Hebrew at Padua university. Cesarotti won fame with his sonorous verse translation (1763–72) of the fragments attributed by James Macpherson to the Gaelic bard "Ossian"—a sequence of poems that had considerable influence not only on his admirer, the poet Ugo Foscolo, but also on the development of romantic sensibility in Italy as a whole. Cesarotti's other works include translations of Demosthenes, of the *Iliad* and of Voltaire's tragedies; an epic poem, *Pronea* ("Providence"; 1807) in praise of Napoleon; a wealth of *Rime* and *Lettere,* and two important essays on aesthetics: the *Saggio sulla filosofia delle lingue* (1785)—a synthesis of 18th-century linguistic theory—and the *Saggio sulla filosofia del gusto* (1785).

Cesarotti died on Nov. 4, 1808.

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CESENA, a town in the Emilia-Romagna region, northern Italy, in Forlì province, is situated on the Savio river where it leaves the Apennines to cross the plain to the Adriatic sea, 82 km. (51 mi.) E.S.E. of Bologna by road. It is on the main railway line from Milan and Bologna to Ancona, Bari, Brindisi and Lecce. Pop. (1957 est.) 76,133 (commune). The town is dominated by a medieval fortress, on a hill (Rocca Malatestiana), built 1381–1450 and partially rebuilt 1466–80. The 14th–15th-century cathedral, largely Gothic, has a romanesque portal. Renaissance Biblioteca Malatestiana, a complete medieval library built by Matteo Nuti for Malatesta Novello in 1452, retains a medieval atmosphere with the original desks and chained books. On a hill to the southeast, the church of Sta. Maria del Monte has many fine paintings, a collection of old votive pictures and beautiful 16th-century carved stalls. The town is an important mining and agricultural centre and many tourists attend races held there.

The ancient Caesena was a station on the Via Aemilia and a fortress in the wars of Theodoric and Narses. In 1357 it was heroically defended by Cia, wife of Francesco Ordelaffi, lord of Forlì, against the papal troops under Cardinal Albornoz. In 1377 it was sacked and destroyed by Cardinal Robert of Geneva (afterward the antipope Clement). It was then held by the Malatesta of Rimini until 1465 when, after the death of Malatesta Novello, it came under the domination of the church. Both Pius VI (b. 1717) and Pius VII (b. 1740) were born at Cesena. In World War II it was captured by Allied forces on Oct. 20, 1944.

(AN. DO.)

CESIS (TSESIS, Russian VENDYEN, German WENDEN), a town in the Latvian Soviet Socialist Republic of the U.S.S.R., is on the main railway from Riga to Pskov. Pop. (1959) 13,900. The castle (1283), destroyed in 1577 by Ivan IV, was restored, and St. John's church dates from 1283. Located near land and water routes to Novgorod and Estonia, Cesis was a 13th-century Hanse town. Long the seat of the Livonian knights, the town was under Polish-Lithuanian rule from 1561 to 1629; it was conquered and held by Sweden until 1721 and then passed to Russia. In 1918 Cesis was incorporated in the newly formed state of Latvia, and in 1919 the Germans, who occupied the town in World War I, were defeated in the vicinity by Estonian and Latvian forces. In 1940 it was occupied by Soviet troops and except for the German occupation, July 1941 to Oct. 1944, it has remained in Soviet hands.

Cesis is a popular summer resort in the "Livonian Switzerland." Mainly an agricultural centre, it also manufactures building and road materials. (J. A. Bo.)

CESIUM (CAESIUM), a rare metallic element of the alkali group, symbol Cs, atomic number 55, chemical atomic weight 132.91, was the first element discovered by the use of the spectroscope (*see* SPECTROSCOPY: *Historical Spectroscopy*). Two blue lines of unknown origin in the flame spectra of certain mineral water concentrates led R. Bunsen and G. R. Kirchoff to claim the discovery of cesium (Latin *caesius*, "sky blue") in 1860. Chemically very similar to the other members of the alkali group (lithium, sodium, potassium, and rubidium), its earlier discovery was overlooked not merely because of its scarcity but through confusion with potassium.

Occurrence.—Although rare, cesium is widely distributed in nature, occurring in certain mineral waters and soils and in minute concentration in some granites and pegmatite dikes. It is approximately half as abundant as lead and about seventy times as abundant as silver. V. M. Goldschmidt estimated the abundance of cesium in the earth's crust to be about 7 parts per million. Cesium is commonly found in association with lithium in lepidolite in concentrations ranging up to 0.7% and with potassium in carnallite. The chief cesium-bearing mineral is pollucite, a hydrated cesium aluminum silicate whose theoretical composition corresponds to $Cs_4Al_4Si_9O_{26}.H_2O$. Pollucite deposits of commercial interest have been found in the Black hills of South Dakota. The extraction of cesium from pollucite is accomplished by digestion of the finely pulverized ore with either hydrochloric or sulfuric acid. In the early 1960s southern Africa was the principal producer of cesium ores.

Uses.—Comparatively little commercial use has been made of cesium metal or its compounds because of its rarity. Its principal value is in photoelectric cells where advantage is taken of the fact that cesium, in common with other alkali metals, emits electrons when illuminated by visible light. For the same reason it is widely used in the pickup tubes of television cameras. Cesium salts mixed with a reducing agent provide a source of cesium metal for use as a "getter" for scavenging the last traces of gas from vacuum tubes. In the early 1960s there was increasing interest in cesium-137 as a source of gamma rays both for medical and industrial radiology. The advantage of cesium-137 over cobalt-60 for such applications is its long half life of 30 years.

Properties.—Twenty-one isotopes of cesium have been identified, ranging in mass number from 123 to 144. All are synthetic radioactive nuclides except for the naturally occurring stable isotope of mass number 133. The radioactive isotopes decay with half lives ranging from less than one minute to 2.0×10^6 years with the emission of electrons, positrons, or gamma rays, or by K-capture.

Cesium is the most reactive of all metals, melting and inflaming spontaneously on exposure to air and decomposing water with explosive violence. Despite its reactivity, cesium metal may be prepared comparatively easily either by the electrolysis of fused cesium cyanide or by the reduction of cesium chloride with calcium metal. A silvery white metal in its pure state, cesium acquires a brass-coloured tarnish in the presence of a trace of oxygen. It is one of the softest metals and is readily cut by knife even at liquid nitrogen temperatures. Cesium metal has the body-centred cubic structure with a unit cell parameter of 6.05 Å. Its gram atomic volume (69.95 c.c.) is the largest of all elements. The following table lists a number of its important physical properties.

Physical Properties of Cesium

Density of solid at 20° C., g. per c.c.	1.90
Melting point, °C.	28.45
Boiling point, °C.	690
Coefficient of thermal expansion, linear	$97\ \mathrm{x}\ 10^{-6}$
Atomic radius, Å	2.35
Ionic radius, Å.	1.69
Heat of fusion, cal. per g.	3.76
Heat of vaporization, cal. per g.	120
Ionization potential, v.	3.89
Standard Electrode potential, v.	3.02

Cesium is univalent in all of its compounds, a consequence of the ease with which its outermost (6s) electron is removed. The outer electron configuration of the neutral atom is $5s^25p^66s^1$, and the large atomic radius, low ionization potential, large atomic volume, high coefficient of compressibility and many related properties of the metal are all consequences of the low binding energy of the 6s electron to the nucleus. The intervening electrons effectively screen the valence electron from the charged nucleus. Cesium ion is isoelectronic with xenon, and owes its stability (lack of higher valence states) to the complete occupation of the 5s and 5p electron levels.

Compounds.—Cesium forms all the usual simple salts, such as the chloride, carbonate, sulfate, and nitrate which resemble the corresponding salts of potassium and rubidium. The crystal structure of cesium chloride, bromide and iodide differs from that of other alkali metal halides because of the large radius of the cesium ion. The perchlorates and chloroplatinates of these three alkali metals are sparingly soluble in water and are used in their analysis. No completely quantitative gravimetric separations of cesium from potassium or rubidium have been devised, although the double salt of cesium and antimony chlorides ($3CsCl.2SbCl_3$) is more or less satisfactory. In low concentrations cesium and the other alkalies are determined by flame photometry.

In addition to the monoxide (Cs_2O) cesium forms three additional compounds with oxygen, viz., the dioxide (Cs_2O_2), the sesquioxide (Cs_2O_3) and the tetroxide (Cs_2O_4 or CsO_2). Polyhalides, such as CsI_3, CsI_4, CsClIBr and even $CsI_9.1\frac{1}{2}C_6H_6$, are favoured because of the large radius of the cesium ion. In all of these compounds cesium is univalent. Like the other alkali and alkaline earth metals cesium forms a nonvolatile salt with hydrogen, in which hydrogen plays the unusual role of the negative ion. Compounds in which cesium replaces a hydrogen atom in either aliphatic or aromatic hydrocarbons are typically colourless solids, nonvolatile, and insoluble in most organic solvents. Cesium triphenyl methyl, however, is a blood-red solid which is sparingly soluble in ether. Mono- and di-substituted derivatives of acetylene have been prepared for all the alkali metals, including cesium. They are colourless crystalline solids which may be prepared by the action of acetylene on a liquid ammonia solution of the metal or by the direct action of acetylene on the molten metal. Cesium acetylide reacts violently with water, regenerating acetylene and yielding an aqueous solution of cesium hydroxide.

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CESKE BUDEJOVICE (Ger. BUDWEIS), a city of Ceske Budejovice region, Czechoslovakia, at the junction of the Malse river with the Vltava (Moldau), lies in the centre of one of the curious lake regions of southern Bohemia. Pop. (1957 est.) 63,862. Ceske Budejovice is a navigation head on the Vltava for very small craft. It is an old city and had a strong German element up to the time of World War II. The main feature is the great square in the heart of the city, surrounded chiefly by 18th-century buildings. Ceske Budejovice has always had a vigorous, if small-scale, economic existence. It has a trade in lignite mined locally and timber from the south-Bohemian forests, and various manufactures of long standing, including the one-time Hardmuth pencil factories, Budweiser beer and porcelain industries. In 1827 the first railway in the Habsburg territories, horse drawn on wooden lines, was opened between Ceske Budejovice and Linz. The city is an important road and rail intersection point. (H. G. S.)

CESNOLA, LUIGI PALMA DI (1832–1904), Italian-American soldier and archaeologist, was born at Rivarolo, near Turin, Italy, on July 29, 1832. Educated as a professional soldier, he served with distinction on the continent and, on emigrating to the United States in 1860, opened an officers' training school in New York city. The almost immediate outbreak of the American Civil War drew him into the Union army as a colonel. He was wounded, imprisoned and discharged with the rank of brigadier general and a presidential appointment as United States consul in Cyprus (he served concurrently as Russian consul there). His duties were light, and he developed an archaeological fervour which, in over ten years of exploration and excavation, resulted in his amassing the largest and richest collection of Cypriote antiquities in the world. The bulk of this collection was acquired in 1872 by the New York Metropolitan Museum of Art; part of it is still on exhibit there. He was appointed director of the museum in 1879 and held this post with distinction until his death in New York city on Nov. 21, 1904. In 1897 he was awarded the medal of honor for an action he took part in during 1863.

An ugly series of charges against the authenticity of parts of his collection, in 1880–82, resulted in libel suits, newspaper publicity and eventually the complete exoneration of Cesnola. The accuracy of his records regarding objects in his collection has been repeatedly challenged, but modern scientific research has tended to vindicate him on every verifiable point.

Cesnola published *Cyprus, Its Ancient Cities, Tombs, and Temples* (1877); *The Metropolitan Museum of Art* (1882), and the monumental work *A Descriptive Atlas of the Cesnola Collection* (1884–1903).

See John L. Myres, *A Descriptive Atlas of the Cesnola Collection of Cypriote Antiquities in the Metropolitan Museum of Art, New York*, pp. xiii–xxi (1914). (J. H. Yo.)

CÉSPEDES, PABLO DE (1538–1608), Spanish poet, painter, sculptor and architect, was born at Córdoba and educated at Alcalá de Henares, where he studied theology and oriental languages. On leaving the university he went to Rome, where he became the pupil and friend of Federigo Zuccaro, under whose direction he studied particularly the works of Raphael and Michelangelo. In 1560, while he was yet in Rome, proceedings were taken against him by the Inquisition at Valladolid, but they were dropped. He returned to Spain a little before 1577 and received a prebend of the cathedral at Córdoba, where he resided till his death. Cristobal de Vera, Juan de Peñalosa and Zambrano were among his pupils. His "Last Supper" at Córdoba was much admired in his time. Cespedes was author of several opuscules in prose on subjects connected with his profession. His poem on "The Art of Painting," containing a glowing eulogy of Michelangelo, is considered among the best didactic verse in Spanish. The few remaining fragments were first printed by Francisco Pacheco in his treatise *Del arte de la pintura*, in 1649.

CÉSPEDES Y MENESES, GONZALO DE (1585?–1638), Spanish writer of histories and short stories, is best known for a romance, *Poema Trágico del Español Gerardo, y Desengaño del Amor Lascivo* (1615–17), translated (1622) by Leonard Digges as *Gerardo the Unfortunate Spaniard, or a Patterne for Lascivious Lovers*, and drawn upon by John Fletcher for two plays, *The Spanish Curate* (licensed 1622) and *The Maid in the Mill* (licensed 1623). Céspedes was born in Madrid, but when his *Historia apologética en los Sucessos del Reyno de Aragón y su Ciudad de Zaragoxa, años de 1591 a 1592* (1622) was confiscated, he moved to Saragossa and later to Lisbon. While in exile, he published *Historias Peregrinas y Ejemplares* (1623), short stories which, like those of *Poema Trágico*, show considerable imagination and insight into character, despite an affected style; and the first part of a *Historia de Felipe III* (1631), a fulsome eulogy for which he was rewarded with the post of official historiographer to the Spanish king. Céspedes died in Madrid, Jan. 27, 1638.

See the introduction by E. Cotarelo y Mori to a reprint (1906) of *Historias Peregrinas.*

CESSIO BONORUM, literally "a cession of goods," was, in Roman law, a voluntary surrender of goods by a debtor to his creditors. It did not amount to a discharge of the debt unless the property ceded was sufficient for the purpose, but it secured the debtor from personal arrest. The creditors sold the goods, applying the proceeds to their claims. The procedure of *cessio bonorum* enabled the debtor to avoid infamy, and though his after-acquired property might be proceeded against he could not be deprived of the bare necessaries of life. The main features of the Roman law of *cessio bonorum* were adopted in Scots law, and also in the French and several other legal systems. In England it exists under the internal regulations of certain commercial bodies, such as the recognized stock exchanges. In Scotland the process of *cessio bonorum* was abolished by the Bankruptcy (Scotland) act, 1913.

CESTI, PIETRO ANTONIO (1623–1669), one of the leading Italian composers of the 17th century, was born at Arezzo, Aug. 5, 1623, and studied in Rome. He moved to Venice, where the first of his 15 known operas, *Orontea*, was produced (1649). In 1652 he became *maestro di cappella* to the archduke Ferdinand of Austria at Innsbruck, a post he combined for a time with membership in the papal choir. From 1666 until 1669 he was vice-*kapellmeister* to the imperial court in Vienna. He died in Florence on Oct. 14, 1669.

After Francesco Cavalli, Cesti was probably the best-known composer of his generation. Throughout the 17th century his operas were frequently performed in Italy and elsewhere. He wrote sacred and secular music, the former influenced by the Roman school, the latter by the Venetian. Though his works are too rare for the tracing of any development of style, they show an originality uncommon at that time. Christ Church, Oxford, possesses an important manuscript collection of 18 secular and 3 sacred cantatas. His most sumptuous opera, *Il Pomo d'oro* (1667), appeared in a modern edition (*Denkmäler der Tonkunst in Österreich*, vol. iii–iv, 1896–97) and *La Dori* (1661) in *Gesellschaft für Musikforschung*, vol. xi (1883).

See F. Coradini, "P. Antonio Cesti," *Rivista Musicale Italiana* (1923). (S. T.)

CESTODA, a class (or subclass) of parasitic flatworms commonly called tapeworms. *See* Tapeworm.

CETACEA, the order of mammals that includes whales, dolphins and porpoises. *See* Whale.

CETEWAYO (Ketshwago) (d. 1884), king of Zululand from 1873 to 1879 and the last of the great Zulu kings, was born about 1834, the eldest son of Panda who was recognized as king of Zululand when Britain annexed Natal in 1843. As Panda's physical disabilities reduced his active share in government Cetewayo became increasingly influential in Zulu affairs, especially after the battle of the Tugela (1856) where he defeated and killed Mbulazi, his brother and rival. In 1861 Theophilus Shepstone, secretary for native affairs in Natal, visited Zululand to witness his formal recognition as heir to the throne. Although Cetewayo was suspicious of the good faith of the Natal government, which had afforded protection to two of his brothers, his relations with it remained fairly amicable; and after Panda's death in 1872 Shepstone again visited Zululand, this time to install Cetewayo as king (1873) and to impress upon him the need for more humane government.

Shepstone was anxious to maintain the integrity of Zululand against the encroachment of Transvaal Boers who asserted that Cetewayo had promised them territorial concessions; but after the annexation of the Transvaal (1877) Shepstone shifted his ground and supported Boer claims. However in 1878 a Natal commission reported in Cetewayo's favour, denying any cession of land to the Boers. Fear of Transvaal reactions to this report, and a probably unfounded belief that Cetewayo was threatening colonial security, precipitated the Zulu war. The high commissioner, Sir Bartle Frere, seized on minor incidents—Cetewayo's violation of the Natal frontier to recapture fugitives, his failure to observe his coronation "promises," his expulsion of missionaries from Zululand—as a pretext to wage a preventive war. He delayed publication of the boundary commission's report until Dec. 1878, and accompanied it with an ultimatum to Cetewayo. The demands, as Frere had anticipated, were not accepted; and Lord Chelmsford's army moved into Zululand in Jan. 1879 to enforce them. Though defeated at Isandhlwana, the British were able to check the Zulus at Rorke's Drift, finally destroying their power at Ulundi (July 1879). The Zulu military power was broken, and Cetewayo was captured in August and exiled to Cape Town.

Zululand was then divided among 13 chiefs. However Cetewayo was allowed to visit England in 1882 to plead for his release. A portion of his former kingdom was restored to him, and in Jan. 1883 he was once more installed by Shepstone. But he did not long survive his return. Defeated by a rival chief, he was compelled to seek the protection of the British resident at Eshowe, and died there on Feb. 8, 1884. *See* also Zululand: *History*. (G. B. No.)

CETHEGUS, in ancient Rome the cognomen or third name of a patrician family of the *gens Cornelia*.

Marcus Cornelius Cethegus (d. 196 B.C.), Roman general and orator, was *pontifex maximus* and curule aedile, 213 B.C. In 211, as praetor, he had charge of Apulia; later, he was sent to Sicily, where he proved a successful administrator. In 209 he was censor, and in 204 consul. In 203 he was proconsul in Upper Italy, where, in conjunction with the praetor P. Quintilius Varus, he defeated Mago, Hannibal's brother, in the Padus (Po) valley, forcing him to leave Italy during the Second Punic War. He had a great reputation as an orator: the poet Ennius calls him *suadae medulla* ("the essence of persuasion") and Horace calls him an authority on the use of Latin words.

Gaius Cornelius Cethegus (d. 63 B.C.) joined the conspiracy of Catiline (*q.v.*) in the hope of getting his debts canceled. When Catiline left Rome in 63, Cethegus remained behind as leader of the conspirators with P. Lentulus Sura. He undertook to murder Cicero and other prominent men, but was hampered by the dilatoriness of Sura. He was condemned to death, and executed, with Sura and others, on the night of Dec. 5.

See Sallust, *Catiline*, 46–55.

CETINA, GUTIERRE DE (1515?–1555?), Spanish poet and soldier, whose madrigal "Ojos claros serenos" is one of the most famous of Spanish poems, was born at Seville. After serving in Italy and Germany, he retired from the army in 1545, sailing for Mexico in 1546. On a second visit in 1554 he was wounded in a brawl in La Puebla de los Angeles. He died before 1557. A follower of Boscán and Garcilaso de la Vega, Gutierre de Cetina wrote extensively in Italianate metres under the name of Vandalio; his sonnets and epistles are elegant. Much of his verse consists of translation from Petrarch, Ariosto, Ludovico Dolce and Ausias March, and he was influenced by Luigi Tansillo and Pietro Bembo, as well as by classical poets such as Martial, Juvenal and Ovid.

See A. M. Withers, *The Sources of the Poetry of Gutierre de Cetina* (1923). (J. Gs.)

CETINJE, former capital of Montenegro, one of the republics of Yugoslavia, is situated in the mountains of southwest Montenegro, 128 km. (80 mi.) E.S.E. of Dubrovnik and 48 km. (30 mi.) E. of Titograd (Podgorica) by road. Pop. (1961) 9,345. The town, 2,068 ft. above sea level, is dominated by Mt. Lovcen (5,738 ft.). The fortified monastery became the residence of the prince-bishops, theocratic rulers of Montenegro (*q.v.*). The Biljarda (1847) was the home of Bishop Petar Petrovic Njegos (Peter II), the greatest Serbian poet. Among other fine buildings is the palace of King Nicholas, the last independent Montenegrin ruler. The main industries are agriculture and tourism. Founded in 1484, Cetinje had a printing press at the monastery by 1493. It was occupied by Austria from 1916 to 1918, and after World War I was incorporated into Yugoslavia. In World War II it was occupied by the Italians in April 1941, and from July 1941 until late 1944 was the scene of continuous fighting. In 1945 the capital was moved from Cetinje to Titograd. (V. De.)

CETTE: *see* Sète.

CETUS ("The Whale"), in astronomy, a constellation of the southern hemisphere, fabled by the Greeks to be the monster sent by Neptune to devour Andromeda, but which was slain by Perseus. It contains the long-period variable star Mira Ceti (*o* Ceti), which was the first star recognized to be variable (by Fabricius in 1596). It usually ranges from the ninth to the third magnitude in about 340 days; but this kind of variation is always rather irregular. It has a companion distant rather less than a second of arc. The companion was first suspected from spectroscopic observations; when looked for visually it was easily seen, but it is difficult to understand why it had escaped notice in a star which was so continually studied. The companion is itself a very interesting star, possessing an unusual type of spectrum with bright lines. (A. S. E.)

CEUTA (Arabic Sebta), a Spanish military station and free port on the north coast of Morocco, Africa, administered with Cádiz province. Pop. (1960) 73,182. At its eastern end is a promontory marking the southeastern point of the Straits of Gibraltar, which between Ceuta and Gibraltar are 14 mi. wide. The highest of the seven hills of the headland is Mount Acho (636 ft.), the ancient Abyla, one of the "Pillars of Hercules." A narrow isthmus connects the promontory to the mainland. The old town covers the low ground of the isthmus at the western end of which is a moated fort dating from the Portuguese occupation, and the new town spreads along the hills to the west. To the northwest of the isthmus is the port, protected by breakwaters. At the quayside is the terminus of the railway to Tetuán, which is also linked by road. Five centuries of Christian occupation have given the town an appearance more Spanish than Moorish.

There were successive Carthaginian, Greek and Roman colonies there, the last said to have been called Septem Fratres, whence came the Arabic and Spanish names. It was held in turn by the Vandals, Goths and Byzantines; the Byzantine governor Count Julian invited the Arabs, whom he had successfully resisted, to invade Spain (710–711). Long contended for by Berber and Spanish-Moorish dynasties, Ceuta became a commercial and industrial city, noted for its brassware and its trade in ivory, gold and slaves. It is said to have had the first paper factory in the west. In 1415 it was captured by the Portuguese, passed to Spain in 1580 and was definitely assigned to Spain by the treaty of Lisbon (1688). It often withstood siege by the Moors; that by Mulai Ismail beginning in 1674 lasted 26 years. Occupied by British troops in 1810, with Spanish consent, it was returned to Spain at the close of the Napoleonic Wars. From Ceuta, during the "national movement" of 1936, General Franco dispatched an expedition to Spain. (G. L. M.)

CEVA, GIOVANNI (1647 or 1648–1734), Italian mathematician and engineer, was professor in Mantua most of his life. His book *De Re Nummaria* (1711) is one of the first works in mathematical economics. Ceva's theorem concerns the transversals from a point to the vertices in a triangle.

TOMMASO CEVA (1649–1736), his brother, was a poet and mathematician who taught mathematics at the Jesuit college in Milan. He is best known for his literary works, which appeared in several editions: *Jesus Puer* (1690); *Philosophia novo-antiqua* (1704); *Sylvae* (2nd ed., 1704). A collection of his mathematical works, mainly geometrical in nature, was published from 1695 to 1699. (O. OE.)

CÉVENNES, highlands in southern France, formed by the uptilted southeastern margin of the Massif Central (*q.v.*), overlooking the lower Rhône valley and the plain of Languedoc. The highest parts rise well above 5,000 ft. and experience long, snowy winters. The Cévennes form part of the watershed between Atlantic and Mediterranean drainage, and the Mediterranean slope is gashed by the valleys of torrents that descend steeply toward the Rhône and the Mediterranean coast. Cultivation of the vine, the olive and fruits extends up the valleys, but mulberry growing, which was at one time widespread on the slopes, is largely abandoned. Although sericulture has declined, there are still some textile mills in the Cévennes valleys. Heavy industries are represented on the small Alls coalfield. Sheep are grazed on the high pastures, but in small numbers. Although the name Cévennes signifies wooded slopes, the highlands have been largely denuded of woodland, and by 1960 afforestation had made only modest beginnings, especially on the Aigoual. The secluded valleys of the Cévennes provided a refuge for dissenters during the religious wars of the 16th century, and Protestantism is still well represented there. (AR. E. S.)

CEYLON (Sinhalese from Sanskrit SRI LANKA; Tamil ILAM or ILANKAI), a large island in the Indian Ocean and a member of the Commonwealth of Nations. Pop. (1963) 10,624,507. It is 270 mi. (435 km.) long and 140 mi. (225 km.) wide at its broadest part and has an area of 25,332 sq.mi. (65,610 sq.km.), about half the size of England. It lies between 5°55′ and 9°50′ N and between 79°42′ and 81°52′ E, and is situated southeast of Cape Comorin in India, from which it is separated by the 33-mi.(53 km.)-wide Palk Strait.

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I. PHYSICAL GEOGRAPHY

1. Geology and Structure.—Ceylon is essentially a detached portion of the Deccan Plateau of south India and, like it, is underlain almost everywhere by hard, old Precambrian rocks. As in most areas of similar geological makeup, the precise origins and relationships of the rocks leave much room for disagreement and for alternative interpretations; this is especially true in Ceylon where systematic geological mapping was late in beginning. It has become usual to recognize that a broad belt in the centre of the island consists of the Khondalite series, altered sediments like those making up the series of the same name in Madras and Orissa. Schists, quartzites, and crystalline limestones are all to be found. Some authorities consider that these rocks are disposed in a synclinorium pitching northward. This would certainly explain the trend of the pronounced strike features that make such a mark on Ceylon's relief; *e.g.*, the east-west ridges at the southern end of the main central highland mass, the bow-shaped hills and valleys to the southwest of this mass in the province of Sabaragamuwa, and the long quartzite edges that run north and northeast from the highlands to terminate in the imposing and beautiful headlands of Trincomalee. It is to the Khondalite series that most of Ceylon's scanty mineral wealth owes its origin: graphite from mines in the solid rock and gems of high quality chiefly from alluvium derived from that rock.

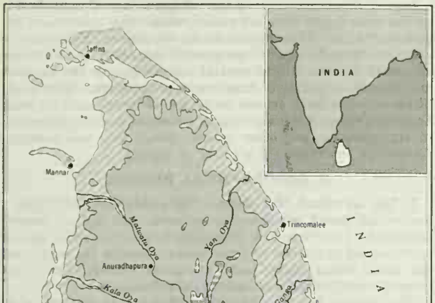
In a broad belt to the east of the Khondalites and in a narrower and less continuous belt to the west, there outcrop the gneisses and schists of the Vijayan series. The geological map of Ceylon is also complicated by various ancient intrusions (the charnockites of Ceylon are now thought to be, in part at least, metasedimentary).

Ceylon is mainly made of crystalline rocks and this has important economic consequences. There is little hope of coal or oil or of rich reserves of underground water (which is, in fact, confined to certain bands, to joints and fissures, and to the layer of surface weathering); and there is little chance of highly fertile soils on ancient crystalline rocks in the tropics.

There are certain exceptions to these generalizations. Miocene limestones occupy the Jaffna Peninsula in the far north together with the outlying islands and also stretch, in less pure form, down the northwest coast; these give underground water. Alluvium occurs in the larger valleys and also stretches in broadish bands behind sandbars along parts of the east and west coasts. In the northwest there is a capping of "plateau deposits"—red earths, quartz gravels, and iron concretions, possibly Pleistocene in age.

2. Physiography.—The south central part of Ceylon is a hilly region of great and varied beauty known to the Sinhalese as Uda Rata (up-country). The highest land there, that over 5,000 ft. (1,500 m.), is disposed very much in the shape of an anchor with a north-south shank. The shank is broken into two parts by the deep valley of the east-west reach of the Mahaweli Ganga, Ceylon's biggest river. To the north of this valley rises the Knuckles Range (6,112 ft. [1,863 m.]); to the south lies the fine scenery round the hill station of Nuwara Eliya (*q.v.*), including the highest summit in Ceylon, Pidurutalagala (8,281 ft. [2,424 m.]), a rounded and not very distinguished mountain. To the south of this the shank joins the two hooks of the anchor in Horton Plains, an elevated tableland much of which lies above 7,000 ft. (2,130 m.).

The western hook of the anchor includes the fine pyramid of Adam's Peak (*q.v.*; 7,360 ft.) and encloses between itself and the shank a basin drained partly by tributaries of the circuitous Mahaweli Ganga and partly by streams flowing more or less directly to the west coast. It seems reasonably clear that the Mahaweli headwaters are under attack from these west coast streams, notably from the Kelani Ganga, and that some of them have breached the hook ridge to effect actual capture. There is a great difference in level between adjacent valleys where one flows to the Kelani and the other to the Mahaweli, a situation that is exploited by the important Laksapana hydroelectric station. The



CEYLON SHOWING PHYSICAL FEATURES AND MAJOR TOWNS AND CITIES

western basin as a whole is a region of considerable relief and forms one of the principal tea-growing districts; its routes converge on Kandy.

There is a corresponding eastern basin, that of Uva, centring on Badulla and draining northward to the Mahaweli Ganga through deep valleys separated by considerable ridges. It is noteworthy that the hook enclosing this basin is nowhere breached by east-flowing streams, perhaps because these are dry zone streams with much less potency than the Kelani and its neighbours. The south edge of the two hooks of the anchor forms a great, continuous mural scarp; at the point known as "World's End" (7,142 ft.) there is a breathtaking drop of 5,000 ft. (1,500 m.) or more.

Up-country Ceylon, the region that can be described in terms of the anchor and its two basins, ends at about the 1,000-ft. contour. Between this contour and the west coast lies a region of mainly westward-sloping valleys separated by hills falling in altitude as the sea is approached until, at Colombo itself, they are little more than low, deeply weathered humps. Some have seen a stepped appearance in these hills and interpreted the relief of Ceylon in terms of successive peneplains, though in the mid-1960s much more work remained to be done on this problem. To the southwest of the central hills the steady descent to the sea is interrupted by the outlying hill mass of Rakwana. To the east of the eastern hook a number of east-flowing streams, like the Gal Oya, find their way between considerable isolated hills, such as the great landmarks known from their shapes as Friar's Hood and Westminster Abbey, and then between smaller inselberglike features, to form deltas in the east coast alluvium. To the north of the main hill mass there stretches for more than 100 mi. (160 km.) a rolling country cut by rivers flowing at more or less right angles to the coast and diversified by strike ridges and by many isolated hills. Some of the latter, like Ritigala (2,514 ft.), are large; some, like Sigiri or Sigiriya, a former hill fortress, are spectacular; and all add charm to this ancient Rajarata (the "king's country").

The limestone Jaffna Peninsula is, in fact, a raised coral reef, rising to 50 ft. or so above sea level; it is a flattish country with occasional rocky hillocks. A number of offshore islands, such as Kayts, are made of the same limestone material.

Apart from the Jaffna Peninsula and islands, the exposed southwest and the rocky headlands formed by the quartzite ridges running out to sea at Trincomalee, the coasts of Ceylon are low and consist largely of spits, bars, and similar forms. The great bar south of Batticaloa, behind which a lagoon is gradually being filled up by the east-flowing rivers, is a most interesting feature.

3. Climate.—Temperatures at or near sea level in Ceylon are high and show little variation from month to month. Thus the mean monthly temperature at Colombo varies only from 79.5° F (26.4° C) in December to 82.1° F (27.7° C) in May. In the northern half of the island and in the east, the dry zone, the hottest month is slightly hotter (*e.g.*, Trincomalee, 77.8° F [25.4° C] in January to 85.4° F [29.6° C] in June) and in the hottest weather the daily maximum is apt to exceed 100° F. With increasing height shade temperatures naturally fall but are very much less than sun temperatures. At Nuwara Eliya (6,170 ft.) monthly average shade temperatures are around 60° F (15.5° C) and frost is not unknown in the cooler months.

In terms of rainfall and its effects, Ceylon is a country of great contrasts. The southwestern sector of the island, including the basin within the western hook, is well watered at almost all seasons, and high humidity often makes high temperatures seem even hotter. This sector, the wet zone, receives rain from the southwest monsoon (late May until August or September), from the so-called northeast monsoon (December until February), and also in intermonsoon periods. The annual total varies from 75 in. (1,805 mm.) north of Colombo to more than 200 in. (5,000 mm.) in the hills; the pattern of maxima and minima varies from station to station with exposure and other factors, but nowhere in this zone, except in years of rain failure, is there a real dry season.

In all other sectors of the island, on the other hand, there is a very marked dry season during the southwest monsoon, some rather variable intermonsoon rain, and a heavy concentration of rainfall during the northeast monsoon. Annual totals vary from 40 in. (1,000 mm.) in the northwest and southeast to more than 75 in. In the lowland dry zone the dry season is a period of acute drought and of burned-up vegetation, but low humidity conditions are somewhat mitigated in the upland dry zone, which may be roughly equated with the Uva Basin. Moreover, dry zone rainfall is subject to considerable and often critical variability. Not surprisingly, the dry zone is a region where from ancient times irrigation has been practised as a way of ensuring against fickle rains in the wet season and of cultivating in the absence of rain in the dry season. Since there is little underground water outside the Jaffna Peninsula, irrigation means reliance on rivers. Given the radial pattern of Ceylon's drainage, it follows that most rivers in the wet zone (with the notable exception of the Mahaweli Ganga) flow only through the wet zone, and that dry zone rivers, rising in the dry zone, receive little water during the dry season and degenerate into mere strings of pools. Tank irrigation, with storage of water from wet season to ensuing dry season, is the traditional answer to the problem.

4. Vegetation and Soils.—Ceylon's natural vegetation, where it remains, bears the clear imprint of relief, climate, and the hand of man. The lowland wet zone and lower western slopes of the hills were formerly covered by dense tropical evergreen forest similar to the familiar rain forest. Very little of this remains outside the somewhat scanty forest reserves. The region is mainly either under cultivation, covered by coarse grassland (*talawa*), probably the result of repeated burning, on the lower slopes of the outermost foothills or, over a rather wider area, by wet low fernland dominated by *Gleichenia linearis, kekilla* to the Sinhalese.

Much of the lowland dry zone is still forested, although the rate of clearing is accelerating, with mixed evergreen and deciduous woodland adapted to seasonal droughts. Much of the forest is probably secondary, the result of partial regeneration after shifting cultivation. Much, too, is of poor quality, but some valuable timber trees, notably ebony and satinwood, are to be found. A certain amount of teak is being planted. In some places, especially in the eastern dry zone, the climax forest is replaced by grassland of savannalike aspect, the *damana* of the Sinhalese, probably as a result of clearing followed by repeated burning. In the extreme northwest and southeast and on dry zone coastal sandbars the forest degenerates into thorn scrub.

Up-country there must once have been an interesting succession of altitudinal belts. The remains of these are still discernible, but much has been cleared for cultivation or replaced by grasslands. On the wetter hills, for example, wet evergreen forest from 4,000 to 8,000 ft. varies little in composition but varies greatly in physiognomy and structure. The trees become increasingly gnarled and dwarfed, the undergrowth becomes lighter, and eventually a fascinating elfin forest is reached. Above 5,000 ft. in these wetter hills there occurs a secondary grassland often known as wet *patana,* which consists mainly of rough tussocks of *Chrysopogon zeylanicus; Rhododendron arboreum* occurs there in stunted form. In the drier Uva Hills and elsewhere it is difficult to determine what the climax vegetation was, for square mile after square mile of rolling hilly country is covered with dry *patana,* a coarse dry grassland which also extends into many parts of the western basin between 1,500 and 5,000 ft. The grassland is dominated by *Cymbopogon confertiflorus* and subject to periodic burning. Some have thought dry *patana* to be true climatic climax vegetation, others have more convincingly argued that the climax is forest and that dry *patana* is the result of clearing and burning.

Soils.—Notable progress was made in the 1950s and 1960s in mapping and classifying the soils of Ceylon. The soils of most parts of the wet zone and of the up-country are classified as "red-yellow podzolic," a number of subgroups being recognized. In the wet zone lowlands soft laterite (*cabook* in Sinhalese) occurs as the B horizon, and is readily and frequently cut out and sun dried for use as bricks. These humid podzolic soils are not notable for their natural fertility, and they may erode rather badly on steep slopes; but they are able to grow such crops as tea and rubber, and respond to suitable fertilizers. In some up-country areas (notably near Kandy and Kegalla) they give way to immature soils on steeper slopes; these grow good plantation and garden crops.

Over most of the interior dry zone the soils are mapped as "reddish-brown earths." These, again, are broken down into subgroups, of which that occurring in the ancient heartland around Anuradhapura is notably more fertile than is normal in tropical soils derived from ancient crystalline rocks, but demands careful handling. However, there are also, especially in the east, poor "noncalcic brown" soils (much of the area of the Gal Oya development scheme is known to be, unfortunately, in these soils), while in various parts (notably in the ridge culminating at Trincomalee) quartzites give rough topography and poor soils. Also in the "poor" category are the saline soils to be found along the coast near Mannar and south of the Jaffna Lagoon. Another belt of difficult soils, mapped as latosols, retaining water poorly and shunned by traditional settlement, runs along the northwestern coastal strip and south of the saline soils of the Jaffna lagoons. In the Jaffna Peninsula, however, otherwise similar latosols are affected by the underlying limestone and are intensively cultivated. Ceylon has also alluvial soils in river valleys and in infilled coastal lagoons and patches of other soils of minor importance.

5. Animal Life.—Ceylon is renowned for its wildlife, but by the 1960s the advance of cultivation had already confined some of the more interesting species of birds to the few remaining wet zone forests and even the dry zone fauna was in danger. Three fine national parks exist: the Wilpattu National Park on the northwest coast, the Ruhuna National Park on the southeast coast, and the Gal Oya National Park, but these are not large enough to ensure the preservation of certain species, notably the elephant.

Ceylon's fauna shows many signs of insularity. Certain Indian species such as the tiger are absent, while other species are peculiar to Ceylon. These include the Ceylon sambar (*Rusa unicolor unicolor*), Russell's viper (*Vipera russelli pulchella*), and a number of species of birds. Other notable animals include the elephant and leopard, a species of bear, monkeys, squirrels, many kinds of snake, and a large number of species of birds, many of great beauty. Ceylon, like many tropical countries, abounds in species of ant, mosquito, and other insects, though only one mosquito (*Anopheles culicifacies*) is a vector of malaria.

II. GEOGRAPHICAL REGIONS

1. The Lowland Wet Zone.—The coastal lowlands form a narrow, hot humid belt down the wet zone coast and are densely populated. There is a large urban population in Colombo and its satellites and in a string of other towns. Outside the towns and the coastal fishing villages, paddy and garden cultivation and commercial crops (rubber and coconut) are dominant.

The coconut belt is a triangle with its apex just north of Colombo. It is a region of coastal sands and alluvium and, inland, of valleys between low hills, dominated by the production of coconut, mainly in small holdings. The ridge and valley country fills most of the province of Sabaragamuwa and consists mainly of high ridges and valleys following the Khondalite strike. Rainfall is high there and some of the country is still fairly wild, but its northern part is Ceylon's principal rubber area.

2. The Hills.—Around the historic town of Kandy there lies the lower part of the western basin, which is a very beautiful region of hills and valleys with much steep land. Rainfall is high. Many traditional-style Kandyan Sinhalese villages with their paddy and gardens are still to be found, but there is also much commercial cultivation of tea on both estates and small holdings.

The tea region proper occupies the higher portions of the western basin and is largely devoted to tea cultivation on large estates. It is an area of heavy rainfall and strong relief. The Uva Basin (the eastern basin) is a distinctive region of ridges and valleys within encircling high ground, with Sinhalese valley villages, tea estates, and wide stretches of open *patana* grassland. It has a marked dry season.

3. The Lowland Dry Zone.—This zone includes all lowland areas subject to a pronounced dry season. The west coast is a region of low relief, of low rainfall, and of sparse population away from a northward extension of the coconut belt. The Jaffna Peninsula and islands form a region of limestone terrain, of dense rural settlement by Ceylon Tamil, and of a large urban population in and around Jaffna. Paddy, tobacco, and other crops are grown.

The east coast lowlands consist of alluvium behind sandbars and are also largely peopled by Ceylon Tamil who grow paddy on the alluvium and coconut and other crops elsewhere. Trincomalee and Batticaloa are the local towns. The southeast coast is a low region, dry and rather desolate, with a sparse population except in the western part where restored irrigation works have attracted cultivators.

Bintenne is the name given to the region of confused relief between the mural scarp of the central hills and the eastern coastal lowlands. It is a difficult region, for long sparsely peopled, though part of it has been opened up under the Gal Oya development scheme. The north centre is a rolling plain with inselbergs (*q.v.*), the Rajarata of ancient Sinhalese civilization. It is a country of many small villages clustering around little tanks and, increasingly, of new settlement, much of it under restored irrigation works. Anuradhapura is the regional centre.

III. THE PEOPLE

1. Ethnic Groups.—The population of Ceylon is increasing rapidly; it rose by 31.2% in the ten years before the 1963 census. The main centres of population are Colombo, Jaffna, Kandy, Galle, Negombo, Kurunegala, and Nuwara Eliya. Ceylon nationals as a whole are known as Ceylonese and include two principal language groups, Sinhalese and Ceylon Tamil (*q.v.*). Smaller groups are the Ceylon Moors, the descendants of seafaring Arab merchants; Malays, whose ancestors once formed Malay regiments;

Burghers, mainly descendants of the Dutch; Eurasians; and a small number of naturalized Europeans, Indians, and other nationalities. The Sinhalese are of two main types: low-country Sinhalese, who inhabit the plains and were affected by more than four centuries of European impact; and Kandyans from the mountains and dry zone jungles, who were so affected for only 150 years. The possibly aboriginal Vedda are almost completely intermixed with Sinhalese. The various groups in Ceylon in 1953 are given in the table.

Ethnic Groups in Ceylon, 1953 Census

Group	Number	Group	Number
Low-country Sinhalese .	3,469,512	Malays	25,464
Kandyan Sinhalese . .	2,147,193	Indians*	1,021,560
Ceylon Tamil . . .	884,703	Europeans	6,508
Ceylon Moors . .	463,963	Others	33,042
Burghers and Eurasians .	45,950		

*Mainly Tamil.

Ceylon Tamil society reproduces in modified form the caste and other features of Indian society. Sinhalese society, though Buddhist, is also stratified on caste lines, the Goigama or cultivators being both the most numerous and traditionally the highest caste. The Karava (fishers) and Salagama (cinnamon peelers) rose to prominence after Portuguese days and now include some of the wealthiest of the Ceylonese.

2. Religion.—The Sinhalese are mainly Buddhists and the Tamil are principally Hindus. Moors and Malays are uniformly Muslims, but a considerable proportion of all other groups are Christian. The distribution of religions in 1953 was as follows: Buddhists 5,217,143; Hindus 1,614,004; Christians 714,874; Muslims 541,812. Religion plays a large part in Ceylonese life.

The public holidays, 22 in all, are based on religious festivals, and pilgrimages feature prominently in both business and pleasure. The most famous pilgrimage is the ascent of Adam's Peak. Another goal of pilgrims and tourists is the Temple of the Tooth in Kandy, wherein is enshrined the sacred tooth relic of the Lord Buddha. The Perahera, or annual torchlit temple procession, in which gorgeously caparisoned elephants and hundreds of dancers take part, draws thousands of devotees and sightseers. At Anuradhapura (*q.v.*) is the famous 2,000-year-old bo tree, an offshoot of the tree under which Buddha meditated. A revival of Buddhism was associated with developments in Sinhalese nationalism and a section of the Buddhist priesthood was very much concerned in the electoral success of Solomon Bandaranaike in 1956.

(B. H. F.)

IV. ARCHAEOLOGY

Geographically and culturally Ceylon is closely related to India, with which its prehistoric culture sequence has much in common although certain phases found in India are absent in Ceylon. However, archaeological research in Ceylon, at least until the early 1960s, was chiefly directed toward the study and preservation of monuments of the historical period.

The island falls into two main cultural regions: the southern, mountainous and with a high rainfall, which retains its Sinhalese character; and the northern, flatter and with a lower rainfall, which has much in common with the Tamil Plains of India.

No certainly identifiable tools of the Early or Middle Stone Age had been found in the island by the early 1960s. The earliest human culture to be identified is the Late Stone Age, remains of which are found chiefly in the south. The outstanding feature of this culture is its highly developed stone industry (sometimes referred to as the Bandarawelan or Balangodan industry), which includes geometric microliths and extremely fine bifacially worked points, almost entirely made of crystalline or vein quartz. The industry shows traces of a Middle Stone Age tradition of stone working, such as is found on the mainland of India, combined with Late Stone Age techniques. It has close parallels in southeastern India. It is found at extensive open-air factory sites such as Bandarawela on the southeastern hills and in the occupation deposits of caves and rock shelters, many of which were inhabited by the Vedda, into modern times. At the latter the industry is associated with an extensive bone industry, grinding stones, hearths, and numerous snail shells. In the topmost layers iron tools and pottery of the early Buddhist period are also found. Burials suggest that the culture can be associated with the ancestors of the modern Vedda. There are rock paintings in certain caves, including depictions of elephants and riders.

No remains of the Neolithic or Chalcolithic cultures which spread through peninsular India in the 2nd millennium B.C., with their distinctive painted pottery and ground stone axes, had been found in Ceylon by the early 1960s, but further exploration, particularly in the drier parts of the north, might well reveal them. That there was an extension of the south Indian Iron Age into the island is attested by the finds of megalithic remains, stone cist graves, and circles, mainly in the north, and terra-cotta elephant-formed sarcophagi, and of urn burials in the North-Western Province. There typical black-and-red pottery, sometimes with scratched owners' marks, was found. These marks included some which resemble letters of the early Brahmi inscriptions of India and Ceylon (from the 3rd century B.C.), and the discovery of similar black-and-red pottery in the lowest levels of Anuradhapura suggests that this invasion, probably of Tamil speakers, may not have been earlier than the colonization of Ceylon by north Indian settlers. *See* also INDIA-PAKISTAN, SUBCONTINENT OF: *Archaeology*. (B. AL.; F. R. A.)

V. HISTORY

The salient fact in Ceylon's long history is the coming of the Sinhalese ("lion race," a term of totemistic origin) from India, probably about 550 B.C. (The name Ceylon derived by various stages from Sinhaladwipa "the island of the Sinhalese.") The two events next in importance are the introduction of the Buddhist religion from India in the 3rd century B.C. and the coming of invaders from Europe, early in the 16th century. For the first period outside influences on Ceylon were wholly Asian; for the second, largely European, bringing a gradual but only partial westernization by three successive colonial powers. Freedom from foreign domination was gained in 1948.

The history of Ceylon has been strongly influenced by the geography of the island. A study of this geography, therefore (*see* above), is essential to the understanding of the events set out below. When the Sinhalese arrived they found the Vedda still in the hunting stage of civilization. The newcomers came from northwestern or northeastern India, possibly both, and brought with them a knowledge of agriculture and the use of iron.

1. Buddhism.—Ceylon's traditional history was first set down in writing in the 6th century A.D. Written records thereafter are continuous. The early history is in the form of an epic, the Mahavamsa, based on ancient legends and written in the Pali language by Buddhist *bhikkhus* ("monks"). In the 3rd century B.C. the great Indian ruler Asoka (*q.v.*) became converted to Buddhism and determined to spread his religion far and wide. He sent to Ceylon a *bhikkhu* named Mahendra (Mahinda), possibly his son, and later Mahendra's sister, a *bhikkhuni* ("nun"), brought with her a branch of the bo tree under which the Buddha was sitting when enlightenment came to him. Mahendra set forth the *dharma* (*dhamma*), the noble teaching of the Buddha, which King Tissa (Devanampiyatissa) gladly adopted. It was propagated by Sinhalese *bhikkhus*, vowed to poverty and celibacy. They lived first in caves, later in *viharas* ("monasteries"), and depended for their living on charity. They brought to Ceylon the arts of writing, architecture, and sculpture. The ruins of old *viharas* are plentiful, especially in the ancient capitals of Anuradhapura and Polonnaruwa. The type of Buddhism they introduced was the simplest and purest form, Theravada (*see* GAUTAMA BUDDHA).

Anuradhapura became the headquarters of the Sangha (the order of *bhikkhus*). Their dagobas, vast domes of brick, usually bell-shaped, topped by a kind of spire and built over relic chambers, remain ruined or restored. King Tissa built the first of these, the Thuparama. He also had the bo tree branch planted with great ceremony; it still lives. Buddhism spread rapidly throughout Ceylon, imposing itself on top of ancient cults, traces of which survive among the people.

2. Sinhalese and Tamil Kings.—In the next century came invaders from south India, eventually driven out by the hero-king Duttha Gamani. He did much to rehabilitate the Buddhist religion and built the most famous of all the dagobas, the Ruanveli.

For the next few centuries the descendants of this king and then a dynasty from a rival clan ruled the Rajarata. They were faced with internal troubles from the semi-independent rulers of the other parts of the island, and with occasional invasions from southern India, with whose kingdoms—Chola, Pandya, Chera, and Kalinga—they maintained sometimes friendly, sometimes hostile relations. They encouraged and protected the Sangha, even though it had split into sects. One of them, Mahasen (4th century A.D.), even looked favourably on the introduction of Mahayana, a somewhat different type of Buddhism, but it did not take root.

This king first started large-scale irrigation works. For centuries landholders had dug wells and constructed small reservoirs called tanks, but under Mahasen vast tanks with great stone dams were constructed, irrigating thousands of acres. One of them, the Minneriya, still irrigated 4,500 ac. (about 1,800 ha.) in the 1960s.

Under the influence of Buddhism a quite advanced civilization developed. Many of the kings were beneficent rulers and some showed marked administrative and military ability. Some are credited with setting up a medical service. Nor were the arts—sculpture, painting, poetry, and the study of language—neglected. The ruins of many fine buildings survive, notable among which are those erected to house the venerated tooth of the Buddha, sent to Mahasen by a south Indian ruler. The evidence of foreign writings and inscriptions points to an established trade on the west coast, carried on first by merchants from northern and southern India, from Iran, and occasionally from Greece and Rome, and later by Arabs and Chinese also.

Up to the 10th century the kings tried with varying success to bring the whole island under their actual rather than nominal rule. The best known of them is the parricide Kasyapa who built the rock fortress of Sigiri (*q.v.*), still one of the great sights of Ceylon.

Invasion by the Chola king Rajaraja I early in the 11th century and foreign occupation till 1070 brought about the move of the capital to Polonnaruwa, the ruins of which are of remarkable interest and beauty (*see* INDIAN ARCHITECTURE: *Ceylon;* INDIAN ART: *Ceylon*). The Cholas were driven out by Vijayabahu I. A successor of his in the next century, Parakramabahu I, who came to the throne in 1153 or 1154, is the most famous in Sinhalese annals. He showed a high order of military and administrative skill. He restored the standards of the Buddhist religion and temporarily imposed unity on its sects. He was a great builder of temples and palaces. Above all, he renovated the irrigation system and encouraged better methods of agriculture. He is credited with the saying: "Not even a little of the water that comes from the rain must flow into the ocean without being made useful to man."

However, Parakramabahu's capital works, particularly his unremunerative *viharas* and palaces, and most of all his foreign wars against Burma (successful) and southern India (unsuccessful), put an unbearable strain on his kingdom's economy. After him the Sinhalese kingdom made a slow retreat southward from Tamil invaders, who now settled, bringing into Ceylon another element, differing from the Sinhalese in race, language, and religion (Hindu). The capital city was moved from place to place, till by the 16th century it had reached Kotte, a few miles from Colombo (*q.v.*), which even at that time was the centre of a considerable trade, largely in the hands of the Moors, Muslims from Arabia and India. Meanwhile a Tamil kingdom was established in the northern peninsula of Jaffna, and the Tamil settled there and down the northeastern coast, where their descendants still predominate. Only one Sinhalese king, Parakramabahu VI, succeeded in bringing them under his rule.

3. The Portuguese.—The beginning of the 16th century brought new invaders. In 1505 Portuguese ships anchored off Colombo. The Portuguese made a treaty with the king, who gave them permission to trade in cinnamon, even then an important export. Next time they came they were allowed to build a fort. Thenceforward they took advantage of the divisions among the Sinhalese rulers with skill and duplicity, took over their lands in the southwest and confined them mainly to the Malayarata, the kingdom of Kandy. Sometimes the Portuguese were driven back by the Sinhalese, and were saved only by reinforcements from Goa, the Portuguese headquarters in India. At other times they invaded the Kandyan kingdom, but though they managed to reach Kandy, the difficulty of communications and the unhealthy climate always brought them to disaster.

Just before the turn of the century the Portuguese formally took over the sovereignty of Ceylon in the name of their king, Philip II of Spain. This involved them in war with the Dutch, who had become a strong maritime power. The Portuguese incentives for keeping Ceylon were its strategic importance and the trade in cinnamon, areca nuts, and precious stones, of which they had deprived the Moors. They had sedulously propagated Christianity, sending out missionaries, Jesuits, and friars, who converted thousands of lower-caste Sinhalese and Tamil, but their efforts to convert the kings and higher caste people had little success.

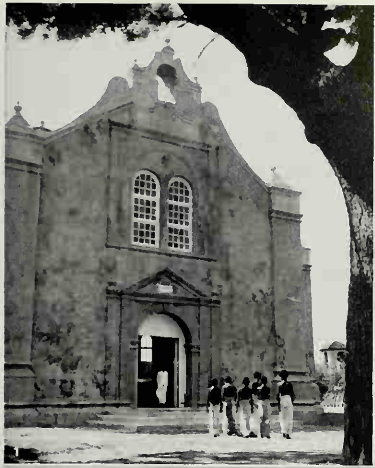
The Portuguese intermarried with the Sinhalese and Tamil. Many of their social customs had a permanent effect on the low-country Sinhalese and most of those who became Christians, actually or nominally, took Portuguese names, which their descendants still bear. But the main legacy of the Portuguese was the Roman Catholic religion, which in the 20th century still claimed thousands of followers.

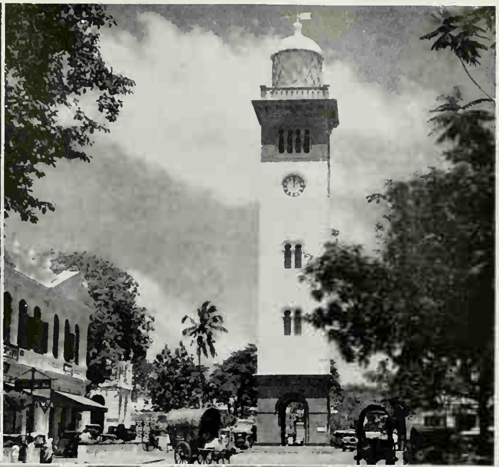
4. The Dutch.—Quite early in the 17th century the Portuguese had to face Dutch opposition. In 1602 the Dutch East India Company was formed to exploit the rich trade of south Asia. Once it gained control of the Indian Ocean, the Portuguese in Ceylon were doomed. The Dutch negotiated with Rajasinha II, the king of Kandy, and undertook to drive out the Portuguese. By 1644 they had captured Batticaloa and Trincomalee on the east coast and two west coast seaports, Galle and Negombo; after a few years of uneasy peace they attacked again, and in 1656 took Colombo after a hard-fought six-month siege.

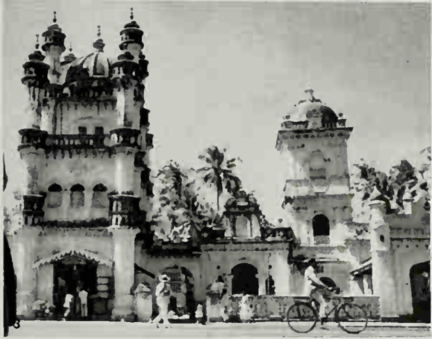
Rajasinha had understood that the Dutch would restore the old territories of the Sinhalese kings in return for a trading monopoly, but the Dutch found plenty of excuses for keeping the fortresses they had captured. Henceforward the kingdom of Kandy was confined to the up-country area, with only a few outlets to the coast.

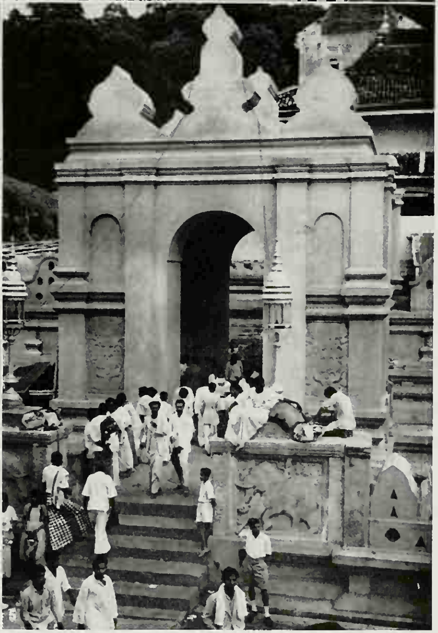
The Dutch ruled more efficiently than the Portuguese, although their taxation was systematic and heavy. Their headquarters in Batavia sent many able governors to Ceylon, but their main interest was always trade, particularly in cinnamon. Toward the middle of the 18th century the Dutch became increasingly afraid of the English and French East India companies, which they had thus far succeeded in barring from trading with Ceylon. In 1739 the royal line died out in Kandy and the last Sinhalese king's brother-in-law, a Nayakkar from south India, was put on the throne. He was hostile to the Dutch, and this led in the 1760s to a Dutch invasion of the kingdom. They were unable to hold it, but made an advantageous treaty by which they won the whole seaboard, a trade monopoly, and an undertaking that the king would have no dealings with other countries.

Despite these successes Dutch power was declining. Their land policy was disliked by the low-country Sinhalese, and the Kandyan kings intrigued with both French and English. Their rule came to an end during the Napoleonic Wars. It left two major legacies, the Roman-Dutch law, which remains as the highly respected basis of the legal system, and the Dutch Burgher community. Unlike the Portuguese, the Dutch intermarried comparatively little with the Sinhalese and Tamil. When their occupation ended a number of their people, including some of mixed descent, stayed on, speaking Dutch and practising the religion of the Dutch Reformed Church. Dutch gave way to English, but the Dutch Burgher community kept its identity and in the 19th century its members occupied most minor posts in government and mercantile offices. Many left Ceylon in the mid-20th century.







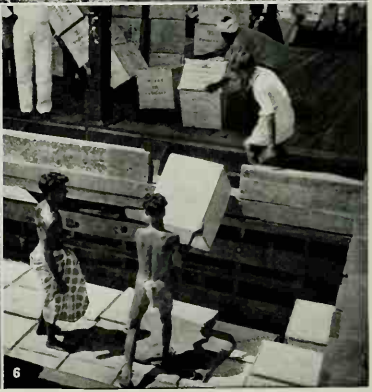


BY COURTESY OF (4) DEPARTMENT OF BROADCASTING AND INFORMATION, CEYLON PHOTOGRAPHS (1, 3) WERNER COHNITZ—PIX, (2) DEANE DICKASON FROM EWING GALLOWAY, (4) VICTOR SUMATHIPALA (5) REG VAN CUYLENBURG FROM THREE LIONS

VIEWS OF CEYLON

1. Dutch church in the fortified town of Jaffna built in 1705, during the Netherlands occupation
2. Clock tower and lighthouse in the "Fort" or business quarter of Colombo, the capital
3. An elaborate mosque in Colombo
4. Beach at Mount Lavinia, a seaside resort on the west coast of Ceylon
5. Entrance to the "Temple of the Tooth," Kandy. The sacred Tooth Relic of the Lord Buddha is enshrined in the temple

CEYLON



PHOTOGRAPHS, (1, 2) FRITZ HENLE, (3-6) WERNER COHNITZ-PIX

NATIVE OCCUPATIONS IN CEYLON

1. An outrigger fishing canoe drawn up on the beach
2. Ox-drawn carts in Ceylon
3. Labourers unloading coconuts on a plantation
4. Villagers filling a water cart from a well
5. Sinhalese and Tamil rubber tappers reporting for work on a rubber plantation
6. Loading crates of tea for export at the docks of Colombo

5. British Rule.—Following the refusal of the Dutch governor in 1795 to admit British troops, the British East India Company sent a well-equipped expedition to Ceylon which captured first Trincomalee and then Colombo, after a peculiar intrigue by which a Swiss mercenary regiment which had been part of the Colombo garrison was bought and changed sides. It seemed doubtful for a time that the British would keep Ceylon, but the East India Company pressed hard for it, and it was taken over by the Treaty of Amiens in 1802. The short time it was under company rule was unfortunate, for the British and Indian officials who were sent from Madras knew little about Ceylon and cared less. Distrusting the local officials, they scrapped the former system of administration. This led to a revolt in 1797 and Frederick North, who was sent out from England as governor, restored the old system. The control of trade was for a time left with the company, but in 1802 Ceylon became a crown colony.

The kingdom of Kandy was a problem. Some Kandyan chiefs, dissatisfied with their Tamil king, entered into an intrigue with North. In 1803 he sent an expedition which captured and garrisoned Kandy, but the garrison, weakened by sickness, surrendered and was massacred. Once the Napoleonic Wars were over, in 1815, Sir Robert Brownrigg, then governor, sent a force which easily defeated and captured the king, who received little support from the chiefs. Brownrigg made a treaty with them, guaranteeing their rights and privileges and the protection of the Buddhist religion. However, the chiefs and the *bhikkhus* soon became dissatisfied with the new regime and in 1818 a serious rebellion broke out, which was repressed severely after considerable difficulty. After this a proclamation modified the treaty. The ancient kingdom ceased to exist and, although there were a few minor revolts, these were easily suppressed.

The subsequent history of Ceylon was peaceful. Its most interesting aspects in the 19th century were concerned with administration and economics and in the 20th with constitutional development and social change. Up to the 1830s the government found it hard to make ends meet. Cinnamon, as a result of competition from the Dutch East Indies, was a dwindling asset, but in the 1820s the cultivation of coffee, on a plantation basis, was begun and with government encouragement thousands of acres of upcountry jungle were cleared and planted. The Sinhalese villagers refused to undertake the arduous, regular work involved, so the European planters imported Tamil labour from southern India, thus creating a problem that remained unsolved. Roads were built and later railways, primarily for the planting districts but eventually for the whole island.

Coffee went through more than one crisis until, in the 1880s, it was wiped out by plant disease. Much money was lost, but the economy of Ceylon was saved by the planting of cinchona (for quinine) and later of tea, which became and remained its mainstay. Toward the end of the 19th century a second cash crop was introduced: rubber, cultivated mostly in the foothills of the mountain massif on which the tea estates flourished. Many Sinhalese and Tamil became owners of rubber estates and small holdings. The plantation system even spread to the centuries-old coconut cultivation, though coconuts remained mainly a staple product of the peasant economy. Some Sinhalese successfully established graphite mines.

The development of export crops on a plantation scale meant a great growth of external trade, and Colombo became a big business centre and a great port. With the opening of the Suez Canal in 1869 it became more than ever a port of call for world shipping and for refueling, especially after an adequate harbour had been constructed. The export and import business, with the accompanying banking and insurance enterprises, were, like tea planting, for a long time exclusively in European hands, but eventually a new Ceylonese middle class grew up, and Sinhalese and Tamil, who first found clerical employment in government and mercantile offices, came to man all ranks of the government service and later entered planting and business management.

The history of administration under British rule is one of slow progress. In the early days civil servants' duties were confined to the maintenance of law and order, the local administration of justice, and the collection of revenue, but with growing specialization came separate departments such as public works, irrigation, forests, survey, agriculture, postal and railway services, and police. The higher ranks were for many years filled by British officers. With the growth of education in Ceylon and of a more liberal colonial policy in Britain, however, these posts became increasingly open to the sons of the upper and middle classes of Ceylon, regardless of caste.

The development of education was of basic importance. It stemmed from two sources: the necessity for staffing government and mercantile offices, and the propagation of religion, mainly the various denominations of Christianity. Hence it had a distinctly Western slant, particularly on the secondary and higher levels where the medium of instruction was always English. The government, at first inclined to leave education to the missionaries, was impelled to establish state schools and in 1921 founded a university college which attained university status in 1942.

The Buddhists and Hindus entered the field of "English education" in the 20th century, but the old system of *pirivena* schools attached to Buddhist *viharas* somehow maintained itself and, after the Buddhist revival, expanded. Two of these schools, Vidyodaya and Vidyalankara, were granted university status in 1959.

One of the most significant factors in the modern history of Ceylon was the revival of Buddhism and Hinduism, in reaction against the activities of the Christian missionaries. The Buddhist Theosophical Society and other societies for promoting Buddhism and Buddhist education sprang up and with them came a revival of oriental studies. These movements contributed materially to the development of nationalism in Ceylon.

These developments promoted the growth of an educated middle class, which came to demand constitutional advance. As early as 1833 the Colebrooke Commission, which initiated important reforms such as the abolition of forced labour, had recommended the establishment of executive and legislative councils, to include representation from the communities of the island, a turning point in Ceylon's history. Little was done in this direction during the 19th century, but some progress was made with the setting up of local government authorities.

Early in the 20th century the new middle class was insistently demanding more representative government. A beginning was made in 1912, with the provision of an elected "educated Ceylonese" representative in the Legislative Council. Constitutional reform in India had its effect in stimulating demand for progress in Ceylon. During World War I (which affected Ceylon hardly at all) a religious riot was put down with severity. The result was to arouse nationalism to a remarkable degree and the Ceylon National Congress was founded. The result of the consequent agitation and of the increasingly liberal policy of the United Kingdom government was the introduction of two measures of reform (1920 and 1924) by which an unofficial Ceylonese majority was created in the Legislative Council and given considerable financial control. These reforms failed to satisfy the Congress, in which the leading figures were low-country Sinhalese. In 1928 a royal commission was sent out from Britain which recommended sweeping reforms, including universal adult suffrage and the creation of a board of ministers, together with a scheme of executive committees in the new State Council to give its elected members some acquaintance with the business of administration.

The royal commission's proposals were grudgingly accepted and the reforms came into operation in 1931, but the Ceylonese leaders wanted full responsible government on the Westminster model. It was delayed by World War II, during which Ceylon, in danger for a time from the Japanese and heavily garrisoned, put forward a vigorous war effort. Even before the war was over, however, the leaders renewed their demands, and in 1945 another royal commission was sent out. Nearly all their demands were met, and when the new constitution came into operation, in October 1947, the grant of full independence was announced. It took effect four months later.

6. Independence.—The new constitution followed the Westminster model closely. (See *Constitution and Government*, below.) The first prime minister was D. S. Senanayake, a Sinhalese of great political wisdom. The cabinet included Tamil and Muslim as well as Sinhalese ministers. The peaceful transition of Ceylon from a colonial to an independent status was regarded as a model throughout the Commonwealth.

In 1951 the United National Party (the UNP, the government party) split, Solomon Bandaranaike leading the dissident group. The next year the prime minister was killed in a riding accident and his son, Dudley Senanayake, succeeded him and went to the country successfully. He resigned not long after, partly on grounds of health, and his place was taken by Sir John Kotelawala. But the UNP was losing popularity in the island and in a general election in 1956 was decisively defeated by the Sri Lanka Freedom Party (SLFP) led by Bandaranaike, who had formed a coalition with one of the three Marxist groups in parliament, and a Sinhalese party which was strongly nationalist and Buddhist. His success was due to a reaction among the "Sinhalese-educated" against the westernized "English-educated," and an appeal to Sinhalese racial feeling.

Bandaranaike found it difficult to run this somewhat mixed cabinet and to carry out all his election promises. In foreign policy he followed a neutralist line, terminating an agreement made in 1947 that the British government should retain the use of the naval base at Trincomalee and the air base at Katunayaka. In internal politics he was a moderate socialist. His government introduced a measure to make Sinhalese the official language. This incensed the Tamil community, always fearful of being dominated, and they demanded a federal constitution. The relations between the two communities deteriorated, and in May 1958 severe rioting broke out. There were attacks on the Tamil living in the Sinhalese areas and many casualties.

In 1959 Bandaranaike was assassinated by a *bhikkhu* and the government collapsed through internal dissensions. A general election in 1960 brought in the UNP again, under Dudley Senanayake, as the largest party, but with no overall majority. The government he formed was immediately defeated in parliament. The ensuing election gave the SLFP, now led by Sirimavo Bandaranaike, Bandaranaike's widow, a decisive majority, and she became the first woman prime minister in history. She claimed to follow her husband's policies—neutralism in foreign affairs, moderate socialism, and the encouragement of Sinhalese language and culture. The nationalization of bus transport and of the port of Colombo introduced by Bandaranaike was followed with that of insurance and of the import and distribution of petrol and oil. Foreign banks and export firms were being brought under government control; but the nationalization of foreign-owned plantations was disclaimed. The growing and sale of rice was heavily subsidized, a serious burden on the economy. Industries were introduced, many of them run with state cooperation.

In 1960 Mrs. Bandaranaike's government took over control of the schools belonging to religious bodies, provoking strong protests, some disorderly. In 1964, to save her government, she formed a coalition with a left-wing Socialist group, the Lanka Sama Samaja Party, whose leader N. M. Perera became finance minister. Elections in March 1965 returned the United National Party under Senanayake to power.

After 1956 the economic position of Ceylon deteriorated and its sterling assets were heavily depleted. A very rigorous exchange control was set up, but foreign investment and foreign exchange became increasingly difficult to secure. (S. A. P.)

VI. ADMINISTRATION AND SOCIAL CONDITIONS

1. Constitution and Government.—The main lines of the constitution of Ceylon were prepared by the Ceylonese ministers in 1943–44 and approved with some amendments by the Soulbury Commission in 1945. It was enacted as the Ceylon (Constitution) Order in Council, 1946. Before it took full effect, however, the government of the United Kingdom agreed that Ceylon should become an independent country within the Commonwealth. Effect was given to this decision by the Ceylon Independence Act, 1947, and the Ceylon Independence Order in Council, 1947. Dominion status was attained on Feb. 4, 1948, but in 1957 it was decided to produce a new republican constitution and a joint select committee of both houses of parliament was established to work out the details. The committee had done no more than produce an interim report when it was discharged through the dissolution of parliament in 1959.

Under the constitution of 1946–47, the sovereign is represented by a governor-general and there are two houses of parliament. The Senate consists of 30 members, half elected by the House of Representatives by single transferable vote and the other half nominated by the governor-general. One-third of the members retire every second year. The House of Representatives consists of 151 members elected by Ceylon citizens over the age of 18 and 6 members appointed by the governor-general to represent minority interests. Better minority representation is also secured by distributing extra seats in sparsely populated provinces, in which the minorities are more numerous. Ordinary cabinet government is provided for in accordance with British constitutional conventions, the prime minister and other ministers being, subject to the collective responsibility of the cabinet, in charge of the government departments. The appointment, dismissal, and disciplinary control of public servants is, however, vested in an independent Public Service Commission.

Colombo is the seat of government and for administrative purposes Ceylon is divided into 9 provinces (Western, Central, Southern, Northern, Eastern, North-Western, North-Central, Uva, and Sabaragamuwa) which are subdivided into 21 administrative districts. The latter are in charge of government agents and assistant government agents who are responsible to the Ministry of Home Affairs. There are four types of local authorities: rural village committees (407), rural town councils (42), urban councils (36), and municipal councils (7).

The judges of the Supreme Court are appointed by the governor-general and have the same independent status as the high court judges in England. Other judicial officers are appointed, dismissed, and subjected to disciplinary control by an independent Judicial Services Commission. The common law of Ceylon is the Roman-Dutch law, but there has been much importation of English law, especially in commercial matters, and the personal laws of the Kandyans, the Jaffna Tamil, and the Muslims have been retained. Civil and criminal procedure is essentially English and the penal code is based on that of India.

Responsibility for defense and external affairs is vested in the prime minister, subject to cabinet control. The small armed forces are modeled on those of the United Kingdom. The police are controlled by an inspector general responsible to the minister of home affairs.

2. Social Conditions.—The mass of the people are peasants, but the population multiplied ten times between the British occupation in 1799 and the mid-20th century while the land available for peasant cultivation tended to contract. Many peasant families are therefore landless and subdivision of holdings has made most of them insufficient to maintain the families dependent upon them. In the lowlands there is some employment on the coconut estates planted by Ceylonese. In the hill country the tea and rubber estates were planted by Europeans and Indians and the labour was Indian, though in later years Ceylonese workers replaced some of the Indians. The plantation industries made possible the development of the towns, especially Colombo, Kandy, and Galle, as administrative and commercial centres. Industries, though actively encouraged by successive governments, are few and on a small scale. In commerce there was a considerable replacement of European and Indian employees after 1947, but there was much unemployment, which was likely to continue until plans for industrialization matured.

The high birth rate and the low death rate make heavy demands for social services. Education, accounting for the largest item in the budget, is free from primary school to the three universities. Almost all children are at school between the ages of 6 and 11 and a high proportion continue until the age of 16 or 18. Even in 1953 the standard of literacy was unusually high for Asia (75.9% among males and 53.6% among females) and it continued to rise rapidly.

The second expensive service is health. Cholera, smallpox, and malaria have been virtually wiped out, but in the early 1960s there was still a great deal of tuberculosis and diseases caused by parasitic worms were common. Other social services are not highly developed. Few of the recommendations of the Social Services Commission of 1946 were carried out, chiefly because of their expense. Taxation, both direct and indirect, is high. Income tax, for instance, ranges from 10% on Rs. 6,000 to 85% on Rs. 120,000. (W. I. J.)

VII. THE ECONOMY

Ceylon, a member of the Colombo Plan (*q.v.*), is an underdeveloped country with a low per capita income (about £40 or $115 per capita per year), but it is more fortunate in this and other respects than many other southeast Asian countries. A ten-year plan published in 1959 sought to raise per capita income by at least one-third by the late 1960s, though this was unlikely to be achieved.

1. Production.—More than half of the gainfully employed persons in Ceylon are engaged in agriculture, which also supplies more than half of the national income. The peasant economy of Ceylon was and to a large extent remains centred on the cultivation of rice combined with the growing of coconut, other tree crops, and vegetables on unirrigated land and, in the dry zone, of grains and other crops grown by shifting cultivation. Technical standards are relatively low, but are improving.

The replacement of *chena* or shifting cultivation by more stable agriculture raises many problems. Experiments are pointing the way to the growing of sugar, cotton, and other new crops and there are efforts to recolonize the dry zone.

The many large estates growing tea, rubber and, to a lesser extent coconut, which contrast strongly with peasant villages, produce mainly for export. In the 1960s the export economy involved many Ceylonese landowners and cultivators and large numbers of small holdings. Nearly 80% of the coconut acreage was in units other than estates, while more than 40% of the tea acreage and 70% of the rubber was owned by Ceylonese individuals. The export sector was narrowly based, being dependent almost entirely on tea, rubber, and coconuts (the traditional spices playing a very small part); it was therefore subject to instability because of market fluctuations. It was, however, very valuable, contributing 35–40% of the national income. With most of the larger estates it was also a very efficient sector; the small holdings tended to lag behind. Little land was available for expansion of these crops because tea and rubber cannot grow in the dry zone and the coconut is limited to places where ground water exists or can be provided. The ten-year plan for export crops was, in the absence of much suitable new land, primarily concerned with increasing yields of export crops on existing acreages.

Tea is grown mainly up-country, that from high altitudes being of exquisite flavour and excellent reputation, but it is also grown in lowland parts of the wet zone. Rubber is essentially a lowland wet zone crop, though it climbs into the lower hills. Coconut grows all along the wet zone coast, in the coconut-belt triangle north of Colombo, in the Jaffna Peninsula, and on the east coast.

Forestry employs only a few hundred persons but is of local importance in the wilder parts of the wet zone and in the dry zone. Fisheries employ nearly 40,000 persons who are mainly sea fishers using traditional methods.

Mining and quarrying employ just over 9,000 persons, nearly half in stone quarrying. The graphite and gemstone industries of part of the Khondalite belt (see *Geology*, above) make some contribution to exports. Ceylon has no great mineral potential, but iron ore may be worth working, as are ilemnite and monazite sands.

In the absence of coal or oil, Ceylon's only source of power lies in its water resources. There are hydroelectric stations at Laksapana, on the western edge of the hills and in the Gal Oya Valley. In the 1960s traditional craft products were still made, including exquisite silver and lacquer work. The most important industries, however, are those that process the products of the export sector. There are also factories making cement, cotton goods, soap, and other products, and an expansion of industries (notably cement, sugar, fertilizers, and textiles) was being accomplished under the ten-year plan.

2. Trade and Finance.—In the late 1950s and early 1960s the imports and exports of Ceylon generally maintained an average value of £130,000,000–£150,000,000 per year. The usually favourable visible balance of trade of earlier years was generally replaced by an adverse balance. Tea, rubber, and coconut products normally accounted for 90% or more of the exports; imports were made up mainly of rice and other foodstuffs, manufactures, and raw materials. Principal recipients of exports included the United Kingdom and other Commonwealth countries, the United States, and China. Imports came mainly from India, China, the rice-producing countries of southeast Asia (*e.g.*, Burma), and the United Kingdom.

Ceylon's unit of currency is the rupee, of the same value as the Indian rupee. There is a central bank and, in addition to the Bank of Ceylon, a number of old-established banking concerns operate in the country.

3. Communications.—Bus services and railways are state-owned. Ceylon has about 15,000 mi. (24,000 km.) of motor roads and 900 mi. (1,450 km.) of railways, nearly all of the latter being of broad (5-ft. 6-in.) gauge. This network is, however, very unevenly distributed over the country: in general the lowland wet zone and the up-country areas are very well serviced but, apart from the Jaffna Peninsula, the dry zone as a whole has poorer facilities. There are regular air services from Colombo via Jaffna to south India, and connections with London and Australia.

See also references under "Ceylon" in the Index. (B. H. F.)

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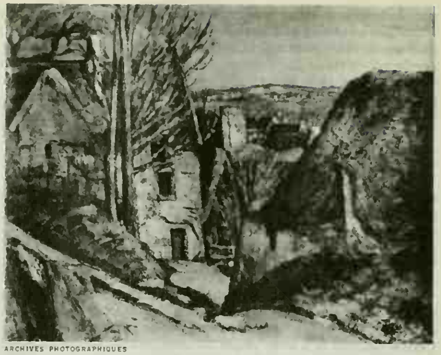
CÉZANNE, PAUL (1839–1906), perhaps the most profound and significant of French 19th-century painters, was born at Aix, the ancient capital town of Provence, on Jan. 19, 1839. His father, a banker, had at first been in trade as a hatter and had married one of his workgirls. Paul was educated at the Collège Bourbon at Aix, where he formed an intimate friendship with Émile Zola. The two boys were inspired by a love of the classics, particularly of Virgil, through whom, perhaps, Cézanne realized the beauty of his native country. Both decided to consecrate themselves to art. Zola settled down to a literary career in Paris, but Cézanne, after a short period as a law student, endeavoured to comply with his father's wish that he should carry on in the management of the family bank. After failing in this he was allowed to settle in Paris and attend the Atelier Suisse, where he was expected to prepare himself for the examinations of the École des Beaux-Arts, which he never passed. He arrived in Paris in 1863.

Cézanne became known as one of the most extreme of the young revolutionary painters, the bitterest in his denunciation of official art and of Ingres who, then in his old age, was regarded as the head of the reactionaries. In this way he became acquainted with the group of painters who encircled Manet, and were later known as the Impressionists. At this period he was most influenced by Delacroix and by the baroque painters whom Delacroix studied, by Rubens and Tintoretto. The colour theories of Delacroix, coupled with the "law of simultaneous contrast," formulated by the chemist Michel Chevreul, by the end of the 1860s were beginning to be taken up by the young artists with whom Cézanne was familiar. His ambition was to create grandiose compositions of a purely imaginative description, expressive of his own moods, using either violently dramatic themes—"Les Assassins," "L'Autopsie," "Lazare"—or lyrical motifs—"Le Jugement de Paris," "Déjeuner sur l'herbe." He also painted a series of portraits in which dramatic and psychological effects were undertoned. In these the influence of Gustave Courbet is evident. They are painted with broad strokes, the palette knife plowing up and planting down an exceedingly thick and dense impasto. In all these early works the colour is reduced to a few simple notes in which black, white, earth reds and yellows predominate. The tension of Cézanne's imaginative life shows itself in the tumultuous vehemence of these early compositions. His outlook on nature seems to have been confined for the most part to the search for motifs of chiaroscuro suitable to dramatic effects. He showed at this stage nothing of the curiosity about natural effects of colour which distinguished the Impressionist group. A few still lifes of this period, however, show how much greater his native endowment was in this direction than in the one he was consciously pursuing; but even in these latter the dramatic evocations of the thing seen are what chiefly interested him.

During the years 1872–73 a great change came over Cézanne. He spent the summers of these years at Auvers-sur-Oise in the company of Camille Pissarro, one of the foremost Impressionists. Pissarro, who was some years older than Cézanne, had already discovered his personal style and perfected a methodical and precise technique adapted to it. Cézanne learned for the first time to look on nature with a curious and contemplative gaze and learned the process of recording the results thus obtained. Above all, the whole world of atmospheric colour was thus revealed to him. Certain pictures painted by Cézanne in these years approximate very nearly to Pissarro's work but they show Cézanne's greater power of organizing form (*e.g.*, the "Maison du pendu à Auvers" of 1873, in the Louvre) and the greater profundity of the conceptions that the contemplation of natural appearance provoked in his intensely passionate nature. For these years, then, Cézanne may be counted an Impressionist.

But Cézanne's response to appearances gave him a notion of design more vigorously constructed, and evocative of far deeper feelings, than any that the Impressionists envisaged. Cézanne always believed in some underlying reality of a permanent kind, more consonant with the deeper instincts of human nature. The Impressionist vision was both too casual and too imperfectly organized for him. It missed part of the truth that the older masters had apprehended. Cézanne summed up his own attitude by saying that his ambition was to do Poussin over again after nature; *i.e.*, to incorporate into a clearly organized formal unity, like Poussin's, the vision of natural appearance as enriched by Impressionist researches. From this point Cézanne's personal vision and his personal expression of it were established. Such changes as his style underwent in the succeeding decades were only gradual modifications of what he had established once for all. The essentials of that style were due, as noted above, to the special use he made of the Impressionist vision. They were based upon the most rigorous construction of the design by means of the interplay of clearly articulated planes. But the movement of these planes, their salience and recession, was interpreted quite as much by changes in local colour as by the definition of form by light and shade. A characteristic of Cézanne's completely realized manner is the extreme simplicity of the approach, the fact that objects are presented in full frontal aspect. In nearly all his portraits the sitter is placed nearly in the centre of the canvas, the head and body being seen nearly in full face. In the landscapes a similar treatment is found; objects are extended in planes parallel to the picture plane, and frequently the main mass is centrally placed. Such extreme symmetrical simplicity of approach takes us back to the practice of the Italian primitives and is violently opposed to the principles of baroque composition as followed by most of Cézanne's predecessors and by himself in his early period. Cézanne was not the only artist to absorb and then react against the methods of the pure Impressionists; Renoir, Seurat and his disciples, Gauguin and Van Gogh to a greater or lesser extent abandoned their habit of making a sensitive but indiscriminate ocular record of what lay before them and attempted to reconcile what they had learned with a discipline of form and structure. For this reason the group came to be known as postimpressionist, though the term hardly suffices to link the aims of, for instance, Seurat with those of Van Gogh.


ARCHIVES PHOTOGRAPHIQUES

"MAISON DU PENDU À AUVERS" ("THE HOUSE OF THE HANGED MAN AT AUVERS") BY PAUL CÉZANNE; 1873. IN THE LOUVRE, PARIS

Such an exaggeratedly simple disposition would probably strike us as crude and uninteresting if it were not that within the volumes Cézanne places before us in this elementary fashion his analysis of changes of surface and plastic movement is pushed to an extraordinary degree, and this is accompanied by innumerable slight modulations of colour so that the whole surface takes on something of the infinity of natural appearance. This practice he developed with ever-increasing power. In the 1870s and early 1880s, the almost laborious scrutiny of infinitesimal colour changes led him to load the canvas with repeated layers of colour, though without ever losing purity and intensity. This method achieves its greatest power in the "Still Life With a Fruit Dish" (Lecomte collection, Paris) painted at the end of the 1870s. In the next decade Cézanne spent less and less time in Paris and continued his researches alone in the neighbourhood of Aix and his family house, the Jas de Bouffan, which, together with an independent income, passed into his hands on his father's death in 1886. He now began to seek the same complexity of surface with thinner layers of colour, and his increasing use of water colour during the critical period after 1885 probably influenced his practice in oil paint. Together with this he tended at this time to simplify the colour changes, adopting even a regular principle of colour sequences to express movements away from the highest relief of any given volume. Superfluous material was pared away, and in many works of this time portions of white ground vied with and punctuated the areas carrying the colour and modeling. All this was strictly in keeping with his philosophical conception of the aim of painting. In everything he did he sought a synthesis in which the most rigorously logical plastic structure should be combined with the utmost liveliness of surface; that is to say, he sought, without losing the infinitude of natural appearance, to give to it an intelligibility and a logical coherence which it lacks. This, no doubt, is more or less the problem of all painting; what distinguishes Cézanne is his endeavour to attain this synthesis when each of the opposite terms is at its highest pitch. The irreconcilability of these ideals may have been responsible for Cézanne's transformation from a violently outspoken youth to a solitary, pertinacious and analytically minded man.

To the last decade of the 19th century belong some of his most celebrated works: the portrait of Geffroy, which is perhaps unequaled in modern art for the completeness of its realization, the complexity and assurance of its harmonies; several compositions of men seated at a *café* table and playing cards, of monumental simplicity; and a series of landscapes dominated by the pyramidal mass of Mont Sainte-Victoire. Even to the end of his life, Cézanne cherished the hope of creating poetical designs of nude figures in landscape, after the manner of some of Giorgione's and Titian's pictures. But in this he was hampered by his extreme reluctance to draw from the nude model, and most of these grandiose attempts remain failures.

At the very end of his life there seems to have been a kind of reappearance in Cézanne of the romantic tendencies of his youth. His paintings became richer, more intense and vivid in colour, more agitated in rhythm, more vehement in accent; they also departed more and more from the careful analysis of natural appearance of the middle period, as though his long apprenticeship to nature had ceased and he felt free to follow unhesitatingly his instinctive feeling. In the 1880s and 1890s his very name had become almost unknown in the larger art circles of Paris, though he never lacked a few enthusiastic admirers in that city and in Belgium. Gradually, however, his fame began to circulate among artists, and in 1904 a retrospective exhibition of his works in the Autumn salon revealed to the public this almost unknown genius. It was his only foretaste of his posthumous fame. He died at Aix on Oct. 23, 1906.

See also references under "Cézanne, Paul" in the Index volume.

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(R. FR.; D. C. T. T.)

C.G.S. SYSTEM, a system of units which takes as a basis the centimetre, the gram and the second. *See* PHYSICAL UNITS and ABSOLUTE UNITS.

CHAADAEV, PETR YAKOVLEVICH (*c.* 1794–1856), Russian philosopher whose ideas of Russian history precipitated the controversy between the opposing intellectual camps of Slavophils and westernizers, was born in Moscow. After leaving the university there he became an army officer and took part in the Napoleonic campaign. During 1823–26 he traveled in Europe and afterward lived in seclusion in Moscow, writing in French his *Lettres Philosophiques* (1827–31). The first letter (the only one to be published during his lifetime) appeared in the review *Teleskop*, in Russian translation, in 1836. A defense of western European culture and a sweeping negation of a Russian cultural tradition, it provoked a storm of patriotic indignation and unprecedented discussion. The periodical was banned, its editor exiled and Chaadaev himself declared insane and forbidden further publication. In his unfinished "Apology of a Madman," also written in French, he attempted, without recanting, to exonerate himself before the authorities. Chaadaev was profoundly religious and, though remaining Orthodox, sympathetic toward the Roman Catholic Church, which he admired for its civilizing influence. He had affinities with both Slavophils and westernizers, but his advocacy of a western path of development for Russia divided him from the former, and his religio-historical conception from the latter.

Chaadaev died in Moscow on April 26 (new style; April 14, old style), 1856.

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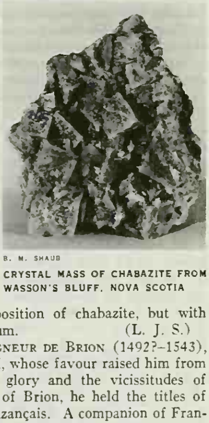
(E. HL.)

CHABAZITE, a mineral species belonging to the group of zeolites. It occurs as white to flesh-red crystals which vary from transparent to translucent and have a vitreous lustre. The crystals are rhombohedral, and the predominating fórm is often a rhombohedron closely resembling cubes in appearance, and the mineral was in fact early (in 1772) described as a cubic zeolite. A characteristic feature is the twinning, the crystals being in many cases interpenetration twins with the corners of small crystals in twinned position projecting from the faces of the main crystal. A flat lenticular form of crystal is also common, this variety being known as phacolite (from the Greek for "a lentil"). The hardness is 4.5, and the specific gravity 2.08 to 2.16.

Chemically, chabazite is a complex hydrated calcium and sodium silicate. The composition is, however, variable, and is best expressed as an isomorphous mixture (*see* ZEOLITE). Chabazite occurs with other zeolites in the amygdaloidal cavities of basaltic rocks; occasionally it has been found in gneisses and schists. Gmelinite may be mentioned here, since it is closely related to chabazite. It forms large flesh-red crystals usually of hexagonal habit, and was early known as soda chabazite, having the composition of chabazite, but with sodium predominating over calcium.

(L. J. S.)



B. M. SHAUB

CRYSTAL MASS OF CHABAZITE FROM WASSON'S BLUFF, NOVA SCOTIA

CHABOT, PHILIPPE, SEIGNEUR DE BRION (1492?–1543), admiral of France under Francis I, whose favour raised him from the petty nobility of Poitou to glory and the vicissitudes of power. As well as the seigniory of Brion, he held the titles of comte de Charny and comte de Buzançais. A companion of Francis I in his childhood, he rose to prominence after that king's accession (1515). In the war between Francis and the Holy Roman emperor Charles V, he took part in the defense of Marseilles (1524) and was captured with Francis at the battle of Pavia (1525). He was made admiral of France and governor of Burgundy after the negotiation of the peace of Madrid (Jan. 1526), being thereafter known as the admiral de Brion. In 1535 he commanded the army for the invasion of Piedmont. Both at court and in military commands, however, he had the constable Anne, duc de Montmorency, as his rival; and his enemies, particularly the chancellor Guillaume Poyet, conspired to get him accused of peculation. He was sentenced to banishment, to the confiscation of his estates and to the payment of a large fine in Feb. 1541; but the king's mistress, Anne de Pisseleu, duchesse d'Étampes, intervened to procure him the king's pardon in March and he was reinstated, Montmorency and Poyet being disgraced. He died on June 1, 1543, shortly before the trial of Poyet.

Though he was no seaman, Chabot took some interest in his duties as admiral of France and did much to promote Jacques Cartier's expedition to Canada.

(RO. M.)

CHABRIAS (d. *c.* 357 B.C.), Athenian mercenary who commanded with distinction for the Athenians against various enemies and for the kings of Cyprus and Egypt. In 388 B.C. he defeated the Spartans on Aegina and commanded the fleet sent to assist Evagoras, king of Cyprus, against the Persians. In 378, when Athens joined Thebes against Sparta, he defeated Agesilaus near Thebes. On this occasion he invented a maneuver, which consisted in receiving a charge kneeling on the left knee, with shields resting on the ground and spears pointed toward the enemy. In 376 he defeated the Spartan fleet off Naxos, but, when he might have destroyed the enemy, remembering the trial of the generals after the battle of Arginusae, he delayed to rescue survivors. In 366, together with Callistratus, he was accused of treachery in advising the surrender of Oropus to the Thebans. He was acquitted, and about 361 he accepted a command under Zedhor (Tachos), king of Egypt, who had revolted against Persia. On the outbreak of the Social War or "War of the Allies" (357) he joined Chares in the command of the Athenian fleet. He lost his life in an attack on the island of Chios, probably in the same year.

See H. W. Parke, *Greek Mercenary Soldiers* (1933).

CHABRIER, (ALEXIS) EMMANUEL (1841–1894), French composer whose best works reflect the verve and wit of the Paris scene of the 1880s and who was a musical counterpart of the early Impressionist painters. Born at Ambert, Puy-de-Dôme, in the Auvergne, on Jan. 18, 1841, he was attracted in his youth to both music and painting. He studied law in Paris from 1858 to 1862. During these years he also studied the piano with Edouard Wolf and harmony and counterpoint with T. Semet and A. Hignard. His technical training was, however, limited, and in the art of composition he was self-taught. From 1862 to 1880 he was employed at the ministry of the interior, producing during this period the operas *L'Étoile* (1877) and *L'Éducation manquée* (first performed with piano accompaniment, 1879; with orchestra, 1913). Two unfinished operettas were sketched out between 1863 and 1865 in co-operation with Paul Verlaine. He was closely associated with the Impressionist painters, particularly with Edouard Manet from whom he purchased *Le Bar aux Folies-Bergère*.

After hearing Wagner's *Tristan und Isolde* at Munich in 1879 Chabrier left the ministry to devote himself exclusively to music. As chorusmaster at the Concerts Lamoureux, he helped to produce a concert performance of *Tristan* and became associated with Vincent d'Indy, Henri Duparc and Gabriel Fauré as one of the group known as "Le Petit Bayreuth." Chabrier's best music was written between 1881 and 1891, when after visiting Spain, where he was inspired by the folk music, he had settled at La Membrolle (Touraine). It includes the piano works *Dix Pièces pittoresques* (1881), *Trois Valses romantiques* (1883) for two pianos and *Bourrée fantasque* (1891); the orchestral works, *España* (1883) and *Joyeuse Marche* (1888); the opera, *Le Roi malgré lui* (1887); and six songs (1890). Less successful was his opera *Gwendoline* (1886). The last three years of his life were marked by a mental and physical collapse. He died in Paris on Sept. 13, 1894. One act of his unfinished opera, *Briséis*, was posthumously produced in concert form (1897).

Chabrier's music, frequently based on irregular rhythmic patterns or on rapidly repeated figures derived from the *bourrée* of his native Auvergne, was inspired by both broad humour and a sense of caricature. Among his songs, the "Ballade des gros dindons" and the "Villanelle des petits canards" are satirical period evocations of farmyard scenes. His melodic gifts, developed by the popular songs of the Paris *cafés-concerts*, were abundant though inclined to coarseness. In his piano and orchestral works he developed a sophisticated Parisian style which served as a model for the 20th-century composers, Francis Poulenc and Georges Auric. His orchestration was remarkable for novel instrumental combinations conceived as aural equivalents of the primary colours used by the early Impressionist painters. In *España* his use of the brass and percussion anticipated effects in Igor Stravinsky's *Petrouchka*.

Chabrier was also a notable letter writer, the collection of his published letters being valued for its literary as well as its musical interest, and for its streak of spontaneous Rabelaisian humour.

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CHACHOENGSAO, a province in southern Thailand at the northeast corner of the upper Gulf of Siam; area, 2,093 sq.mi., pop. (1960) 314,360. The western portion, a continuation of the great Central plain, through which the Bangpakong river flows into the sea, supports most of the population. Rice milling is the major industry. About 8,000 long tons of salt are produced annually along the short coast line, and the government operates a large distillery. Chachoengsao, the capital, also known as Paetriu (pop., 1957 est., 18,951), is a river port 38 mi. by railroad from Bangkok. (G. W. SK.)

CHACMA, the Cape baboon, *Papio (porcarius) comatus*, inhabiting the mountains of South Africa as far north as the Zambezi. The largest baboon (the size of an English mastiff), this powerful old-world monkey is blackish-gray in colour with a tinge of green due to the yellow rings on the hairs. Unlike most of its tribe, it is a good climber. The chacma, like other baboons, is omnivorous, and sometimes is destructive to crops. *See* also BABOON; PRIMATES.

CHACO (EL CHACO), a province of Argentina (pop. [1960] 535,443; area 38,468 sq.mi.), bounded north by Formosa, east by the Republic of Paraguay and Corrientes, south by Santa Fe and west by Santiago del Estero and Salta. It is part of the Gran Chaco (*q.v.*) which includes adjoining lands of Paraguay and part of Bolivia. The Chaco is a large lowland plain, covered with scrub forest and patches of grassy savanna. It borders on the tropical zone and the summers are hot and humid. Heavy rainfall, in combination with the flat terrain, produces widespread flooding during the summer. The Bermejo and Guaycurú rivers cross the province but do not provide adequate drainage. Winters are mild and quite dry. The economic development of the Chaco has been retarded by the climate, the lack of markets and transportation facilities, and tropical pests, notably the locust. Assets of the region include the quebracho tree (a source of tannin), cotton and cattle. Resistencia (*q.v.*) is the capital. Chaco was known as the province of Pres. Juan Perón during the period 1950–55. (J. L. TR.)

CHACONNE, an exotic, sensual dance of Spain, but of doubtful ancestry and etymology. At the French court of the 17th and 18th centuries it was transformed into a solemn dance in $\frac{3}{4}$ time, becoming the concluding dance of court balls. Later it appeared in the theatre as an extended finale, especially in the operas of Gluck, Jean Phillipe Rameau and Jean Baptiste Lully.

As a musical form the chaconne attained great stature. It and its musical twin, the passacaglia, developed along identical lines into three of the important forms of musical literature, rondo, theme and variations, and the passacaglia. A famous example of the chaconne appears in the last movement of J. S. Bach's Fourth Sonata for solo violin.

See PASSACAGLIA; VARIATIONS. (L. HT.)

CHACO WAR. A long dispute over the ownership of the Chaco Boreal caused this conflict between Bolivia and Paraguay. The area involved was about 100,000 sq.mi. north of the Pilcomayo river and west of the Paraguay river. Both countries maintained military posts in the disputed region. On Dec. 5, 1928, Paraguay started a war of incidents by attacking Fortín Vanguardia, a Bolivian post in the extreme northeast of the Chaco. Bolivians retaliated a few days later with raids against Paraguayan posts. The Pan-American conference on conciliation and arbitration, then meeting in Washington, D.C., vainly endeavoured to prevent a war.

Armed clashes in the Chaco became so numerous and serious that both countries began to move more troops to the region. A full-scale war obviously threatened late in 1931 and definitely got under way in 1932, although it is difficult to determine exactly when the series of incidents should be called a war. Strong Bolivian attacks, which captured Paraguayan positions in the northern Chaco, began on June 15, 1932, and were followed by a successful attack in the central Chaco against Fortín Boquerón. Paraguay then ordered mobilization on Aug. 1 and two weeks later Eusebio Ayala became president.

Paraguayan forces under Lt. Col. José Félix Estigarribia mounted their first major offensive against Fortín Boquerón, which fell at the end of September. The rest of the year despite a few sharp engagements was one of preparation. The German general Hans Kundt, recalled by Bolivia to command the army he had trained, concentrated his forces in the south to attack Fortín Nanawa. Battles along the Nanawa front continued with heavy casualties for several months. Paraguay formally declared war on May 10, 1933, and neutrals intensified futile efforts to end the conflict.

General Estigarribia launched a series of attacks along an extended front late in October and made such impressive gains that Pres. Daniel Salamanca replaced General Kundt with Gen. Enrique Peñaranda. At the end of a short truce, from Dec. 19, 1933 to Jan. 8, 1934, Estigarribia renewed his drive against the key Bolivian post of Ballivián on the Pilcomayo river. There for nearly five months, from March to July, occurred the heaviest fighting of the war. Ballivián fell on Nov. 17 and a few days later President Salamanca's enemies forced his resignation.

Paraguay's advance continued into indisputably Bolivian territory in Jan. 1935. After reaching the Parapetí river Estigarribia was forced to fall back several miles and assume the defensive against desperate Bolivian counterattacks. A truce was finally signed on June 12, 1935. By the peace treaty of July 21, 1938, Paraguay gained clear title to about 70,000 sq.mi. of the disputed area. Approximately 100,000 men had lost their lives in the war.

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CHAD (Ceadda), **SAINT** (d. 672), first bishop of Lichfield, was the brother of St. Cedd, with whom he was educated at Lindisfarne under St. Aidan and whom he succeeded as abbot of Lastingham. In 664, at the request of King Oswy, he was consecrated bishop of the Northumbrians (with his see at York) by Wini, the West Saxon bishop, although Wilfrid had gone to France for consecration to the same see. On Wilfrid's return in 669 Chad humbly resigned York, and with Oswy's approval was given the see of Lichfield instead. He is said to have founded a monastery at Barrow. His feast day is March 2.

See *Butler's Lives of the Saints*, ed. by H. Thurston and D. Attwater, vol. i, pp. 457–459 (1956).

CHAD, LAKE, a lake of central Africa, lying between 12° 50′ and 14° 10′ N. and 13° to 15° E., is situated in an immense basin of the same name, on the borders of Nigeria and of the republics of Cameroon, Niger and Chad. It is a lake held in by sand dunes, the remains of a much larger "paleochadian sea" which expanded even in the Quaternary period three successive times. It lies 922 ft. above sea level, in the Sahelian zone, between desert and savanna. It is bounded to the northeast by the dead dunes of Kanem, which run northwest-southeast and which are 100 ft. or less in height. In all this northeast region the shores of the lake are sharp, clearly shaped into peninsulas and islands and underlaid with channels following the line of the dunes. In the southwest and the southeast, on the other hand, where the tropical rivers flow into the lake, in particular the Komadugu Yobe and the Shari, the shores are flat and swampy. The lake itself is composed of two basins separated by the Great Barrier, through which there is only a single permanent channel. They are shallow, being from 13 to 23 ft. deep in the northern lake, 10 to 16 ft. in the southern lake, and occasionally reaching 35 ft. But these depths vary with the area of the lake, which ranges from 3,850 to 9,946 sq.mi. The northern lake, although the deepest, may dry up altogether because the Great Barrier impedes the circulation of water from the southern. Evaporation deprives the lake of an area of water of about seven feet a year. To this must be added smaller losses through infiltration. In addition the lake is filling up with sand carried on the northeast wind, with plants, papyrus and ambatch (*Aeschynomene elaphroxylon*), and with deposits from the Shari whose delta advances at the rate of 165 to 330 ft. every year. Depending on the year, the level of the lake rises and its area extends. The highest levels were 922 and 932 ft. during the 19th century. Low from 1940 to 1950, it again rose until 1958, to the extent of flooding its banks. When the level is high the southern lake is diverted toward the lowest areas of the basin, the "low countries of the Chad," which are in the north, near Borku. This diversion is a string of basins, the Bahr el Ghazal or Soro, which is partially inundated when the lake floods. There is little salt in the waters of the lake, although the waters of the Shari contain 40 gm. per cubic metre and evaporation increases the salt content to as much as 400 gm. per cubic metre away from the delta. The banks are fertile and the lake is rich in fish. It has been thought that the lake was in danger, in the near future, of disappearing through evaporation and through being filled up by sand, river deposits and vegetation, and finally through the capture of the Logone, a tributary of the Shari at Fort-Lamy, by the Benue. When in flood the Logone is diverted westward, in the direction of the lakes Boro, Fianga and Tikem, into which flow the waters of the Kabi. These lakes empty into the Mayo-Pé, a headstream of the Benue. There does not seem to be any immediate danger of river capture and it could be prevented.

Traffic on the lake is hindered by the waves and by papyrus reeds. Although it is confined to communication with the post at Bol, various peoples live on its banks. The islands are inhabited by Yedina fishermen, better known by the name of Buduma, and by Kuri who make boats from bundles of reeds and also raise cattle. The Kanembu, in the dunes, are farmers and herdsmen and they mine natron in the natural basins.

Exploration.—Lake Chad is supposed to have been known by report to Ptolemy and is identified by some writers with the Kura lake of the middle ages. It was first seen by white men in 1823 when it was reached by way of Tripoli by Walter Oudney, Hugh Clapperton and Dixon Denham. By them the lake was named Waterloo. In 1850 James Richardson, accompanied by Heinrich Barth and Adolf Overweg, reached the lake, also via Tripoli, and Overweg was the first European to navigate its waters (1851). The lake was visited by Eduard Vogel (1855) and by Gustav Nachtigal (1870), the last named investigating its hydrography in some detail. Because of an exaggerated belief in its economic importance there was, during the partition of Africa, a "race" for Lake Chad; in 1890–93 its shores were divided by treaty between Great Britain, France and Germany. The first of these nations to make good its footing in the region was France. A small steamer, brought from the Congo by Émile Gentil, was in 1897 launched on the Shari and, reaching the Chad, navigated the southern part of the lake. A British force under Col. T. L. N. Morland visited the western or Bornu side of the lake at the beginning of 1902, and in May of the same year the Germans reached Chad from the Cameroons. In 1902–03 French officers made detailed surveys of the southeastern and eastern shores and the adjacent islands. In 1905 Boyd Alexander, a British officer, found that the lake then contained few stretches of open water. Later travelers found a good deal of open water; the extent of the water varying from year to year. One of the ancient trade routes across the Sahara from Tripoli to Kuka in Bornu strikes the lake at its northwest corner, but this has lost much of its former importance.

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CHAD, REPUBLIC OF (République du Tchad), an independent state of north central Africa, a member of the French Community, is bounded on the north by Libya, on the east by the Republic of the Sudan, on the south by the Central African Republic and on the west by the Republic of Cameroon, the Federation of Nigeria and the Republic of Niger. It has an area of 495,752 sq.mi. and a population in 1961 of 2,674,990. The capital is Fort-Lamy and other towns are Fort-Archambault, Moundou and Abéché.

Physical Features.—North of Lake Chad the country is desert, Saharan in character. The summer wet season lasts less than three months and the rainfall varies from 9.9 in. in Kanem to less than 2 in. on the Ennedi plateau. During the long, dry season the prevailing wind is the arid harmattan, blowing from the northeast. The thorny vegetation is confined to the wadies. Southward the rainfall increases rapidly to reach more than 47 in., and the Sahelian steppe of mimosas gives way gradually to a savanna where the fauna is extraordinarily rich. The watercourses are *bahrs*, permanent rivers which swell with the summer rains to flood the huge plains, making them inaccessible from July to mid-November.

The Saharan Chad is closed on the north by the Tibesti massif (*see* TIBESTI). To the south and east the plateaus are separated by sandy plains. They rise again in the Erdi and the Ennedi (4,000–4,600 ft.) where they are composed of primary and secondary sandstones rising toward the south, cut out into escarpments and eventually resting on the granite core, which reappears in the south. The valleys of the Ennedi and Tibesti converge toward the low countries of the Chad, immense plains where the sand is driven into dunes by the harmattan. The lowest-lying of these plains is the Djourab. It is only when the plateaus of the Tibesti are reached that oases appear, the most important being those of Borku.

The basin of the Sudanese Chad is divided by the dunes of Kanem, which enclose Lakes Chad and Fitri, and by outcrops of the crystalline bed, sometimes startlingly dominated by strange ridges, sometimes cut up into huge hills, as in the Wadai. These outcrops enclose on the southeast the huge marshy basin of the Bahr Aoûk, but the Shari and Logone are able to spread out their alluvial deltas in the southwest without hindrance.

The People.—In the Saharan and Sahelian regions the population includes nomadic shepherds, of whom the principal are the Teda and Daza of the Tibesti and the Ennedi; some groups spread as far as the Kanem. Farther south, Arabs have advanced as far as the Sahel. They keep camels, and those who are sufficiently near to the savanna raise cattle, migrating from north to south with the rains. Fulani (Peuls), who also keep cattle, have advanced as far as Baguirmi. The inhabitants of Kanem, in the north, cultivate millet and raise cattle, as do the Kotoko in the south; the latter also catch fish, which constitute the principal diet of the depressed peoples of the lake, the Buduma. The inhabitants of Baguirmi, Fitri and Wadai grow millet, as do the Saras and related groups, robust tribes living on the southern plains. (J. D.)

History.—The region of the eastern Sahara and Sudan from Fezzan, Bilma and Chad in the west to the Nile valley was well peopled in Neolithic times, as sites discovered attest. Probably typical of the earliest populations were the Negroid cave dwellers described by Herodotus as inhabiting the country south of Fezzan. The ethnographic history of the region is that of gradual modification of this basic stock by the continual infiltration of nomadic, and increasingly arabicized, white African elements, entering from the north via Fezzan and Tibesti and, especially after the 14th century, from the Nile valley via Darfur. According to legend, the country around Lake Chad was originally occupied by the Negroid "Sao." This vanished people is probably represented today by the Kotoko, in whose country, along the banks of the Logone and the Shari, there was unearthed in the 1950s a medieval culture notable for work in terra cotta and bronze.

The relatively large and politically sophisticated kingdoms of the central Sudan were the creation of Saharan Berbers drawn southward by their continuous search for pasturage and easily able to impose their hegemony on the fragmentary indigenous societies of Negroid agriculturalists. This process was intensified by the expansion of Islam. There are indications of a big immigration of pagan Berbers into the central Sudan early in the 8th century.

In medieval times the most important of these states was the kingdom of Kanem, immediately northwest of Lake Chad, which owed its pre-eminence to the command of the southern terminus of the trans-Saharan trade route to Tripoli. It was founded about A.D. 800 by the Sefawa dynasty, which came from Borku and claimed an ultimately Yemenite origin. Fourteenth-century Kanem was torn by internal dissensions and increasing pressure from the related Bulala kingdom of Fittri on its eastern borders. About 1380 the Sefawa dynasty was obliged to withdraw westward to reconstitute its power in Bornu (now in Nigeria), whence Kanem was reconquered by the Bulala under Mai Idris (reigned 1507–09). Kanem-Bornu achieved the height of its power under Mai Idris Alooma (reigned 1580–1603), who revived Islam and imported Turkish mercenaries and firearms. Medieval Kanem was the centre from which Islam, and with it an islamized Sudanic culture, was diffused throughout the central Sudan.

Products of this culture were the kingdoms of Baguirmi and Wadai which emerged in the early years of the 17th century out of the process of conversion to Islam. In the 18th century the Arab dynasty of Wadai was able to throw off the suzerainty of Darfur and extend its territories by the conquest of eastern Kanem. Slave raiding and trading at the expense of pagan populations to the south constituted an important element in the prosperity of all these Muslim states. In the 19th century they were in full decline, torn by continual wars and internecine feuds. Baguirmi, always a buffer between its more powerful neighbours of Bornu and Wadai, suffered most and was finally extinguished by the destruction of its capital, Massénya, by Rabah Zobeir (*q.v.*) in 1893.

Rabah, in the years 1883–93, carved out an empire which briefly comprised Kanem, Baguirmi and Wadai. By this time the partition of Africa was entering its final phase. The first French mission reached the Shari in 1891. In 1900 three French columns converged upon Chad from south, west and north. Rabah was overthrown and the traditional Kanembu dynasty was re-established under French protection. The pacification of the whole area of the present republic was barely completed by 1914, and between World Wars I and II paternalistic French rule was unprogressive. After 1945 the territory shared in the constitutional advance of French Equatorial Africa (*q.v.*).

An autonomous republic within the French Community was proclaimed in Nov. 1958, and complete independence, though still within the community, was attained on Aug. 11, 1960. (D. H. J.)

The Economy.—In addition to camels, there are large numbers of cattle and sheep in the republic. They are exported, on foot, to Nigeria, Cameroon and the Republic of Congo, while there are slaughterhouses and refrigeration plants at Fort-Archambault, Abéché and Fort-Lamy. Meat, leather and hides represent one-eighth of the value of exports. Almost all the remainder is accounted for by cotton, the principal product of the southern plains, which was introduced in 1928. Other crops of increasing importance are rice, particularly in the valley of the Logone, and peanuts.

One of the great problems of Chad is its great distance from the sea and its lack of communications. The Benue and the Shari, which are only navigable when in flood, are supplemented by tracks which are, on the contrary, impassable in the wet season. Nevertheless Fort-Lamy is joined by road to Bangui and the Ubangi river, in the direction of Brazzaville, and an east-west road links the railways of Nigeria with the Republic of the Sudan. Fort-Lamy is also a focal point for air transport. (J. D.)

CHADDERTON, an urban district of Lancashire, Eng., on the lower slopes of the Pennines, 1 mi. W. of Oldham and 5 mi. N.E. of Manchester. Pop. (1961) 32,494. It remains primarily a textile town, despite the decline in the number of cotton mills under a concentration scheme in the late 1950s. Industries also include the production of aircraft and electrical equipment. One of the largest electricity generating stations in Lancashire and Yorkshire is located there. Chadderton hall (now demolished) and Foxdenton hall were both possessed by the de Trafford family, whose name is perpetuated in Trafford park (now an industrial estate) and Old Trafford. (L. ST.)

CHADWICK, SIR EDWIN (1800–1890), English reformer, who made important contributions toward improving sanitary conditions in Britain during the first half of the 19th century. He was born at Longsight, near Manchester, Jan. 24, 1800, and was educated for the bar. His essays in the *Westminster Review* introduced him to the notice of Jeremy Bentham, who engaged him as a literary assistant. In 1832 he was employed by the royal commission on the poor laws as an investigator, and in 1833 he was made a full member of that body. In conjunction with Nassau W. Senior he drafted the report of 1834 which procured the passing of the new poor law. His special contribution was the institution of the union as the area of administration. In 1834 he was appointed secretary to the poor law commissioners. His relations with his official chiefs became much strained, and the disagreement, among other causes, led to the dissolution of the poor law commission in 1846. Chadwick's chief contribution to political controversy was his constant advocacy of entrusting certain departments of local affairs to trained and selected experts, instead of to representatives elected on the principle of local self-government. His report on *The Sanitary Conditions of the Labouring Population* (1842) is a valuable historical document. He was a commissioner of the board of health for improving the water supply, drainage and cleansing of great towns, from its establishment in 1848 to its abolition in 1854. He was made knight commander of the Bath in 1889 and died at East Sheen, Surrey, on July 6, 1890. *See* also PUBLIC HEALTH: *National Developments: United Kingdom and the Commonwealth.*

CHADWICK, FRENCH ENSOR (1844–1919), U.S. naval officer and historian, was born in Morgantown, W.Va., on Feb. 29, 1844, and entered the U.S. Naval academy at Annapolis, Md., on Sept. 28, 1861. He was the first U.S. naval attaché in London; a member of the U.S.S. "Maine" court of inquiry in 1898; and commanding officer of the U.S.S. "New York" and chief of staff to Adm. W. T. Sampson at the battle of Santiago, July 3, 1898 (*see* SPANISH-AMERICAN WAR). Regarded as a scholarly and able officer, Chadwick became a rear admiral while serving as president of the Naval War college (1900–03), and afterward commanded the South Atlantic squadron. He was the author of volume xix of the "American Nation Series," *Causes of the Civil War* (1906); *The Spanish-American War*, 2 vol. (1911); and editor of *The Graves Papers and Other Documents Relating to the Naval Operations of the Yorktown Campaign* (1916). He died in New York city on Jan. 27, 1919. (J. B. HN.)

CHADWICK, GEORGE WHITEFIELD (1854–1931), U.S. composer of the so-called New England group, whose music is rooted in the traditions of European romanticism, was born in Lowell, Mass., Nov. 13, 1854. He studied organ and music theory in Boston and in 1877 went to Germany to study under Carl Reinecke and S. Jadassohn in Leipzig and J. G. Rheinberger in Munich. Returning to America in 1880, he was engaged as instructor in music theory at the New England conservatory in Boston; in 1897 he became its director and held this post until his death in Boston on April 4, 1931. As an educator he played an important role in American music; among his pupils were Horatio Parker, Henry Hadley and F. S. Converse. He also conducted orchestral and choral concerts.

Chadwick was a firm believer in the representational meaning of music; most of his orchestral works bear programmatic titles. In his harmonic writing he followed the procedures of German romantic music; there are also some Wagnerian characteristics. In the scherzo of his Second Symphony, Chadwick made use of Negro spirituals, one of the few instances of utilization of American folk materials in his compositions.

The list of Chadwick's works is considerable and includes three symphonies (1882, 1885, 1894); the concert overtures *Rip van Winkle* (1879), *Thalia* (1883), *Melpomene* (1887), *Adonais* (1898), *Euterpe* (1903); symphonic poems *Aphrodite* (1912), *Tam o'Shanter* (1915), and *The Angel of Death* (1917); the cantatas *Phoenix expirans* (1892) and *The Lily Nymph* (1893); a burlesque opera *Tabasco* (1894); lyric drama *Judith* (1901); numerous choruses; five string quartets; a piano quintet; and many songs and organ pieces. Chadwick also published a textbook, *Harmony* (1897; revised 1922). (N. SY.)

CHADWICK, HECTOR MUNRO (1870–1947), as professor of Anglo-Saxon at Cambridge university, 1912–41, made a notable contribution to the development of an integral approach to Anglo-Saxon studies. Chadwick began his career as a classical philologist, but early turned to the history and literature of Britain in the dark ages, first the Germanic and later also the Celtic. *Studies in Anglo-Saxon Institutions* (1905); *The Origin of the English Nation* (1907); *The Heroic Age* (1912); and, in collaboration with his wife, *The Growth of Literature* (3 vol., 1932–40) are his most important works. The first two are valuable for the light they throw on the early history of the Anglo-Saxons. The third shows Chadwick developing a method of comparative literature, and, by comparison of Greek and Germanic heroic poetry, elaborating the concept of the "Heroic age" as a stage in the growth of civilization reflected in early epics. In *The Growth of Literature* this is applied to every kind of early literature, thus brilliantly illuminating the origin and development of many literary genres in Greek, Germanic, Celtic, Slavonic, Sanskrit, Eskimo, Polynesian, etc.

Chadwick always insisted on treating a civilization as a whole. Britain in the dark ages meant to him not only history and institutions, but also the literature, archaeology, art, languages, place names, etc., of all the peoples who lived there. He founded at Cambridge the School of Archaeology and Anthropology, section B, of which this total approach was the essence. He died at Cambridge, Jan. 2, 1947. (K. H. J.)

CHADWICK, SIR JAMES (1891–), British physicist who received the Nobel prize for physics in 1935 for the discovery of the neutron. He was born in Manchester on Oct. 20, 1891, and was educated at the universities of Manchester and Cambridge, studying also under H. Geiger at Charlottenburg institution, Berlin. In 1923 he was appointed assistant director of research in the Cavendish laboratory, Cambridge.

In 1927 he was elected a fellow of the Royal society and was awarded the Hughes medal in 1932. In 1935 he became professor of physics in the University of Liverpool. His discovery of the neutron (*q.v.*), a hitherto undetected constituent of the atom, electrically neutral and with a mass approximately equal to that of a proton, provided a new weapon for atomic disintegration, since neutrons, being electrically uncharged, could penetrate undeflected to the atomic nucleus.

Chadwick was knighted in 1945 and was awarded the Copley medal in 1950 and the Franklin medal in 1951. He was sometime head of the atomic energy research establishment, Didcot, Berkshire, and in 1948 was elected master of Gonville and Caius college, Cambridge. He published many researches on radioactivity and related problems and wrote (with Lord Rutherford and Sir Charles Ellis) *Radiations From Radioactive Substances* (1930).

(D. McK.)

CHAEREMON (fl. middle 4th century B.C.), Athenian dramatist, wrote comedy as well as tragedy, according to the lexicon *Suidas*, and the title of his *Achilles, Slayer of Thersites* suggests that this was a satyric drama. In the *Poetics*, Aristotle described his *Centaurus* as a rhapsody in all kinds of metres. Aristotle also observed that Chaeremon's work was intended for reading, not representation. The fragments of Chaeremon are correct in form and have an easy rhythm, but are marred by a florid style. It is not certain whether he is the author of three epigrams in the Palatine Anthology which bear his name.

For fragments of Chaeremon's work *see* A. Nauck (ed.), *Tragicorum Graecorum Fragmenta* (1926). *See* also Pauly-Wissowa, *Real-Encyclopädie der classischen Altertumswissenschaft*, vol. ix (1899).

CHAERONEA, a fortified town on Mt. Petrachus above a small modern village which was formerly called Kapraina, Greece, guarding the entry into the northern plain of Boeotia, was the scene of two important battles, both described by Plutarch, who was a native of Chaeronea. In 338 B.C. Thebes, Athens and other states made their last stand against the rising power of Macedonia (*see* GREECE, *History*). The Greek army of about 35,000 infantry held a defensive position almost 2 mi. long, stretching from the foothills east of Chaeronea to the river Cephissus; the Athenians held the left wing and the allied line of heavily armed hoplites stood eight ranks deep in the plain except on the extreme right where the sacred band of Thebans had a deeper formation on the river bank. The Macedonian infantry was less heavily armed but more mobile and better trained, and the Macedonian cavalry was far superior. Philip of Macedonia, commanding the phalanx of approximately

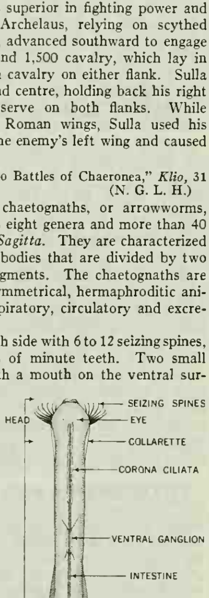
30,000 infantry, and his son Alexander, commanding the cavalry on the left wing, advanced across the plain with the line aslant so that the infantry on the right came into contact first with the Athenians. Philip then retreated with his infantry on the right, drew the Greek line forward to its left front in pursuit and created a gap near the enemy's right wing where the Thebans stood firm. Into this gap Alexander charged, and simultaneously Philip delivered a powerful attack with his phalanx and routed the Athenians. The Greek line broke in flight, the sacred band being annihilated. Having demonstrated his superiority, Philip called off the pursuit. The tomb of the Macedonians who fell fighting on the right wing is probably marked by the surviving statue of a lion sitting on its haunches.

In 86 B.C. the Roman general L. Cornelius Sulla checked the advance of Mithradates VI of Pontus. Sulla was outnumbered by three to one, but his infantry was superior in fighting power and discipline. The Pontic general Archelaus, relying on scythed chariots and squadrons of cavalry, advanced southward to engage Sulla's army of 15,000 infantry and 1,500 cavalry, which lay in the plain north of Chaeronea with cavalry on either flank. Sulla attacked first with his left wing and centre, holding back his right wing and keeping cohorts in reserve on both flanks. While Archelaus tried to overlap both Roman wings, Sulla used his reserves skilfully, broke through the enemy's left wing and caused a general flight.

See N. G. L. Hammond, "The Two Battles of Chaeronea," *Klio*, 31 (1938). (N. G. L. H.)

CHAETOGNATHA. The chaetognaths, or arrowworms, form a small phylum that includes eight genera and more than 40 species, the majority in the genus *Sagitta*. They are characterized by delicate, elongate, transparent bodies that are divided by two septa into head, trunk and tail segments. The chaetognaths are small, enterocoelous, bilaterally symmetrical, hermaphroditic animals that lack well-developed respiratory, circulatory and excretory structures.

The head is usually armed on each side with 6 to 12 seizing spines, or chaetae, and one or two rows of minute teeth. Two small dark eyes are located dorsally with a mouth on the ventral surface. The head can be covered by an epidermal layer, the hood, which is pulled forward to enclose the teeth and spines. It is retracted when the spines are used. According to L. H. Hyman a dorsal ridge of epidermal cells forms, at the head end, the corona ciliata, or ciliary loop, a structure peculiar to arrowworms. A thin clear cuticle secreted by the underlying epidermal cells covers the body. Beneath the epidermis are four principal bands of longitudinal muscle that control the swimming movements. Arrowworms swim spasmodically by a few quick flips of the caudal fin. The head musculature is complex and allows movements of the spines and teeth and the swallowing of prey. Chaetognaths are predaceous, feeding principally on copepods, other small crustacea and occasionally fish larvae. The mouth opens into a short pharynx that leads directly into a straight intestine, which terminates in an anus at the septum between the trunk and tail. A medial mesentery extending dorsoventrally supports the alimentary canal and continues into the tail segment. The nervous system consists of a cerebral ganglion with lateral nerves. One pair extends posteriorly and connects with a large ventral ganglion on the surface of the trunk. Additional nerves leave the ventral ganglion and spread over the surface of the body.



ARROWWORM (SAGITTA BIPUNCTATA). 12 MM. LONG

Both ovaries and testes are found in all chaetognaths. The ovaries are attached on either side of the posterior portion of the trunk cavity; when mature they may extend forward half the length or more of the trunk. An oviduct lies on the outer side of each ovary. The oviduct encloses a sperm tube that allows the sperm to penetrate the ovary and fertilize the mature eggs. Cross fertilization has been observed in one species (*Spadella cephaloptera*). The fertilized eggs press through the walls of the oviduct and move posteriorly, leaving the oviduct near the tail septum. The testes, which lie along either side of the tail segment, are separated from the ovaries by a septum that divides the trunk and the tail. Clusters of motile sperm are budded off the anterior ends of the testes. These sperm balls circulate in the tail cavity of many species, finally passing through a sperm duct to the seminal vesicles, where they are stored prior to discharge. The fertilized eggs are laid in small numbers and drift in the sea until they hatch a day or two later. Development is direct; the young chaetognath is 1 mm. or less in length and resembles the adult.

Although limited in number of species, chaetognaths are extremely abundant in all the oceans and seas of the world. They have been reported from the open ocean in quantities of less than one to several per cubic metre of water. Nearer shore they are often more numerous. A size gradient is also evident. Mature specimens of 5 mm. or less are taken in tropical waters. In contrast, in deep water or in arctic or antarctic waters specimens of 20 mm. and over are common. By volume chaetognaths form an appreciable fraction of the zooplankton and without doubt are important in the economy of the sea. They are also useful as indicators of water movements in certain localities.

Establishing the correct phylogenetic position for the chaetognaths is difficult. Various authors have related them to a number of phyla including the annelids, arthropods, mollusks, echinoderms and chordates. Superficially their resemblance to nematodes is notable. The covering of cuticle, the longitudinal bands of muscle in the elongate body, the straight intestine, together with the lack of many organs form the basis for this similarity but the presence of a coelom, the three divisions of the body, the well-developed head and distinctly different reproductive system hinder including them in the same group as the nematodes.

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CHAETOPODA, originally a zoological class, including all the Annelida (*q.v.*), except the Echiurida (*q.v.*). Later it was used by some workers to cover the classes Archiannelida, Polychaeta, Oligochaeta, Hirudinea (leeches) and Myzostomidae, and by others to include only the Polychaeta and Oligochaeta. The characteristic feature of Chaetopoda is the possession of bristles (setae). The term is now obsolete.

CHAFARINAS (ZAFARIN) ISLANDS (Arabic, DJAFERIN), a group of three small rocky islands off the northeastern coast of Morocco, Africa, 6.8 mi. N.W. of the mouth of the Wadi Moulouya. Pop. (1950) 67. They are probably the *três insulae* of the *Antonini Itinerarium*, a Roman roadbook of the 3rd century A.D. Occupied by Spain since 1847, they form a semicircle off Cabo del Agua, providing the best anchorage along this coast. They are waterless, uncultivated and almost without vegetation. The largest island, Congreso, to the west, and the smallest, Rey, to the east, are uninhabited, Rey serving as a cemetery. The central island, Isabella II, dominated by a lighthouse, contains the garrison, all their provisions and water being sent from Spain.

To improve the anchorage, Isabella II and Rey were formerly joined by a breakwater, which was breached by a storm in 1914. (J.-J. Ds.)

CHAFEE, ZECHARIAH, JR. (1885–1957), U.S. lawyer, scholar and teacher, known for his writings on civil liberties, was born at Providence, R.I., on Dec. 7, 1885. Graduating from Brown university in 1907, Chafee was associated briefly with his father's foundry business, but in 1910 he entered the Harvard law school, from which he graduated in 1913. In the fall of 1916 he was called from the Providence bar to the faculty of that school, where he made equity, negotiable instruments and unfair competition his principal subjects of interest and instruction. It was in his work in equity that Chafee first found himself concerned with the problems of free speech, issues to which he devoted much of his attention throughout the rest of his career. His first book on this subject, *Freedom of Speech* (1920), which was rewritten and republished as *Free Speech in the United States* (1941), quickly became the leading text of U.S. libertarian thought and did much to affect the development of constitutional law. The vitality of Chafee's achievement came in considerable part from his broad cultivation, his abundant learning in Anglo-U.S. history and his technical competence as a lawyer. His notable gifts as legal historian were best shown in his introduction to the *Records of the Suffolk County Court, 1671–1680* (1933). His technical proficiencies as lawyer were revealed in the federal Interpleader act of 1936, of which he was the draftsman. Among Chafee's other writings were: *The Inquiring Mind* (1928); *Some Problems of Equity* (1950); *Blessings of Liberty* (1956); *Government and Mass Communications*, 2 vol. (1947). He died in Boston on Feb. 8, 1957. (M. DeW. H.)

CHAFER, a term used to distinguish the beetles of the family Scarabaeidae, and more especially those species which feed on leaves in the adult state. For the characteristics of the Scarabaeidae, *see* BEETLE. This family includes a large number of beetles, some of which feed on dung and others on vegetable tissues.

The cockchafers (*q.v.*) and their near allies belong to the subfamily Melolonthinae, and the rose chafers to the Cetoniinae; in both, the beetles eat leaves, and their grubs spend a long life underground devouring roots. In Europe the Melolonthines that are usually noted as injurious are the two species of cockchafer (*Melolontha melolontha* and *M. hippocastani*), large heavy beetles with black pubescent prothorax, brown wing covers and an elongated pointed tail process; the summer chafer (*Amphimallon solstitialis*) is a smaller pale brown beetle.

In the United States, Melolonthines of the genus *Phyllophaga* (popularly known as May beetles or June beetles) may do considerable damage to strawberries, corn (maize), wheat, grass crops and nursery stock. The most important species is probably *Phyllophaga rugosa,* which frequently is very destructive to corn.

In the spring the adult chafers fly about during the night, mating and feeding on foliage; they return to the soil at daybreak. After mating, the female crawls one to several inches into the soil to lay her pearly white eggs. The larvae—heavy, soft-skinned grubs, with hard brown heads provided with powerful mandibles, three pairs of well-developed legs and a swollen abdomen—appear in two to three weeks. As they grow, they become strongly flexed toward the ventral surface, and lie curled up in their earthen cells, feeding on roots. The larval life lasts several years, and in hard frosts the grubs go deep into the soil.

Pupation takes place in the autumn, and though the perfect insect emerges from the cuticle very soon afterward, it remains in its underground cell until summer. The grubs of chafers, when turned up by the plow, are greedily devoured by poultry, pigs and various wild birds.

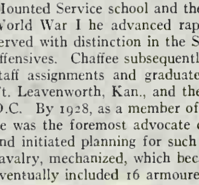
CHAFFEE, ADNA ROMANZA (1842–1914), U.S. army officer, was born April 14, 1842, in Orwell, O. He enlisted in the 6th cavalry regiment July 22, 1861, and was a member of that regiment for 25 years. It was with the army of the Potomac through most of the Civil War. Chaffee was commissioned 2nd lieutenant in May 1863, was wounded and taken prisoner at Gettysburg, refused to be paroled and was abandoned with other wounded. On Feb. 22, 1865, he was made 1st lieutenant.

After the war the 6th cavalry was sent to Texas, and in 1867 Chaffee resigned, planning to enter private business. He was persuaded to change his mind, was restored to his rank, and served in the southwest until the Spanish-American War broke out, rising to the rank of lieutenant colonel. He served in the Spanish-American War, and at its conclusion was made chief of staff of the military governor of Cuba until May 1900. He became a colonel in May 1899.

Chaffee commanded the U.S. troops in China during the Boxer uprising, and was military governor of the Philippine Islands July 1901–Sept. 1902. In 1904 he was promoted to lieutenant general and detailed as chief of staff. He retired Feb. 1, 1906, and died in Los Angeles, Calif., Nov. 1, 1914.

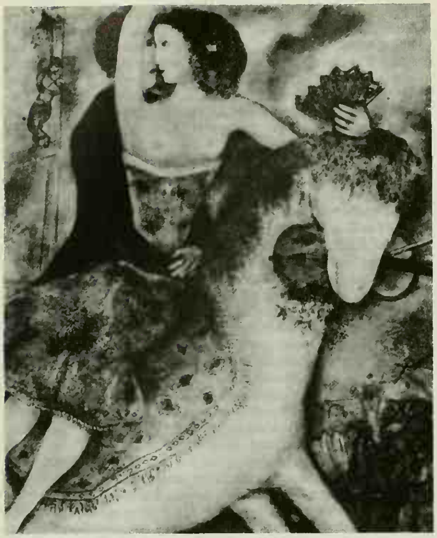
CHAFFEE, ADNA ROMANZA (1884–1941), U.S. army officer who is remembered as the "father of the armoured force," was born on Sept. 23, 1884, in Junction City, Kan., the son of Gen. A. R. Chaffee (*q.v.*). He accompanied his father during the Boxer Relief expedition in China. Graduating from the U.S. Military academy in 1906, he was commissioned in the cavalry. Outstanding skill as a horseman soon led to his assignment to the Mounted Service school and the French Cavalry school. During World War I he advanced rapidly to the grade of colonel and served with distinction in the St. Mihiel and the Meuse-Argonne offensives. Chaffee subsequently held many important troop and staff assignments and graduated from the School of the Line, Ft. Leavenworth, Kan., and the Army War college, Washington, D.C. By 1928, as a member of the war department general staff, he was the foremost advocate of an armoured force of all arms and initiated planning for such a force. Later he joined the 1st cavalry, mechanized, which became the nucleus of the force that eventually included 16 armoured divisions and 139 separate battalions. Chaffee, who was promoted through the grades to major general, died in Boston, Mass., on Aug. 22, 1941. The decisive role of U.S armour in the great campaigns of World War II testifies to the soundness of Chaffee's ideas. (P. M. Rt.)

CHAFFINCH, a bird (*Fringilla coelebs*), belonging to the finch (*q.v.*) family (Fringillidae), distinguished, in the male sex, by the deep grayish-blue of its crown feathers, the yellowish-green of its rump, two conspicuous bars of white on the wing coverts and the pinkish-brown passing into wine-red of the throat and breast. The female is drab, but shows the same white markings as the male; the young males resemble the females until after the first autumn molt. The chaffinch breeds early, and its song may be heard in late winter. The nest—moss and wool, lined with grass and feathers—is built on low trees and bushes. It lays four or five eggs of a pale bluish buff, streaked and spotted with purplish red. In spring the chaffinch is destructive to early flowers, and to young radishes and turnips; in summer it feeds on insects and their larvae, while in autumn and winter its food consists of grain and other seeds. On the continent of Europe the chaffinch is a favourite songbird. In winter chaffinches form small flocks, often composed solely of males. The continental chaffinch (*F. c. coelebs*) ranges generally over Europe to tree limit in the north, wintering southward. The British chaffinch (*F. c. gengleri*) is a breeding resident. Allied races are found in northwest Africa, the Canaries, Azores and Madeira islands. (G. F. Ss.)


M. S. WOOD

CHAFFINCH (FRINGILLA COELEBS)

CHAGALL, MARC (1887–), one of the important painters of the 20th century, was born of Jewish parents at Vitebsk, Belorussia, on July 7, 1887. From 1907 to 1910 he studied in St. Petersburg, for a while with Léon Bakst, then left for Paris. The idiom of his early pictures ("Death," 1908; "Birth," 1909) was strengthened and clarified by contact with the paintings of Gauguin, Van Gogh, the Fauves and, in 1911, the Cubists. Then his pictures became "constructions" based on the expressive quali-



BY COURTESY OF THE STEDELIJK MUSEUM, AMSTERDAM, NETH

"THE CIRCUS" BY MARC CHAGALL, ONE OF A SERIES OF PAINTINGS COMPLETED 1956–59. IN THE P. A. REGNAULT COLLECTION, STEDELIJK MUSEUM, AMSTERDAM, NETH.

ties of both pictorial and formal elements. The pictorial elements derived from childhood experiences in the small Russian-Jewish town, from impressions transmitted through the icon, or from spontaneously created images of symbolic meaning; and they combined with formal elements by virtue of their inner poetic force, rather than according to the rules of logic. This art, which preceded Surrealism, is an expression of psychic reality ("I and the Village" and "Hommage à Apollinaire," 1911).

In 1914 Chagall returned to Vitebsk ("Above Vitebsk," 1914) and, after the Revolution, an increase in the compositional freedom of his work (murals, State Jewish theatre, Moscow, 1918) may be noted. In 1922 he left Russia for Berlin, where he made his first lithographs and engravings ("My Life"). These were followed, in Paris, where he lived from 1923 to 1941, by "Dead Souls" (1923–27), "Fables of La Fontaine" (1927–30) and "The Bible" (1931–56). Contact with France increased the purely painterly features of his art; and flowers, dreamlike scenes of lovers and animals became the principal motifs. At the same time, themes of religious significance made their appearance ("Falling Angel," 1923, 1933, 1947; "Crucifixions," 1939–43). An autobiography he had written in Russia was published in France in 1931 as *Ma Vie*. From 1941 to 1948, Chagall lived in the United States creating scenery and costumes for the ballets *Aleko* and *Firebird;* then, in 1950, he settled at Vence, France ("Paris" cycle, 1951–53; new biblical paintings, 1949–56; circus series, 1956–59; scenery and costumes for the ballet *Daphnis and Chloe,* 1958). During this period his work showed a heightened psychic reality, expressed through colour, as well as intensified symbolic meaning.

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CHAGAS' DISEASE: *see* TRYPANOSOMIASIS.

CHAGGA, an important Bantu-speaking Negro tribe, numbering about 240,000, who live on the southern slopes of Kilimanjaro in northern Tanganyika. In pre-European days they perfected a system of irrigation which carried water many miles by conduit from the mountain to their banana and millet gardens. Efficient crop production permitted a high population density. Since the 1920s, coffee has been an important cash crop and the people are now extremely wealthy in comparison with their neighbours.

The Chagga have an elaborate system of initiation for boys and girls, and age sets (*q.v.*) are instituted every ten years or so.

The people are descended from immigrants of various tribes who migrated into the once forest-covered foothills. Most of the 400 main clans are of Kamba origin; others are from Teita, Masai (*q.v.*) and other tribes. Neighbouring groups were thus diverse in origin, culture and language and formed distinct political entities which generally controlled their own system of irrigation. There was much intermingling and also warfare between groups. The original leaders of the immigrant clans were later succeeded by chiefs, who sometimes controlled more than one clan, but there was no paramount chief until Marealle was established in this position by the German administration in 1893. Thomas Marealle, son of the first paramount, was paramount chief from 1951 to 1960 when the office was abolished in favour of a tribal council with an elected president. *See* also AFRICA: *Ethnography* (*Anthropology*): *East Africa.*

BIBLIOGRAPHY.—C. C. F. Dundas, *Kilimanjaro and Its People* (1924); O. F. Raum, *Chaga Childhood* (1940); B. Gutmann, *Das Recht der Dschagga* (1926); J. E. Goldthorpe, *Outlines of East African Society* (1958). (J. F. M. M.)

CHAHAR (CH'A-HA-ERH), a province of the Inner Mongolian region of China from 1929 to 1952, then absorbed by the Inner Mongolian Autonomous Region, Hopeh and Shansi provinces. Area (1948) 107,705 sq.mi., pop. (1948 est.) 2,185,774. Except for the southern tip, now within Hopeh, it lies outside the Great Wall, spreading east into the Greater Khingan mountains and elsewhere to the Mongolian plateau and the basin of the Gobi desert. Essentially Mongol grazing lands, the area has been increasingly penetrated by Chinese farmers, merchants and administrators since the 17th century. Kalgan (Chang-chia-k'ou) is Peking's closest gateway, marked by the Peking-Suiyuan railway. Good quality iron ore is mined at Hsuanhua, 90 mi. N.W. of Peking. A new regional industrial centre is rising in the Silingol Mongol league on the eastern border at Silinhot (pop., 1953, 9,000) while the railway to Ulan Bator, completed in 1955, joins the Outer Mongolian line at P'ang-pei on the northwest border. (TE. H.)

CHAIKOVSKI, NIKOLAI VASILIEVICH (1850–1926), Russian socialist whose life exemplifies the ironic fate of the Russian intelligentsia of his time, as he was one of the spiritual mentors of the Narodniki (Populists) in his youth, but ended his political career fighting communism as vehemently as he had once opposed tsarism, in the cause of democracy and ethical socialism. Born at Vyatka on Dec. 26, 1850, Chaikovski joined a radical students' circle in St. Petersburg in 1869 and subsequently became its leader, so that it took his name. His followers, disillusioned by the terrorist extremism associated with the ruthless S. G. Nechaev, at first welcomed Chaikovski's emphasis on moral self-improvement, but later swung to the left, favouring active revolutionary propaganda among the masses. Considering this development premature, Chaikovski broke away and became converted to a new "religion of humanity," an idealistic blend of Comtian positivism and the millennarianism characteristic of the sectarian Raskolniki. To test his beliefs in practice and point the way to the perfect future society, he emigrated to the United States in 1873 and established a small socialist commune in Kansas (1875). The experiment soon failed; Chaikovski, returning to western Europe, now sought to realize his former ideals by more conventional methods of political action. As his views mellowed, he became more appreciative of democratic institutions and political liberties. He returned to Russia in 1907 and subsequently played a leading part in the cooperative movement.

During 1917, as a leader of the Popular Socialist party and an ardent opponent of the proposals for a separate peace for Russia in World War I, Chaikovski tried to combat the growing influence of the Bolsheviks, whose November *coup* he condemned as a tyrannical usurpation of power from the democratically elected constituent assembly, of which he was a member. It was in this capacity that in Aug. 1918 he took office as head of the provisional White administration in northern Russia, at Archangel. His socialist tendencies earned him the distrust of the military, upon whose support his regime rested, and of the British and French representatives, who urged the paramount importance of prosecuting the war; meanwhile, material hardships were causing growing popular dissatisfaction. Unable to maintain the precarious balance between rival pressures, Chaikovski left for Paris (Jan. 1919), where he represented his government at the peace talks, and then for Ekaterinodar (Krasnodar), where, despite opposition from his fellow socialists, he accepted office under Gen. A. I. Denikin. He died in England, at Harrow, on April 30, 1926.

See A. A. Titov (ed.), *N. V. Chaikovski*, 2 vol. (1929); L. I. Strakhovsky, *Intervention at Archangel* (1944). (J. L. H. K.)

CHAIN, ERNST BORIS (1906–), biochemist of Russian origin, was awarded the Nobel prize for physiology and medicine in 1945, jointly with Sir Alexander Fleming and H. W. (later Sir Howard) Florey, for his prominent part in researches on penicillin. His contributions to biochemical science include studies on the mode of action of snake venoms, spreading factor and insulin, and researches on antibiotics and various submerged mold fermentations. Born in Berlin on June 19, 1906, he studied chemistry and physiology at the Friedrich-Wilhelm university there and after researches in the chemical department of the Institute of Pathology at the Charité hospital, Berlin, during 1930–33, he went to England where at first he worked under Sir Frederick Gowland Hopkins in the school of biochemistry at Cambridge. In 1935 he became university demonstrator and lecturer in chemical pathology at Oxford university and in 1948 was appointed scientific director of the International Research Centre for Chemical Microbiology, at the Istituto Superiore di Sanità, Rome. As well as being a Nobel prize winner, he was made a commander of the Legion of Honour and in 1954 received the Paul Ehrlich centenary prize. He was elected a fellow of the Royal society in 1949.

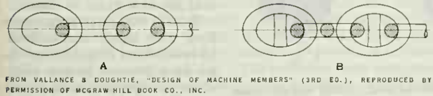
(R. A. P.; X.)

CHAIN, a series of links, usually of metal, joined together to form a flexible connector. The chain may be formed by interlocking welded or knotted loops or cast links, or by pinning together formed links. In general, chains may be considered in two classes: (1) those used for binding, hoisting, holding, supporting or retaining; and (2) those used in transmitting power or conveying materials.

Thousands of miles of chain are in daily use throughout the world—from tiny fancy jewelry chain to massive anchor chains for ocean liners, from miniature drive chains in delicate control mechanisms to huge "silent" chains weighing more than 50 lb. per foot and transmitting thousands of horsepower.

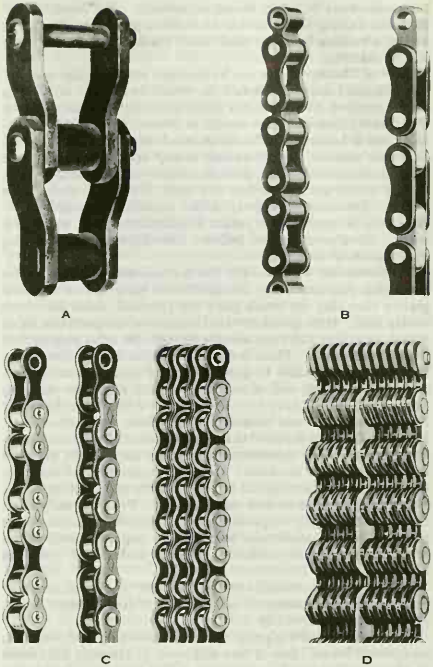
General Chain Types.—*Crane Chain.*—Without any restrictive term, chain usually refers to the first class, *i.e.*, coil chain (fig. 1[A]). For applications where failure might be dangerous to life or property chains known as crane chains, made from a high-grade wrought iron, are used. This type is intended for slings, cranes, power shovels and marine uses, as in anchor chain. The wrought iron has high ductility, weldability and rust resistance, properties desirable for high-grade chain. The ductility allows the links to deform, making it possible to detect an overload before complete failure of the chain. In operation such a chain may gradually stretch without failure, but a work-hardening effect occurs. When the stretch reaches a certain percentage of the total length, the chain either must be annealed to restore its ductility and usefulness or must be replaced.

For practically all uses, handmade chain of the smaller sizes—made of materials $\frac{3}{8}$ in. or less in diameter—has been replaced by machine-made chain; for this type, the links are formed, interlocked and welded automatically.



FROM VALLANCE & DOUGHTIE, "DESIGN OF MACHINE MEMBERS" (3RD ED.), REPRODUCED BY PERMISSION OF MCGRAW HILL BOOK CO., INC.

FIG. 1.—HOISTING CHAINS: (A) COIL CHAIN, (B) STUD-LINK CHAIN



(A) FROM "PRINCIPLES OF MECHANICAL POWER TRANSMISSION"; REPRODUCED BY PERMISSION OF POWER TRANSMISSION COUNCIL, (B AND C) BY COURTESY OF DIAMOND CHAIN COMPANY, INC., (D) BY COURTESY OF LINK-BELT CO

FIG. 2.—TYPES OF CHAINS: (A) EWART LINK WITH BUSHING, (B) BLOCK CHAINS, (C) ROLLER CHAINS, (D) SILENT CHAIN

Proof-Coil Chain.—For general construction, railroad and forestry work, proof-coil chain is employed. The links are formed from steel, generally of the open-hearth type, with a low phosphorus and sulfur content.

Anchor Chain.—Also known as cable or stud-link chain this is made from links having a bar or stud across the inside width of each link. This bar keeps the chain from fouling or kinking, adds weight to the link and prevents the link from deforming under a relatively light load. It does not increase the breaking strength of the chain. (*See* CABLE.)

Weldless Chain.—This type includes a wide range of styles such as knotted chain, stamped link chain, bead chain and jewelry chain. Knotted chain is usually made on automatic machines which cut, thread and tie the wire to form the completed strands. Made only in the small sizes, it has replaced welded chain to a large extent due to its lower cost. Bead chain finds use in electric fixtures, key chains and other small articles, as well as in light-load drive units where motion in any direction may be desired; it consists of hollow balls connected by solid bars, the bars having upset or balled ends. Stamped link chain, such as sash chain, is a low-cost, moderate strength chain made automatically from links stamped and formed from metal strip.

Testing of Chain.—Proof-coil and crane chains are generally given a proof test by the manufacturer. Large purchasers of chain have established specifications giving definite loads under which the chains must be tested before acceptance. The American Society for Testing Materials has established proof test, break test and safe working loads for chain made from bar stock of $\frac{1}{4}$ in. to 2 in. in diameter.

Care of Chain.—Chain can be damaged easily by improper use. For industrial use chain should be wound on sheaves or winding drums grooved to receive the links smoothly without twisting. The sheaves should be large enough to prevent bending in the links, and kinks or knots should be straightened out. Twisting and dragging over metallic objects, as well as any action which nicks the links, damages the chain. Even in normal use a peening or hammering action occurs between the links, tending to make them brittle. Annealing at intervals under carefully controlled conditions may be necessary to reduce this brittleness and work-hardening. Good practice also includes lubrication of chain passing over sheaves or drums.

Transmission Chain.—For the transmission of power or for conveying purposes where the shafts are separated at distances greater than that for which gears are practical, chain drives are widely used. Here sprockets take the place of the gears but, being widely separated, drive one another through the chain passing over the sprocket teeth. These drives are positive in that there is no slip, yet are adaptable to greatly varying centre distances and, to a limited extent, will absorb shocks from a rapidly changing load. Chain drives have been in use about 2,000 years, but most progress in design and manufacture has been made since 1900. Leonardo da Vinci designed chain drives used in Europe in Shakespeare's time. The invention of the safety bicycle, the horseless carriage and farm machinery and the introduction of assembly lines in factories provided an impetus for the development of the high-quality drive chain now manufactured. From the early crude chains to the highly improved, precision-made products of the mid-20th century efficiencies have steadily improved until figures of 98% to 99% are commonly achieved under good operating conditions.

Although many varieties are in service, the types most generally used for power transmission fall into one of four groups: Ewart, block, roller and silent (fig. 2).

Ewart Chain.—Principally used for conveying and elevating equipment, Ewart chain is also employed to transmit light loads at speeds under 400 ft. per minute. The open-link type uses a one-piece cast link, unmachined, which can be assembled or disassembled at will. Use of a pin to form a closed-link, or pintle, chain improves the life and performance.

Block Chain.—On low-speed, light-load drives the block chain is an improvement over the Ewart type. Maximum speeds may run up to 900 ft. per minute. This chain consists of solid or laminated blocks connected by side plates and pins, the sprocket teeth engaging the blocks and the pitch being the centre-to-centre distance between alternate pins.

Roller Chain.—More accurate timing and higher speeds require the use of roller chain or silent chain. Roller chain is basically a development of the block chain wherein the block is replaced by two side plates, a pair of bushings and rollers. This type of chain is adaptable to widely varying needs, from small-strand drives for microfilm projectors to large multiple-strand chain for heavy-duty service in oil field equipment.

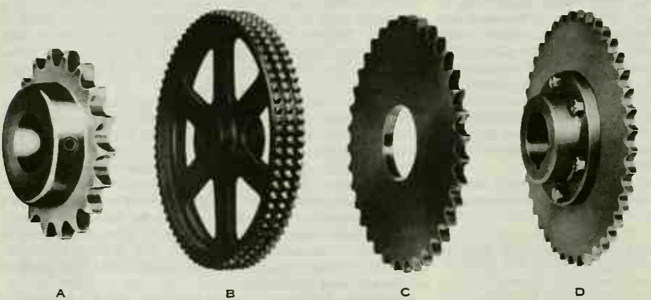
In order to run at speeds up to 4,000 ft. per minute it is necessary for all parts of the chain to be made with extreme accuracy. The bushings, pins and rollers are ground to close tolerances and the chain is run over balanced cast-iron or steel sprockets having carefully machined teeth. The use of high-quality steels creates chains with ultimate tensile strengths ranging to more than 100,000 lb. for the 3-in. pitch chain. Where increased power requirements must be met without increasing the pitch, a wide chain using multiple strands can be employed. Because the shorter pitch permits a greater number of teeth for a given sprocket diameter and a reduction in drive weight, quieter and smoother operation is attained.

The sprocket is a wheel with teeth shaped to mesh with the chain (fig. 3). Accurately made sprockets are as essential to good operation and long life as good chain. Four types, depending on the hub arrangement, are in general use, with webbed or solid disks available. Sprockets with more than 17 teeth are normally required for best operation, while the nominal maximum is around 125. A small amount of wear in the chain will cause improper tooth action when using excessive numbers of teeth. It is also universal practice to use sprockets with uneven numbers of teeth and chain with an even number of links where possible in order to distribute the wear uniformly. Another feature contributing to difficulty in operation is the chordal action which is especially disturbing in large-pitch, small-sprocket installations. This occurs because the links behave as chords of circles upon entering and leaving the sprocket rather than bending smoothly around the circular surface. Idler sprockets and flat guides may be used to control chain whip.

Silent Chain.—The term silent chain is used to describe a type of chain which, while not exactly silent, is much quieter in operation than other transmission chains. Also known as inverted tooth chain, it consists of a series of inverted tooth links or laminations which mesh into place and seat between the sprocket teeth. In contrast to roller chain the tooth engagement is a gradual sliding action. The links are joined by bushed round pins or combinations of seat and rocker pins. These constructions have been developed to minimize the wear which occurs in the joints. Most silent chain is designed so that straight-sided jaws of the links mate with straight-sided teeth of the sprockets; however, curved (involute) profiles on the teeth engaging straight-sided links also are employed. Such profile changes reduce the chordal action and make possible increased operating speeds. The most economical speeds for silent-chain operation are from 1,200 to 1,500 ft. per minute, but enclosed, well-lubricated drives may be operated up to 5,000 ft. per minute. At speeds below 1,200 ft. per minute it is normally more economical to use standard roller chain.

One feature of silent chain is its variable width. The laminated construction of the links permits the chain to be built up to any desired width to transmit the required power. Thus, installations up to 2,000 h.p. are readily designed on the basis of the manufacturer's ratings of permissible load per inch width of chain.

Roller-chain drive components have been highly standardized; however, silent chain and sprockets have involved greater differences of construction and each manufacturer has carried out his



BY COURTESY OF DIAMOND CHAIN COMPANY, INC.

FIG. 3.—ROLLER-CHAIN SPROCKETS: (A) HUB ON ONE SIDE; (B) SHORT HUB ON ONE SIDE, LONGER HUB ON OTHER SIDE; (C) WITHOUT HUB; (D) WITH DETACHABLE HUB

own design and ratings. Consequently, there is less interchangeability among various makes of silent chain. *See* also POWER TRANSMISSION: *Power Transmission, Mechanical.* (F. J. B.)

See Association of Roller and Silent Chain Manufacturers, *Design Manual for Roller and Silent Chain Drives* (1955).

CHAINAT, the name of both a province (*changwat*) and its capital in the western part of central Thailand. The area of the province is 1,018 sq.mi. and its population in 1960 was 241,025. Chainat, along with other provinces on the Bangkok delta plain, is noted for the production of rice, corn, oil seeds and hogs. Agriculture is limited because much of the surface is covered with loams that do not hold water as well as does the Bangkok dark heavy clay. The town of Chainat is on the left bank of the Chao Phraya river, 155 mi. north of Bangkok. It had a population of 24,213 in 1947. In 1957 a concrete dam was built across the river a few miles downstream from the town. (T. F. B.)

CHAIN STORE. The chain store is a type of retail operation that links together a central unit with warehouse units and retail stores (selling units). The central unit contains the administrative offices. Physical handling of inbound shipments and outbound orders to stores, along with some buying, are functions of the warehouse units. The actual selling and related operations are performed in the separate retail units.

The retail units may be highly uniform as to physical size, arrangement and inventories, or they may combine several diverse forms. They may consist of department store units or they may be a series of stores selling only food or drugs. But all have one basic principle in common: enough units to permit the physical separation of central office from warehouse and from retail selling units. In sales volume, chains may vary from a few million dollars per year to the multibillion-dollar giants such as Sears, Roebuck and company and the Great Atlantic & Pacific Tea company.

Chain stores may be classified as corporate or co-operative. The term co-operative chains refers to those arrangements whereby either wholesale middlemen or independent retailers or combinations thereof act as the sponsors. This article deals mainly with the corporate chain.

The corporate chain store as a type of retailing institution has been called one of the revolutionary developments in marketing. However, the chain actually evolved from other marketing developments. But even if it is not truly a revolutionary development it is at least one of the most significant in the whole marketing field. Together with the department store and the mail-order company, the corporate chain store represents the first successful application of large-scale integrated methods to a form of retailing.

UNITED STATES

Operating Characteristics.—The success of the corporate chain form of marketing operation is due to the following factors: (1) low selling prices; (2) reduced operating costs; (3) improved retailing practices; (4) extensive use of advertising; (5) distribution of risks; and (6) experimentation with new marketing methods.

The chain's greatest advantage resides in reduced selling prices for comparable quantities and qualities of merchandise. (This does not mean, of course, that corporate chains have lower prices than other retailers for everything they sell.) These lower selling prices may result from lower operating costs, better buying based on financial strength, the ability to use specialists and better knowledge of consumers' demands. By emphasizing larger volume per store, chains usually have worked on lower operating profit margins than other retailers.

The corporate chain placed emphasis on reduced operating costs in relation to sales in fields of retailing where high costs were common. Its achievement of lowered costs resulted from larger sales volume and from other factors. The corporate chain successfully persuaded customers to trade in stores offering fewer free services. It also emphasized fast turnover of goods and utilized division of labour advantageously. The corporate chain made excellent use of integration by owning or leasing motor trucks and by setting up wholly owned subsidiaries either to buy or to manufacture goods. By operating many unit stores, chains made use of widespread advertisements at low costs. Of special significance was the flexibility of the corporate chain in being able to transfer goods, operating methods and personnel among stores at different geographical locations.

Some of the corporate chain's most significant innovations were in the area of improved retailing practices. From its inception, one of these was the clean, modern-appearing, well-planned store utilizing excellent layout and arrangement, bright colours inside and out, modern interior illumination and good physical equipment. The average investment per store of the National Tea company (a food chain) in 1920 amounted to $5,000, compared with more than $100,000 by the mid-1950s, indicating the continued emphasis on store improvement. The corporate chain developed techniques for selecting and training both clerical and managerial personnel. Successful operation involved also careful study, analysis and experimentation in selection of store locations. The corporate chains used government grades in selling goods and greatly expanded the varieties of merchandise carried.

The corporate chain, with its large total sales volume, large volume per store and wide geographical coverage, is in a position to use advertising extensively and effectively. These advertisements are then related to promotion and display within the store. The chains use advanced research methods in evaluating the effectiveness of such advertisements.

The corporate chain may secure good distribution of market risks by diversifying locations and by market research. In addition, the chain often can reduce insurance burdens by combining unlike risks.

One of the most important contributions of the chain is the knowledge gained through experimentation with new marketing methods. Experiments can be carried on in pilot stores and the problems can be reduced or eliminated with little or no effect on the chain's overall operation. Then the new experiment can be extended, if successful, to the entire corporate chain.

Influence on Economy.—In its effect on direct competition the corporate chain started some significant marketing trends. The success of the corporate chain stimulated independent retailers and wholesalers to evolve a similar form of organization—the voluntary co-operative chain—which permitted the independent retailer in effect to apply the principle of the corporate chain to his own needs while maintaining his independent identity. Independent retailers who did not join voluntary chains responded directly to trends introduced by the corporate chain. Thus, independents modernized store appearance and layout to match or exceed corporate chain standards. In addition, many independents adopted similar price policies. The success of the corporate chain was such a shock to its competitors that it caused a revitalization of the competitors' management operations and marketing outlook. This revitalization was one of the most progressive aspects of retailing history in the second quarter of the 20th century.

Corporate chains affected wholesalers in the following ways: (1) by causing them to form wholesaler-sponsored voluntary chains; (2) by causing them to use other forms of integration, such as private branding; and (3) by forcing them to eliminate or change services in order to build up sales volume and to reduce costs.

Several effects were felt by producers and manufacturers. Farmers were faced with buyers who could and often did dominate particular markets. But, on the other hand, the chains helped farmers by stimulating sales, especially of surplus crops. By use of their own private brands they affected manufacturers. Their ability to enter into production exerted significant influence over their competitors regardless of whether they used it to secure benefits of integration, to exert undue pressure on suppliers or to serve as a threat to induce price concessions. The corporate chains' influence extended also to various service industries—transportation, storage, finance, etc. Through direct ownership of facilities or direct pressure of its accumulated demand for services, the corporate chain upset existing relationships and caused new relationships to be formed.

Finally, the corporate chain gave the consumer better stores in terms of appearance, modernization, etc. It gave the consumer an opportunity to choose stores providing fewer free services with lower selling prices. The competition so created improved the quality of the entire retailing structure. On the other hand, corporate chains sometimes used their weight to exact unethical advantages while their competitors, in attempts to curb the chains, frequently supported uneconomic legislation which, in turn, worked against the best interests of the consumer. The net total social costs have yet to be measured.

Important Trends.—The corporate chain has played a large part in furthering the following developments:

Use of Chain-Controlled Brands.—These may be carried under direct identification or under subsidiaries' names. Under either form, competition has been stimulated, chains' reputations have been enhanced and consumers' range of choice has been widened.

Support of Government Grades and Grade Labeling.—As used and publicized, these have been useful in giving consumers more objective information on which to base price comparisons. In addition, they have made possible much more effective packaging and thus more effective use of self-service principles.

Experiments in Widening of Merchandise Lines.—The corporate chain, together with other retailing units, has been among the leaders in experimenting in the sale of products not usually associated with their basic line of business. A greater variety of goods adds to profit margins, attracts customers, increases average sales per customer and creates competition among types of stores not normally competitive.

Experiments in Physical Arrangements.—As the size of store and average sale per customer increased, the corporate chain has had to experiment continually with new physical arrangements. Examples are special shelving, store directories, check-out stands, mechanized movements of goods within stores and windowless stores.

Innovations in Unit and Method of Sale.—It is claimed that corporate chains have been leaders in changing sale of fresh fruits and vegetables from a unit to a pound basis. The influence of self-service on prepackaging of many items has also been considerable. These changes affect sales, change consumption habits and create a demand for new packaging materials and methods. *See* also MARKETING. (D. A. R.)

GREAT BRITAIN

There are two main types of chain store in Great Britain, the multiple shop and the variety chain store, both of which developed in the second half of the 19th century. By 1900 there were important multiple tea dealers, grocers and provision merchants, chemists, news agents and tobacconists.

Examples of the variety chain stores were the Penny Bazaars which flourished at the end of the 19th century; Marks and Spencer, first opened in 1887; and Woolworth, which spread from the U.S. to England in 1910.

In 1950, according to the first census of distribution, retail firms (other than co-operative societies) with ten or more establishments (branches) handled retail sales to the value of £1,156,000,000; that is, 23% of a total of £5,923,000,000 handled by all retail shops. More than 80% of the trade of the multiples was handled by firms with 25 or more branches. Though no further census had been taken, other official statistics suggest that the chain stores had gained ground relatively to other retailers by the 1960s.

Most multiple organizations developed from small retailing beginnings. In a few trades (*e.g.*, in footwear) some manufacturers set up their own chains of retail shops. In others some multiples extended their operations by going into manufacturing. The "tied house" system of the brewing industry is a form of retailing which has some but not all of the characteristics of multiple store control and management.

The growth of multiple trading in the 20th century became an important competitive force in retailing, affecting small independent shopkeepers, department stores and co-operative societies. In Great Britain, unlike some other European countries and the United States, no government measures have been introduced to control the growth or to handicap the operation of multiple firms. (B. S. Y.)

CHAIR AND SOFA. Most of the sitting postures of human beings require no accessories, but cushions or more rigid supports may be used. A support that lifts the sitter above ground or floor level is called a stool, chair, bench or sofa. A stool, meant for one person only, is a horizontal surface lifted up by legs, solid sides or a central stem. Legs, the commonest support for the horizontal surface, are used in threes or more often fours, occasionally more. Back legs may be prolonged upward and cross braced to support the sitter's spine, shoulders or even head; a seat so made is called a chair, or, if support is provided also for elbows and forearms, an armchair. A chair widened to seat two or more people side by side is a bench (or settle) if hard-surfaced, and a sofa (settee, couch) if upholstered.

The Chinese, in touch with the west, made beautiful chairs from Han times onward, but in general oriental and primitive cultures favoured sitting without such adjuncts, though cushions and back or armrests were sometimes used. In the far east was developed the cross-legged sitting posture familiar to the west from statues of the Buddha. In the ancient near east men reclined with legs more or less stretched out, and for this utilized day beds or couches.

The occident, sometimes influenced by eastern usages, developed a rich variety of seating furniture over a period of 5,000 years.

Elements of Seating Design.—The characteristic design of seating furniture was concentrated, to begin with, usually in the supporting framework rather than in the surface that was covered when the seat was used. Seat legs often were modeled on animal legs, and details of animal anatomy were used on backs and arms as well; paws and claws often were carved on furniture feet. A symbolic custom of ancient rulers, sitting on slaves or conquered enemies, was echoed occasionally in seat design. Architectural forms often were reproduced, sometimes to create harmony between a room and its furnishings. Twentieth-century taste tends to prefer another approach that has recurred throughout the history of furniture: parts and joints accented to express the principal forces of support and elasticity.

Ancient Egypt.—Furniture is clearly depicted in Egyptian bas-reliefs and wall paintings, many of which have survived, as has some actual furniture and miniature furniture originally deposited in tombs. The earliest seats represented, shown in use by gods, kings or prominent persons, were animal-legged stools or simple rectangular constructions with flat cushions and low backs; special honour was indicated by a high canopy or, more often, by a footrest. Such chairs were sometimes lifted on platforms borne by subordinates. Higher backs and armrests appear next, and litters (portable couches) for noble ladies. Later, open structure prevailed, the seat was curved for comfort and a sloping back was added, allowing more relaxed posture and stiffening the chair. Egyptian furniture was lightly but strongly built of wood with pegged joints, sometimes bound with leather thongs. The usual rectangular four-legged seat frames often were stiffened by crossbars and small struts; central stems were used only for tables and headrests. Egyptian officials traveled a great deal, and folding furniture, including X-framed stools and chairs, was familiar. Seats accommodated only one person; couches were used only rarely at gatherings, benches apparently not at all. Seats sometimes were richly inlaid and overlaid with precious materials. The principal forms were either abstract or derived from the animal world; details derived from architecture hardly occurred. Egyptian skill and elegance were seldom matched in later chairs.

Ancient Mesopotamia.—Ancient near-eastern empires left bas-reliefs that show stools, chairs, armchairs and couches more massive than the Egyptian and enriched, though less subtly, by inlays and bronze fittings, some of which have survived. The reliefs show the ruler reclining on a thickly cushioned couch, a small table at hand, quaffing wine; his queen attended, seated in a high armchair with footstool. Related Hittite reliefs show a chair with a back that sloped backward beyond vertical rear legs. The set of couch, table, chair and footstool, like the recumbent posture while drinking, remained features of western life for thousands of years, disappearing only in the early middle ages. Mesopotamian furniture design echoed the ornaments of architecture; animal forms were mere details.

Ancient Greece.—Ancient Greek arts and artifacts show seats and seating arrangements that reflect the influence of older cultures. Men often reclined while eating or drinking; respectable women sat in chairs. The refinement of Egyptian form was equaled and surpassed in the best Greek chairs and couches. Some new elements in seating perhaps were due to the influence of Aegean cultures about whose furniture little is known. In the Greek dining room couches were ranged along the sides of the room, around a drained area into which the food was carried on tables. Greek gods are shown assembled, seated on stools of diverse design, with Zeus in an armchair (Egyptian gods were shown seated on uniform sets of chairs); similar variations in seating are shown in pictures of daily life. Simple scoop-shaped chairs occur in small early Greek terra-cottas.

Most Greek seats were four-legged, while tables and stands were frequently tripod. Folding stools were known. Greek wooden couches, chairs and stools were both tenon- and peg-joined. Cushion covers were strikingly patterned. Chair forms were abstract or referred to animal anatomy; architectural influence is limited to ornaments. The grace of Greek furniture has often been emulated and only very rarely equaled.

Ancient Rome and Etruria.—Etruscan ladies were shown sharing their lords' couches decorously in public, but Roman custom was closer to the Greek. Couches used at feasts usually accommodated three reclining persons. Romans translated Greek furniture forms from wood to bronze, which was either structural as well as decorative or was slipped over a wood core. Pieces of this furniture were excavated at Herculaneum and Pompeii; Hellenistic Greece probably led the way in this metallic development. Seats with mattresses, draped to conceal the frame, had draperies behind them and raised ends; seemingly used in women's quarters only, these resemble modern sofas. Both Greeks and Romans built theatres with carved stone seats for prominent persons, and other ceremonial seats of marble or other stone have survived. These sometimes appear as round-based chairs with round, flaring backs and sides. The Romans had similar chairs with high, hooded backs, all woven of rush, straw or wicker; a late Roman relief shows teacher and pupils using equally a set of barrel chairs (but the teacher has a footstool). Roman generals and officials were equipped with folding furniture of wood and metal; the use of folding X-frames survived the middle ages, joining the re-use of classical forms in the Renaissance. Rome's influence was extended by trade to India, where echoes of classical seat forms linger.

Early Middle Ages.—Surviving furniture of this era is largely ecclesiastical. Bishops' chairs of stone, metal or wood, richly ornamented, were often enveloping and monumental; on them and on benches, which were much used, architectural detailing was common, particularly arcading. Seats with storage space built in were often constructed like cabinets, with frames and filler panels, the panels carrying the chief burden of ornament. This taste for massiveness and elaboration led to the neglect of open-frame construction; the independent art of chair design languished for the next thousand years. Illuminated manuscripts showed boxlike high-backed seats mounted on platforms in cubistic massing. Many seats were portrayed with heavy spool-turned frames. Regal chairs often were metallic, open and folding since they were meant to recall the traditions of Roman officialdom.

Later Middle Ages.—The closed forms and architectural detailing of seats continued, with motifs varying to match those on buildings. Oak was a favourite wood. Some chairs, benches and cabinets had canopies cantilevered from high backs; a few elaborate folding stools with X-frames survive from this period. Drawings and pictures show textiles draped over seats; a formal gradation of seating according to rank evolved, evident in pictures of court life. Built-in masonry benches, already known to the classical world, became commoner; *e.g.*, in window embrasures. A common piece of furniture before a fireplace was a wood bench with a hinged back rail, allowing the sitter to warm alternately front or rear. Late in the middle ages two typical peasant chairs appeared, one with a rush or straw seat, like those still made, and another, all wood, with a solid slab seat into which two upright slabs or three or four splayed legs were wedged; a wider splat driven in from above formed the back.

RENAISSANCE AND AFTER

Renaissance.—The folding chairs of antiquity became prominent again; benches and slab-seat chairs were improved with lighter forms; new rectangular open-framed chairs were devised, their elements sometimes scaled down from architecture. Oak and walnut were commonly used, accompanied by velvet and leather. Sets of chairs, hardly known since the end of the Roman imperium, reappeared. In time, padded seats and backs became known, softening the rectangularity that prevailed in all save X-framed chairs of metal or wood. One chair with a tilted back, common in Spain, was uncommonly like the Hittite chair. In Spain metal was combined with wood to allow knockdown construction and adjustable backs. Adjustable furniture was regarded as a luxury in other lands: upholstered sofas and chairs with hinged ends or backs appeared in England; similar pieces were considered scandalous when introduced into the palaces of Henry III of France. A growing interest in mathematics and mechanics was expressed in chair frames by the widespread use of spiral wood turning; caning was introduced from the orient, and a few chair frames showed Chinese influence.

Baroque.—At the height of Egyptian and Greek civilizations chairs had been beautiful objects, clearly incomplete without occupants; now, with new means, chairs again were designed more for sitters than as things in themselves. High-backed armchairs acquired side pieces forming wingchairs that sheltered the occupants and localized warmth ("sleeping chairs"). Chair frames, still basically rectangular and now often gilded, were constructed with uprights pivoted to the diagonal, expressing the dominance of the centre where weight was borne. Oblique angles next were introduced in chair backs and legs, particularly back legs to balance the slope above, and in arm elements. These many deviations from strict rectangularity were accompanied by more sensitive carving of the framing members, and by the use of curves and double curves throughout the silhouette of the chair (*e.g.*, cabriole legs) and in horizontal members. Joints were reinforced with glue. Chair frames, liberated from the expression of rigid structure, looked inviting. Cushions, which previously had been added to chairs as ameliorations, now were designed with the frames; upholstery had begun. Upholstered surfaces became more important than the frames that held them; upholstery textiles and leathers were ornamented accordingly. Animal ornament dwindled; the vegetable kingdom supplied a variety of motifs paralleling architectural details. Miniature architectural elements were less favoured in chairs of this era. Stools, benches and sofas all went through these developments; day beds were relegated to private quarters. Baroque etiquette provided a strict hierarchy of seating, but this was often relaxed in private life. Some vagaries of clothing design affected chairs; hoopskirts, for example, required that chair arms retreat from the front corners of seats to accommodate the new width of skirt. Other usages, such as private prayers or gambling also evoked special chair forms.

Rococo.—The vigorous tendencies of baroque chair design were subjected to graceful and capricious detailing by rococo taste. Painted as well as gilt frames were upholstered in tapestry woven like pictures; floral and c-scroll details were common. The highest achievements of antique chair makers were equaled and surpassed at least in sumptuous variety and originality. Signed furniture indicated that contemporary French society appreciated the accomplishment; in England, however, not even the chief cabinetmakers marked their works. Invalids' chairs became elaborately mechanized; rockers were transferred from cradles to chairs, perhaps first in the United States, where Benjamin Franklin was reported to have had a rocking chair in the 1780s. In England rural craft produced Windsor chairs, a lighter form of slab seat with various back designs made of spindles. Seats, legs, spindles and their frames were made of appropriate woods, often by separate makers, and the chair "maker" only assembled them from ready-made parts. In one Windsor the wheelwright's craft was called on to frame the spindles in a bent inverted U. American Windsor chairs were often more elegant than the English. Naturalistic gardens were one of the chief accomplishments of the English rococo, and rustic effects, recorded many centuries earlier in China, were encouraged in furniture used outdoors or in terrace rooms. For these uses iron furniture gained favour, at first forged and welded and then cast and bolted.

Neoclassicism.—The turn toward a more classical style in furniture seems to have occurred first in England, and chair design changed. Straight lines gained over curved; joints that had been fluid transitions became accented junctions; natural woods, including mahogany, replaced gilt or painted surfaces; inlay became as common as carving; and striped or watered silks prevailed over tapestry. Vegetable ornament in time was replaced by symbolic figures or portions thereof. Generally forms became stable and restful, while constructional skill was expressed in the phenomenal slenderness of many pieces, and in the avoidance of bracing between legs. Beechwood was much used for chair frames. "Gondola" chairs, their backs curved smoothly into the seat frames, and other types were skilfully produced from classical images. The chaise longue or day bed reappeared in public rooms, for ladies' reclining, while men began to enjoy restful club chairs. In Germanic lands Biedermeier furniture arose, least decorated and most inventive extension of neoclassic design; blocky forms were preferred even in upholstery, and for veneers, bright fruitwood. In France contemporaneous taste favoured maple with dark linear inlaid or painted details. In the United States an independent furniture craft flourished among the Shakers, who produced simple, light wooden chairs and benches of extraordinary elegance, refined from German peasant furniture. It was the English, however, with the exemplary designs of Sheraton and Hepplewhite, who lifted this era to its heights. The daring skill and reticent taste of the best English chairs and sofas, frequently ascribed to these makers, challenged the more comfortable masterpieces of the rococo.

Romanticism.—Increased interest in Gothic and oriental effects now swept through design. Chairs and sofas were tufted and fringed to excess, except side chairs (often naïvely "Gothic") and featherweight occasional chairs that supplemented the massive upholstered pieces. Terrace furniture was brought into the house; bamboo became acceptable, as did the folding wood chairs now called deck chairs. Rosewood, dark and richly marked, predominated in elegant furniture. Scoop-shaped chairs were made in *papier maché*, lacquered black and decorated with colour, gilt and inlaid shell. The variety of forms for stools, chairs and sofas was unprecedented; day beds once more retired from public view.

Technological Innovations; Revival Styles.—Toward the middle of the 19th century, wood and metal both contributed to chair design in new ways. Veneers were curved more boldly than ever, as in Belter's carved chair backs made in New York city, and in Michael Thonet's contemporaneous efforts in the Rhineland and Vienna. In 1856, when Thonet perfected the bending of solid wood rods that kept their shape throughout long ocean shipments, he initiated the industrialization of furniture manufacture. Metal coil springs became the basis of tufted upholstery. Whole chair and sofa frames were built up, including arms, above a wood seat ring, in flexible metal wire or rods, buried in upholstery ("Turkish frames"). Chairs also were mounted on small carriage springs (Thomas E. Warren's U.S. patent, 1849). Most ingenious of all was the invention of the cantilevered rocker, produced in tubular iron (1851) by R. G. Winfield of Birmingham, Eng. Iron tubes had served for earlier chairs, some with welded joints; Winfield's was the first chair, so far as is known, to achieve comfort directly through the structure of its frame regardless of upholstery. No subsequent innovation has changed chair design more fundamentally; when the cantilevered chair was again launched in the 1920s it became mass produced as the most popular of all metal porch chairs, especially in the United States.

Adjustable chairs of many varieties were produced for invalids, for barbers, for comfort in the home or in the garden. Few, if any, involved new concepts, and the most popular, the "Morris chair," first made by Morris, Marshall, Faulkner and company of London around 1865, was inspired by an antique; its mechanism resembled that of the Renaissance adjustable seating described above. Chairs were evolved for factory and office uses with appropriate support and adjustability; all but the most utilitarian were designed in one of the many prevalent revival styles. Except for some expert copies of Louis XV and Louis XVI furniture, 19th-century revival styles betrayed their century by an accumulation of minor deviations from the originals.

Aestheticism; the Arts and Crafts Movement; Art Nouveau.—Certain designers of the mid-19th century, particularly in England, believed in returning to handicraft, hoping to recapture its lost excellences. In opposition to them were others who were ready to design for industry and convinced that the needs and means of the times, plus an appreciative understanding of the past and of oriental examples, would lead to suitable furnishings for their day. Both these groups—the aesthetic designers that supplied English industry from the 1870s, and the arts and crafts designers, scornful of industry, that followed them in the 1880s, produced chairs and sofas of good quality and of interesting, if rather forced, style. Arts and crafts furniture was widely accepted in the United States, where it became heavier and plainer than in England. At the turn of the century Belgium, France and Germany led Europe in a movement toward original design, *art nouveau*. Fondness for sinuous outlines and for novelty led to the design of chairs and sofas of great visual interest. More than any previous style, *art nouveau* used vegetal forms and abstractions therefrom, but some of the best designs were wholly abstract. (*See* also ARTS AND CRAFTS MOVEMENT; ART NOUVEAU; DESIGN, 19TH-CENTURY.)

Machine Style.—After World War I European modern designers turned in new directions. The French launched a cubistic style at the 1925 exposition of *Arts Décoratifs*. At the Bauhaus school in Germany and through publications such as *l'Esprit Nouveau* in Paris and *de Stijl* in the Netherlands other Europeans were searching more rigorously for a new style: chromium-plated, tubular-steel frames, often spanned by canvas slings, were developed. Chaises longues and cantilevered chair frames were revived. Severe geometry governed the forms, slick finishes and contrasting colours characterized the surfaces of this furniture that was intended to appeal to and satisfy the needs of a mass public. Yet originally and in several later revivals, the style remained a specialty, like the *art nouveau* it replaced. The philosophy of the machine style was more influential than its furniture; but one of its chairs, designed in 1930 by Ludwig Mies van der Rohe, has remained a favourite throughout the years despite its high cost.

Scandinavian and Italian Modern.—Plywood, bent in forms not unlike those of machine-style designers, formed the furniture of Alvar Aalto in Finland; subsequent Scandinavian modern furniture has had freer shapes. By the 1940s, the Danes took the lead. Smoothly carved, curved frames and slight padding mark the pieces by Finn Juhl, Hans Wegner and others. Italian designers were particularly preoccupied with upholstered furniture.

United States and Others.—While Europe assayed the machine style the profession of industrial design (*q.v.*) arose in the United States, whence it spread widely. In seating design its principal contribution has been the improvement of adjustable chairs for transportation industries. These industries pioneered a new upholstery material in England, in the later 1930s, foamed latex. Two American designers, Edward J. Wormley and T. H. Robsjohn-Gibbings (originally English), successfully adapted foamed upholstery for more decorative uses. Machine-style philosophy was upheld in the face of gross early industrial design by a group of Americans who produced remarkable, original and widely influential seating: Charles and Ray Eames, Eero Saarinen and Florence Knoll, all trained at Cranbrook Academy of Art in Bloomfield, Mich. Their work copied neither the machine style nor any other: it was marked by use of industrial materials and processes; its forms were often molded (in reinforced plastics), its joints flexible, its frames light and linear, its upholstery not notably luxurious. A widely popular chair with a slung seat was evolved in Argentina; English, German, Dutch, French and Japanese designers were also active in the field of seating. Throughout the world, modern designers retained the values recaptured in the baroque era; chairs were designed for users, not as independent works of art or of craft. The old devices of animal, vegetable and architectural ornament seem to have disappeared. *See* Design, 20th-Century; *see* also references under "Chair and Sofa" in the Index volume. (Er. K.)

CHAISE LONGUE: *see* Chair and Sofa.

CHAITANYA (Caitanya; also known as Guaranga), (1486–1533), Indian mystic, though not the founder of Vishnuism in Bengal, left an indelible mark of his personality on that religious movement. Born at Nabadwip in 1486, he grew up in an atmosphere of piety and affection at home and of scholarship and academic pursuits outside. There was in his early career hardly anything that showed promise of his future greatness. But a visit to the holy village of Buddh Gaya (*q.v.*), at the age of 22, resulted in an almost unbelievable transformation in his outlook and personality. Chaitanya returned to Nabadwip a God-intoxicated man, entirely indifferent to all worldly concerns.

A group of Vaishnava devotees soon gathered round him. Not satisfied with the current ritualism and intellectualism, Chaitanya initiated a new mode of congregational worship, called *kirtana*, which consisted in the choral singing of the name and deeds of God, accompanied by peculiar drums and cymbals and synchronized with rhythmic bodily movements, all this culminating in a veritable ecstasy. He thereby propagated *bhakti* (self-surrendering personal devotion) as the most efficacious way of God-realization.

In 1510 Chaitanya became a regular ascetic. He never interested himself in organizing any cult or sect, nor did he produce any authoritative work on theology, philosophy or ethics. But his simple life of intense religious emotion itself proved at once the source and impetus of a great religious movement. Chaitanya died in 1533, but even in his lifetime he was deified and was regarded as incarnating Krishna and Radha in a single personality.

See D. C. Sen, *Chaitanya and His Age* (1922); S. K. De, *Early History of the Vaisnava Faith and Movement in Bengal* (1942). (R. N. D.)

CHAIYAPHUM, the name of a province (*changwat*) and its capital in the western part of northeast Thailand. The province, with an area of 4,165 sq.mi., had a population of 474,751 in 1960. The hills and mountains extend in a north-south direction and are divided by the Pa Sak river, which flows through the province from north to south. Most of the area is covered with fine sandy loams, which are droughty, and with shallow soils on steep, stony slopes. This is one of the country's poorest *changwats*. Chaiyaphum, the capital, is isolated and inaccessible. (T. F. B.)

CHALATENANGO, a department in northern El Salvador, bordered on the south and west by the deep Lempa valley and north by the Sumpul river. Area 817 sq.mi., pop. (1958 est.) 137,257. Although mostly rough country, the department produces 84% of the nation's wheat. Other products include vegetables, cattle, pigs, cheese, henequen, pineapples, corn, beans, sesame and poultry. Near the Honduras border the department is sparsely populated, because of the rugged relief. Its capital Chalatenango (pop. [1958 est.] 15,127), is an old colonial settlement, 38 mi. by highway from San Salvador. (C. F. J.)

CHALCEDON (Calchedon; mod. Kadikoy), an ancient maritime town of Bithynia, opposite Istanbul (formerly Byzantium and Constantinople), in the Istanbul *il* of Turkey. It was originally a Megarian colony founded in the early 7th century B.C. on a site so obviously inferior to that of Byzantium on the opposite shore that it was accorded the name of "The City of the Blind." In its early history it shared the fortunes of Byzantium, vacillated long between the Lacedaemonian and Athenian interests and was bequeathed to the Romans by Attalus III of Pergamum (133 B.C.). It was partly destroyed by Mithradates VI (*q.v.*), but recovered under the Roman empire despite the frequent ravages of barbarian raiders. In A.D. 451 it was the seat of the Council of Chalcedon (*see* Council). The city was captured by Khosrau II of Persia in A.D. 616. The Turks used it as a quarry for building materials for Constantinople.

CHALCEDON, COUNCIL OF, the fourth ecumenical council, was held in A.D. 451 at Chalcedon, near Byzantium. It was occasioned by the need to deal with the Eutychian heresy, and its chief conclusions were concerned with affirming the two natures—divine and human—of Christ. *See* Council.

See also references under "Chalcedon, Council of" in the Index volume.

CHALCEDONY (Calcedony), a smooth or fine-grained variety of native silica occurring in concretionary, mammillated or stalactitic forms of waxy lustre and a great variety of colours—usually bluish white, gray, yellow or brown. It has a compact fibrous structure and a fine splintery fracture. For composition, mode of occurrence, varieties, etc., *see* Silica; Chert and Flint.

Chalcedonic pseudomorphs after other minerals often give rise to very interesting specimens. Hollow nodules of chalcedony containing water and an air bubble which is visible through the semitransparent wall have been found. In all ages chalcedony has been the stone most used by the gem engraver, and many coloured varieties, described under special headings, are still cut and polished as ornamental stones. *See* Agate; Bloodstone; Carnelian; Mocha Stone; Onyx; *see* also references under "Chalcedony" in the Index volume.

CHALCIDICE (mod. Gr. Khalkidhiki) is a *nomos* (prefecture) in northern Greece, and consists of a peninsula which terminates in the promontories of Kassandra, Sithonia and Akti. All three were formerly islands, and the isthmuses at their bases are composed of loose sediments. The Kassandra isthmus is crossed by a canal cut in 1937. Xerxes had a passage made through that of Akti. The northwest-southeast trend of the promontories is the result of geologically recent rifting; in consequence the coasts are still steep and difficult to traverse, and the whole area is liable to severe earthquakes. The axis of the main peninsula is formed by the granite mass of Kholomon. Sithonia, too, is composed of ancient igneous rocks, while Akti rises at its seaward extremity to the great white marble pyramid of Mt. Athos (*q.v.*), 6,667 ft. high. The most accessible and fertile parts of the *nomos* of Khalkidhiki are the low plateaus of the Kassandra promontory and the west coast, where lies Nea Moudhania. Most of the rest is remote wooded mountain country, with some mining villages and many monastic refuges. Area 1,158 sq.mi.; pop. (1961) 79,838. (Wm. C. B.)

CHALCIS (mod. Gr. Khalkis), the chief town of the island of Euboea, Greece, lies at the narrowest point of the Euripus (Evripos or Evripou Porthmos), the strait separating the island from the mainland. Pop. (1951) 23,786. The modern town has a considerable export trade, and rail connections with Athens. It grew rapidly after World War II and became a popular weekend resort for Athenians. The old walled *castro* by the Euripus was traditionally occupied by Jewish and Turkish families, while the new Greek suburb grew up to the north and east. The Turkish fort of Meli-baba replaced an earlier Boeotian and Chalcidian one of 411 B.C. The site of the ancient acropolis and town lies to the south near the remains of a Venetian aqueduct. The 50-yd. strait, spanned by a swing bridge, is remarkable for its tidal currents, which are irregular and sometimes attain a speed of 12 knots. For the probable derivation of the medieval name Negroponte from Euripus *see* Euboea.

Important Early and Late Bronze Age tombs have been found near the town. In classical times Chalcis was occupied by Abantes and Ionians and its artists won particular fame for their metalwork. With Eretria (*q.v.*), Chalcis took a leading part in founding overseas trading posts and colonies, in north Syria (Al Mina) about 800 B.C. and in Italy (Pithecusae, Cumae) about 750. It founded other colonies in the west and in northern Greece (Chalcidice), but about 700 was severely handled in a war with Eretria (the Lelantine War). It sided unsuccessfully with the Boeotians against Athens in 506 and its land was divided among 4,000 Athenian settlers. It sent 20 ships to join the Greek fleet in 480 B.C. and fought against the Persians at Plataea in 479 (*see* Greece:

Ancient History; GRECO-PERSIAN WARS). Later it joined the Delian league (*q.v.*), but led a Euboean revolt against Athens in 446. In the 4th century it joined the second Athenian confederacy. Philip II of Macedonia installed a garrison in 338 to protect his interests in Greece. Aristotle died at Chalcis in 322. During the medieval period, the town was successively under Venetian and Ottoman control. (J. Bo.)

CHALCOCITE, a mineral consisting of cuprous sulfide is known also as copper glance, redruthite and vitreous copper. Next to chalcopyrite, chalcocite is the most important ore of copper, and is perhaps the most characteristic mineral of the zone of secondary enrichment. It seems probable however that at some localities, *e.g.*, Butte, Mont., it is of primary origin. The best crystals are from St. Just, St. Ives and Redruth in Cornwall, and from Bristol in Connecticut.

Chalcocite (Cu_2S) crystallizes in the orthorhombic system. The crystals have the form of six-sided tables or prisms which are usually twinned, with the result that they simulate hexagonal symmetry. The mineral more often occurs as compact masses, which are sometimes of considerable extent. The colour is dark lead gray with a metallic lustre, but this is never very bright, since the material is readily altered, becoming black and dull on exposure to light. The mineral is soft (the hardness is 2.5 on Mohs' scale [*q.v.*]) and sectile; that is, pieces can be shaved off with a knife. Specific gravity is 5.7. It has a hexagonal polymorph not known to occur in nature. (CL. F.)

CHALCONDYLES, LAONICUS (CHALCOCONDYLAS LAONICUS) (*c.* 1423–1490?), Byzantine historian, was the author of the valuable work *Historiarum demonstrationes.* He came of a distinguished Athenian family and was educated under Gemisthus Plethon at the Palaeologan court at Mistra in the Peloponnese. His history is prefaced by an admirable survey of the Greek role in world affairs and a discussion of the relationship between Greeks and Romans. It treats the years 1298–1463 in more detail, describing the decline of the Byzantine empire and its conquest by the Ottomans. Its information on Manuel II includes his experiences when traveling in western European countries in search of aid against the Turks. Chalcondyles tried to model his style on that of Thucydides, but he was a great admirer of Herodotus and roused the interest of contemporary Italian humanists in him. He aimed at an objective analysis and in spite of some inaccuracies and the interpolation of farfetched anecdotes, he is one of the most valuable of the later Greek historians.

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His brother, DEMETRIUS CHALCONDYLES (1424–1511), was born in Athens. In 1447 he went to Italy, where Cardinal Bessarion became his patron. He became famous as a teacher of Greek and the Platonic philosophy; in 1463 he was made professor at Padua, and in 1479 was summoned by Lorenzo de' Medici to Florence. In 1492 he moved to Milan, where he died in 1511. He was associated with Marsilio Ficino, Politian and Teodoro Gaza, in the revival of letters in the western world. One of his pupils at Florence was the famous German scholar, Johann Reuchlin. Demetrius Chalcondyles published the *editio princeps* of Homer (1488); *Isocrates* (1493); the *Suda* lexicon (1499); and a Greek grammar (*Erotemata*) in the form of question and answer. (J. M. HY.)

CHALCOPYRITE (COPPER PYRITES), a copper iron sulfide, is of wide distribution and is the commonest of the ores of copper. Extensive deposits are mined in the United States, particularly at Butte, Mont., and in Namaqualand, South Africa. Well-crystallized specimens are met with at many localities; for example, formerly at Wheal Towan in the St. Agnes district of Cornwall, Eng., at Freiberg in Saxony, Ger., and Joplin, Mo.

The colour of chalcopyrite is brass-yellow, and the lustre metallic; the streak, or colour of the powder, is greenish-black. The mineral is especially liable to surface alteration, tarnishing with beautiful iridescent colours; a blue colour usually predominates, probably due to the alteration of the chalcopyrite to cupric sulfide or covellite (*q.v.*). It is commonly found massive, granular to compact.

Chalcopyrite may be readily distinguished from pyrite (or iron pyrites), which it somewhat resembles in appearance, by its deeper colour and lower degree of hardness: the former is easily scratched by a knife, while the latter can only be scratched with difficulty or not at all.

Chalcopyrite is decomposed by nitric acid with separation of sulfur and formation of a green solution; ammonia added in excess to this solution changes the green colour to deep blue and precipitates red ferric hydroxide.

Chalcopyrite crystallizes in the scalenohedral class of the tetragonal system, but the form is so nearly cubic that it was not recognized as tetragonal until accurate measurements were made in 1822. Crystals are usually tetrahedral in aspect but frequently twinned, and they are often complex and difficult to decipher. The fracture is conchoidal, and the material is brittle. Hardness 4; specific gravity 4.2.

The chemical formula $CuFeS_2$ corresponds with the percentage composition: copper, 34.5%, iron, 30.5% and sulfur 35.0%. However, analyses usually show the presence of more iron, due to the intimate admixture of pyrite. Traces of gold, silver, selenium or thallium are sometimes present, and the mineral is sometimes worked as an ore of gold or silver, which may be present in solid solution. (L. J. S.; CL. F.)

CHALDEA (CHALDAEA), a land in southern Babylonia (mod., southern Iraq) frequently mentioned in the Old Testament, sometimes as the equivalent of Babylonia as a whole. Strictly the name should be applied to the land bordering the head of the Persian gulf, between the Arabian desert and the delta of the Euphrates. This area was called by the Assyrians *Kaldu,* by the Babylonians *Kasdu* and by the Hebrews *Kasdim.* Little is known of the early history when the territory seems to have been settled by seminomads from Arabia, who occupied Ur "of the Chaldeans" (Gen. xi, 28) and adjacent areas.

The first reference to the name is found in the annals of Ashurnasirpal II, king of Assyria from 884 to 859 B.C., though earlier documents commonly designated the same area as the "sea-lands." The Assyrians carefully distinguished the Chaldeans from their northern Babylonian neighbours and from the Aramaeans, Arabs and other tribes in the vicinity. In 850 B.C. Shalmaneser III raided Chaldea and reached the Persian gulf or "Bitter sea" which he called the "Sea of Kaldu." The effect of his incursion was short-lived, however, for his successor, Shamshi-Adad V had to intervene again to defeat the Chaldeans supporting the Babylonian rebel Marduk-balatsu-iqbi at the Daban river. Although Adad-nirari III (*c.* 810 B.C.) claimed several Chaldean chiefs among the vassals of Assyria, the link could not have been strong, for Tiglath-pileser III (745–727 B.C.) met strong opposition from rebel sheikhs during his Babylonian campaigns.

On the accession of Sargon II, the Chaldean Marduk-apla-iddina II, ruler of Bit-Yakin (the biblical Merodach-baladan), seized the Babylonian throne and, despite Assyrian opposition, held it for ten years (721–710 B.C.). His efforts to rouse the western states against Assyria are known from Isaiah's account of his embassy to Hezekiah, king of Judah (Isa. xxxix). After a further brief reign (703–702 B.C.) Merodach-baladan fled and Bit-Yakin was placed under an Assyrian nominee.

With the decline of Assyrian power, a native governor, Nabopolassar, was able to extend Chaldean influence northward. In 626 B.C., he became king of Babylon by popular consent and inaugurated there a Chaldean dynasty that held sway until the Persian invasion of 539 B.C. The prestige of his successors, Nabu-Kurri-usur (Nebuchadrezzar; *q.v.*) II (605–562 B.C.) and Nabonidus (556–539 B.C.), was such that "Chaldean" was henceforth synonymous with "Babylonian" (Dan. iii, 8; ix, 1). "Chaldean" also was used more specifically, in the works of Herodotus, Diodorus and Strabo and in the Book of Daniel, to denote the priests and other persons educated in the classical Babylonian literature and especially in traditions of astronomy and astrology. Through a misunderstanding, the "language of the Chaldaeans" (Dan. i, 4) or "Chaldee" was, until the early 20th century, sometimes used to mean the Aramaic language rather than the Babylonian dialect to which it rightly applies. Xenophon's "Chaldaeans" (*Anabasis*, vii, 25) were the Haldeans or Urartians of Armenia. *See* also BABYLONIA AND ASSYRIA.

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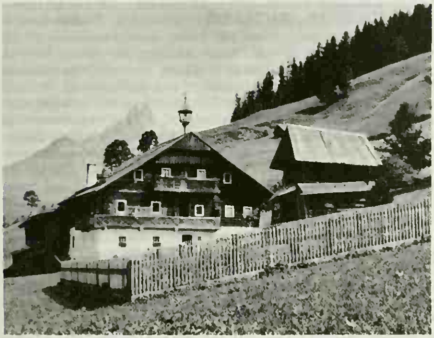
CHALET, a term applied to the timber houses of Switzerland, the Bavarian Alps, Tirol and the French Alps. The chalet is distinguished above all by the frank and interesting manner in which it makes use of its material, wood. The timber used is generally in heavy planks, from 3 to 6 in. thick, and carefully framed together somewhat in the manner of a log house. Side walls, generally low, often project beyond the ends, forming porches or loggias, closed at the ends. Upper floors almost universally project over the stories below, with all sorts of fantastic and interesting bracket treatments. Balconies across the front are common and are frequently enriched with carved railings. Windows are small and hung as casements. In general, roofs are of low pitch and project enormously, both at the eaves and at the gable ends, which are occasionally snubbed with a small triangle of sloping roof at the top. The roof surfaces are covered with large wood shingles, slabs of slate or stone; in the wilder districts planks are often laid over the roof covering and weighted with boulders to prevent damage from heavy gales. In plan, the chalet tends toward the square; frequently, not only the house proper but also stables and storage barns are included under one roof. Many local peculiarities of detail exist.


TIM GIDAL FROM MONKMEYER

AUSTRIAN CHALET, 17TH CENTURY

CHALFONT ST. GILES, a village and parish of Buckinghamshire, Eng., about 20 mi. N.W. of London. Pop. (1951) 4,381. Despite urbanization in the vicinity, the village green with its pond and neighbouring 13th-century church retains its charm. The cottage in which the poet John Milton spent some months during 1665–66 in order to escape the Great Plague then raging in London is now a museum. Thomas Ellwood, the Quaker, had found this "pretty box . . . in Giles-Chalfont" for his friend Milton, to whom he had read on occasions in the past. *Paradise Regained* was written in consequence of a suggestion made by Ellwood during a visit he paid Milton at Chalfont when he received from him the completed manuscript of *Paradise Lost*.

Quakerism has long been associated with this parish, where Friends in the 17th century met for a number of years in what is today the old Jordans hostel, whose barn is reputed to be constructed of timbers from the vessel "Mayflower" that took the Pilgrim Fathers to America. The Friends meeting house at Jordans (built 1688), and more particularly its burial ground, attract visitors from all parts of the world, who come to see the graves of William Penn, Isaac Penington, and other renowned Quakers. (E. J. DA.)

CHALIAPIN (Rus. SHALYAPIN), **FEODOR IVANOVICH** (1873–1938), Russian bass singer whose dynamic impersonations had enormous influence on style in operatic acting in the first decades of the 20th century. He was born at Kazan, Feb. 13 (New Style; 1, Old Style), 1873, in a poor home and made his early living in numerous humble occupations. He sang in a church choir but first seriously studied singing with Dmitri Ussatov in 1892. He established a reputation as a member of Mamontov's private opera company in Moscow and mastered the roles upon which his international fame later rested: those of Boris in Mussorgsky's *Boris Godunov*, Ivan the Terrible in Rimski-Korsakov's *Maid of Pskov*, Mephistopheles in Gounod's *Faust* and Boito's *Mefistofele*, and Philip II in Verdi's *Don Carlos* as well as the *buffo* roles of Leporello in Mozart's *Don Giovanni* and Don Basilio in Rossini's *Il Barbiere di Siviglia*. He made appearances in Milan (1901), New York (1907), Paris (1908) and London (1913). Although sympathetic to the Bolshevik revolution, Chaliapin felt ill at ease in Soviet Russia and in 1921 he left the country. He made highly successful visits to the United States and to London and in his later years was much admired as a recitalist. He died in Paris on April 12, 1938.

Chaliapin's powers resided not so much in beauty of vocal line, which seems to have interested him little, as in vivid declamation, the cavernous resonance of his voice and his dynamic acting. He published two volumes of autobiography, *Pages of My Life* (1927) and *Man and Mask* (1932). (WI. S. M.)

CHALICE, the cup used in the celebration of the Christian Eucharist (*q.v.*). Both the statement of Paul in I Cor. x, 16 about "the cup of blessing which we bless" and the accounts of the institution of the Eucharist in the first three Gospels indicate that special rites of consecration attended the use of the chalice from the beginning. It was not until the recognition of Christianity by the Roman empire in the 4th century that silver and gold became the usual materials for the chalice. In the middle ages the legend of the Holy Grail surrounded the origins of the eucharistic chalice with a magical aura (*see* GRAIL, THE HOLY). The precious stones and elaborate carvings employed for the embellishment of chalices have made them an important part of the history of ecclesiastical art. (J. J. PN.)

CHALK is a white to grayish, loosely coherent limestone composed of the calcareous remains of minute marine organisms—foraminifera (*q.v.*), coccoliths, rhabdoliths, etc.—fine-grained carbonate of uncertain origin and subordinate amounts of shell fragments. The purest kinds of chalk contain up to 99% calcium carbonate in the forms of the mineral calcite (*q.v.*). Sponge spicules, diatom and radiolarian tests, detrital grains of quartz, and chert nodules (flint) contribute small amounts of silica. Also encountered are variable amounts of clayey material, glauconite pellets and calcium phosphate present as pellets and as invertebrate skeletal remains. (*See* also LIMESTONE.)

Extensive chalk deposits occur in the United States from South Dakota through Texas to Alabama. European deposits are found in western Europe south of Sweden and in England; major production has been in England, France, Belgium and Denmark.

Chalk, just as any other high-purity limestone, is used for making lime and portland cement and as a fertilizer. Whiting may be prepared from chalk either by grinding in water and collecting the finer-sized particles from the suspension; or by dry grinding and pneumatic size-separation. Whiting is used in ceramics and putty; as a filler and extender in a wide variety of materials including cosmetics, crayons, phonograph records, plastics, rubber, paper and linoleum; as a mild abrasive in toothpaste. Large amounts are used in oil paints and as the solid ingredient in casein and other calcimine coatings. Whitings composed of ground marble, limestone, shells or chemically precipitated calcium carbonate compete with those made from chalk. The chief use for true chalk whiting is in making putty, for which its plasticity, oil absorption and aging qualities are well fitted.

See also references under "Chalk" in the Index volume.

(D. L. G.)

CHALKHILL, JOHN (fl. 1600), English poet, author of *Thealma and Clearchus. A Pastoral History in smooth and easie Verse. Written long since by John Chalkhill, Esq., an Acquaintant and Friend of Edmund Spencer* (1683). It appeared with a preface by Izaak Walton dated 1678. Two songs attributed to Chalkhill are included in Walton's *Compleat Angler* (1653). Nothing further is known of Chalkhill, and many critics have doubted his existence, assigning all his works to Walton himself. It may be noticed that Walton's second wife's stepmother's father was called John Chalkhill. "Thealma and Clearchus" is in vol. ii of George Saintsbury's *Minor Poets of the Caroline Period* (1905–21). (P. Dw.)

CHALK RIVER, a village in Renfrew county, southeastern Ontario, on the Chalk river, about 95 mi. W.N.W. of Ottawa. A small frontier settlement before World War II, its name was given after the war to the Chalk river project which became the focus of atomic energy research in Canada, occupying 10,000 ac. on the Ontario bank of the Ottawa river. The village was incorporated in 1954. Pop. (1961) 1,115. The town of Deep River, 6 mi. up the Ottawa river, dating from 1944, was developed as a residential community for project personnel. Pop. (1961) 5,347.

Facilities of the project include five reactors and about 100 well-equipped laboratories and auxiliary buildings. The staff is engaged in fundamental and applied research in the various peaceful uses of atomic energy, with special emphasis on the generation of economic electric power by using natural uranium oxide as a fuel, with heavy water as moderator and coolant, to produce steam for operating turbines. A wide variety of fundamental research is performed in physics, chemistry, biology and metallurgy, as well as in electronics, engineering, health physics and medicine. The results of research are published in approximately 100 papers and 200 reports per year. The most notable of the isotopes produced at Chalk river is cobalt 60, used for radiography in industry and in theratron units for the treatment of malignant diseases. (D. A. K.)

"CHALLENGER" EXPEDITION, a prolonged cruise (Dec. 7, 1872–May 26, 1876) for oceanic exploration, carried out through the co-operation of the British admiralty and the Royal society. H.M.S. "Challenger," a wooden corvette of 2,306 tons, was commanded by Capt. (afterward Sir) George Nares (*q.v.*); the scientific staff was under (Sir) C. Wyville Thomson (*q.v.*). The Atlantic was crossed several times. From Cape Town southeast and east the ship visited the various islands between 45° and 50° S., reached Kerguelen Island in Jan. 1874, and proceeded south about the meridian of 80° E. The "Challenger" was the first steamship to cross the Antarctic circle. Early in March she made for Melbourne; from there the route led by New Zealand, the Fiji Islands, Torres strait, the Banda sea, and the China sea to Hongkong. The western Pacific was then explored northward to Yokohama, after which the "Challenger" struck across the ocean by Honolulu and Tahiti to Valparaiso. She then steamed southward, penetrated the Strait of Magellan, touched at Montevideo, recrossed the Atlantic by Ascension and the Azores, and then returned to England. Among the results of the expedition were the determinations of oceanic temperature, ocean currents and the depths and main contours of the great ocean basins; various areas of the world were charted and surveyed, and extensive biological investigation was carried on. Later explorations supplemented these findings but did not materially alter them; the scope and thoroughness of the expedition made it a landmark in the history of exploration. The *"Challenger" Report* was issued in 50 volumes (1880–95), mainly under Sir John Murray, a biologist on the expedition, who succeeded Wyville Thomson in 1882. *See* also references under "Challenger Expedition" in the Index volume.

CHALLIS, JAMES (1803–1882), English clergyman and astronomer who came near to discovering the planet Neptune, was born at Braintree, Essex, on Dec. 12, 1803. Educated at Trinity college, Cambridge, where he was appointed fellow in 1826, he was ordained in 1830, and succeeded G. B. Airy as Plumian professor of astronomy and director of the Cambridge observatory in 1836. He contributed over 200 mathematical, physical and astronomical papers to scientific journals and published 12 volumes of *Astronomical Observations made at the Observatory of Cambridge* (1832–64), containing the chief results of his 25 years' work at the observatory. He also wrote many theological works. Challis is always mentioned in connection with the discovery of Neptune because of his failure to act upon the prediction, given him by J. C. Adams in 1845, which later proved to have given within 2° the true position of the planet. He was searching for the planet in Aug. 1846, but the pressure of routine observatory work prevented him from reducing the observations that would have revealed it; Neptune was discovered at the Berlin observatory in Sept. 1846. Challis died at Cambridge on Dec. 3, 1882. (O. J. E.)

CHALLIS, a light, all-wool or part-wool fabric of almost gossamer texture used for women's dressing gowns and children's suits and dresses. Challis once was distinguished from all the other muslin-delaine weaves, of which class it is a member, by the tiny romantic designs in which it is printed but it is now available in solid colours. These designs are mostly of 18th and 19th century inspiration and show conventionalized versions of dots, rosebuds, violets and other flowers.

CHALLONER, RICHARD (1691–1781), English Roman Catholic bishop, who revised the Reims-Douai translation of the Bible, was born at Lewes, Sussex, on Sept. 29, 1691. He was educated at the English college at Douai, where he was ordained (1716) and appointed vice-president and professor of theology (1720). In 1730 he was sent to London, where the Catholic community remained small and harassed, and in 1741 was consecrated titular bishop of Debra and nominated coadjutor to Bishop Benjamin Petre, vicar apostolic of the London district, whom he succeeded in 1758. He died in London on Jan. 12, 1781.

Challoner was the author of numerous controversial and devotional books, including his *Catholic Christian Instructed* (1737), a witty reply to Conyers Middleton's *Letters From Rome, Showing an Exact Conformity Between Popery and Paganism* (1729); a popular manual of prayer, *The Garden of the Soul* (1740); and *Meditations for Every Day of the Year* (1753), frequently reprinted and used by many outside his own church. His historical works, always carefully documented, include *Memoirs of Missionary Priests* (1741–42) and *Britannia Sancta* (1745), lives of traditional British saints. In his revision of the Reims-Douai version (1749–50) his purpose was to make the Bible more readable by modernizing the language and to correct earlier errors. As the translators of the Authorized version had made use of the Reims-Douai Bible, so Challoner adopted some of their phrases. His third edition (1752) became the authorized translation for English Catholics.

See E. H. Burton, *Life and Times of Bishop Challoner*, 2 vol. (1909); commemorative essays, *Richard Challoner 1691–1781* (1946). (E. E. Re.)

CHALMERS, ALEXANDER (1759–1834), Scottish writer and editor, best-known for his *General Biographical Dictionary* (1812–17), was born in Aberdeen on March 29, 1759. His *Glossary to Shakespeare* (1797) was followed by *English Poets from Chaucer to Cowper* (1810), which revised and expanded Dr. Johnson's *Lives of the Poets.* He edited the *British Essayists: with Prefaces Historical and Biographical* in 45 vol. (1817), as well as publishing the works of James Beattie, Henry Fielding, Edward Gibbon and others. His 32-volume *Dictionary* was a revised and greatly enlarged edition of work first published in 1761. He died in London on Dec. 10, 1834.

CHALMERS, GEORGE (1742–1825), Scottish antiquary, historian and political writer, known principally for his *Caledonia: or an Account, Historical and Topographical, of North Britain,* 3 vol. (1807–24), a comprehensively planned work of antiquarianism, unfinished at his death. Chalmers was born at Fochabers, Moray, educated at Aberdeen and Edinburgh and in 1763 emigrated to Maryland where he practised as a lawyer. After returning to England on the outbreak of the war of American Independence, he published the *Political Annals of the Present United Colonies* (1780), of which only one volume (ending in 1688) appeared, and *An Estimate of the Comparative Strength of Great Britain During the Present and Four Preceding Reigns*

(1782), the intellectual ancestry of which is shown by his reprint with a biographical note of Gregory King's *Observations upon the State of England, 1696* (1804). He held the office of chief clerk of the committee of the privy council for trade from 1786 until his death, in London, May 31, 1825. Besides many political works, he wrote lives of Defoe (1785), Allan Ramsay (1800), Sir David Lyndsay (1806) and Mary, Queen of Scots (1818).

See Grace A. Cockroft, *The Public Life of George Chalmers* (1939).

CHALMERS, JAMES (1841–1901), Scottish missionary to New Guinea, was born at Ardrishaig, Argyll, on Aug. 4, 1841. Ordained in 1865, he was sent by the London Missionary society to Rarotonga in the South Pacific (1866). In 1877 he joined W. G. Lawes in southeast New Guinea and on the savage island of Suau. The courage and energy of both Chalmers ("the Livingstone of New Guinea") and his wife brought many new converts to Christianity. At Dopima on Goaribari Island, on April 8, 1901, Chalmers and his fellow missionary Oliver Tomkins were killed by cannibals.

See his *Autobiography* (1902).

CHALMERS, THOMAS (1780–1847), Scottish preacher and theologian, first moderator of the Free Church of Scotland (*q.v.*), was born at Anstruther, Fife on March 17, 1780. In 1803 he was ordained as minister of Kilmany, Fife, while continuing his successful classes in mathematics at St. Andrews and devoting most of his time to scientific study; but after conversion to a firm belief in the necessity of faith for salvation, effected partly by a reading of William Wilberforce's *Practical View of the Prevailing Religious System* (1797), he took up the evangelical position and contributed an article on Christianity as well as the one on trigonometry, which he had already undertaken, to the *Edinburgh Encyclopaedia* (1813). In 1815 he became minister of the Tron church, Glasgow, where he became so famous as a preacher that, when he visited London in 1817, Wilberforce wrote, "all the world is wild about Dr. Chalmers." In July 1819 he was made minister of the new parish of St. John's, Glasgow, and undertook to deal with the problem of its poor, who were then costing the city £1,400 per annum. By 1823, when he accepted the chair of moral philosophy at St. Andrew's, Chalmers had reduced this figure to £280. In Nov. 1828 he was appointed professor of divinity in Edinburgh and became recognized as the leader of that section of the Scottish Church which was claiming independence from civil interference for the church and a vote for parishioners in the choice of their minister. This opposition to the prevailing policy directed an attack against the exercise of patronage, an attack which culminated in the Disruption of 1843, when, on May 18, 203 commissioners marched out of the general assembly because of the government's refusal to admit the church's spiritual independence (*see* SCOTLAND, CHURCH OF). Chalmers, who had already prepared a scheme for the support of those who wished to make what he called "a Christian outgoing . . . a withdrawal from the intolerable position forced upon us," was made moderator of the Free Church of Scotland. He also became principal of their New college in Edinburgh, where he died on May 30, 1847.

A preacher whose sermons were powerful on account of their rugged eloquence rather than their polish, and a theologian more concerned with the solution of man's problems than with the more difficult questions of the nature and existence of God, Chalmers insisted above all in bringing the ethics of the Christian faith to his study of economics and his practice of philanthropy. In 1808 he published *An Enquiry Into the Extent and Stability of National Resources* in which he maintained an optimistic attitude in face of Bonaparte's hostile commercial policy, and in a series of sermons (published in 1817) he claimed that modern astronomical studies only increased the glory of the Christian revelation. The results of his work among the paupers of Glasgow were fair indication of the efficacy of his ideas, which he later set out in detail in *Christian and Civic Economy of Large Towns*, three volumes (1821–26), and *Political Economy* (1832), works very different in emphasis from those of his contemporaries, William Godwin (*q.v.*) and Thomas Malthus (*q.v.*). His most important theological study was written in 1833 under the title *On the Adaptation of External Nature to the Moral and Intellectual Constitution of Man* and later incorporated in his *Institutes of Theology*, published posthumously (1849). His obituary notices testify to the esteem in which Chalmers was held, both as "the veteran hero of the Disruption," and as a minister particularly aware of and attentive to the social and economic needs of those in his care. For portrait *see* PRESBYTERIANISM.

See H. Watt, *Thomas Chalmers and the Disruption* (1943).

(H. WA.)

CHALNA (PORT JINNAH), an anchorage established in East Pakistan in Dec. 1950 on the Pussur river as an experimental measure to relieve congestion at Chittagong (*q.v.*) and to handle the traffic of the Cis-Brahmputra area of East Pakistan. As it proved to be a self-supporting project it was made permanent in 1952. Some of the moorings were soon found to be dangerous, because of the proximity of eddies, and the anchorage was shifted a few miles downstream to Mongla. This anchorage is 72 mi. from the sea, extends over a distance of 3 mi., has a depth of 21–45 ft., and has nine moorings. The navigable channel is well marked with buoys and shore marks. It can accommodate ships of 23-ft. draft throughout the year and ships of 26-ft. draft during the spring tides. Chalna has emerged as an important seaport served by inland water transport with connections to most of the river ports in the province and with the railhead at Khulna. The chief export of Chalna is jute; chief imports are machinery, bagged food grains, salt, coal and general cargo in bulk. Pop. (1961) 3,944. (K. S. AD.)

CHÂLONS-SUR-MARNE, a city of northeastern France, capital of Marne *département*, is on the Marne in the heart of the rolling Champagne country, 26 mi. (42 km.) by road S.E. of Reims. Pop. (1962) 39,658. The centre of the town is bordered on the west by the Marne, and other branches pass through the town. The cathedral of St. Étienne (13th century) has a 17th-century west façade, fine 13th-century stained-glass windows and a remarkable main altar. The collegiate church of Notre Dame en Vaux (12th century) is a mixture of Gothic and Romanesque styles, having stained-glass windows dating from 1525 and 1526, a Gothic choir and a carillon of 56 bells. Stained-glass windows are a feature of the church of St. Alpin (12th and 16th centuries); St. Jean is another old church. Near the *hôtel de ville* (1772–76) is a 13th-century house containing the library, which includes manuscripts from the 12th to the 15th centuries and carefully preserved incunabula. The college, once a Jesuit establishment, and the former Augustinian abbey (16th and 17th centuries), now a training college, are other notable buildings. Two important railway routes cross at Châlons, from Paris to Strasbourg and from Calais to Basel. The chief industries are beer and champagne production and wallpaper making. Sugar, automobile parts, electrodes, detergents, boots, agricultural machinery, brushes, wire goods and cereals also are produced.

Known to the Romans as Durocatalaunum, Châlons was the chief town of the Catalauni. On the open country between it and Troyes Attila was defeated by the Romans in A.D. 451 (*see* CATALAUNIAN PLAINS, BATTLE OF THE). In the 10th and following centuries it attained great prosperity under its bishops, who were ecclesiastical peers of France. In 1214 the militia of Châlons served at the battle of Bouvines; and in the 15th century the citizens twice repelled the English from their walls. In the 16th-century wars of religion the town sided with Henry IV of France, who in 1589 transferred thither the *parlement* of Paris. The camp of Châlons, about 26 km. (16 mi.) N. of the town, was established in 1856 by Napoleon III, and is a training centre for troops. In World War I Châlons was occupied by the Germans in Aug. 1914 but was retaken by Foch in September. In World War II Châlons was in German hands from June 13, 1940, until Aug. 29, 1944. It was severely bombed in April and July 1944, the cathedral suffering some damage. (P. SI.)

CHALON-SUR-SAÔNE, an industrial town of east central France, capital of an *arrondissement*, *département* of Saône-et-Loire, is 81 mi. N. of Lyons by rail. Pop. (1962) 40,056. Chalon is a well-built town, with fine quays, situated on the right bank of the Saône at its junction with the Canal du Centre. The church of St. Vincent, once the cathedral (mainly 12th–15th centuries), has a choir in the 13th-century Burgundian style. The old bishop's palace dates from the 15th century. The church of St. Peter, with two lofty steeples, is late 17th century. There are remains of the ancient ramparts and a number of old houses. The museum of fine arts and archaeology, recently enlarged, is one of the finest in Burgundy.

Chalon is the seat of a subprefect and a court of assizes, and has a court of first instance, a tribunal of commerce and a chamber of commerce. It ranks next to Le Creusot among the manufacturing towns of Burgundy. With its position as a river port, a railway centre and a crossroad on two highways connecting Paris to Lyons and Switzerland to the west of France, Chalon ranks as the chief commercial centre of the Saône valley. Mechanical and iron and steel works are the principal industries. There are two shipbuilding yards and a works that turns out bridges, tugboats, etc. Chemical and glass works, outfitting workshops and food industries also are important to the town. It is a market for cereals, wines, timber and furs.

Known to the Romans as Cabillonum, it was an important town of the Gallic tribe called the Aedui. It was chosen in the 6th century by Gontram, king of Burgundy, as his capital. The bishopric, founded in the 4th century, was suppressed at the Revolution. In feudal times Chalon was the capital of a countship. In 1237 it was given in exchange for other fiefs in the Jura by Jean le Sage, whose descendants nevertheless retained the title. Hugh IV, duke of Burgundy, the other party to the exchange, gave the citizens a communal charter in 1256. The town resisted a division of the Austrian army in 1814. In World War II the Germans occupied Chalon-sur-Saône from Nov. 1942 until Aug. 1944.

CHALUKYA, the name of two ancient Indian dynasties. The Western Chalukyas ruled as emperors in the Deccan from A.D. 543 to 757 and again from about 975 to about 1189. The Eastern Chalukyas ruled in Vengi (in eastern Andhra Pradesh) from about 624 to about 1070.

Pulakesin I, a petty chieftain of Pattadkal in the Bijapur district (*q.v.*), whose reign began in A.D. 543, took and fortified the hill-fort of Vatapi (mod. Badami) and obtained from the Kadambas of Hangal rule over the triangle between the Krishna and Tungabhadra rivers and the Western Ghats. After military successes further north his son Kirtivarman secured the valuable Konkan coast. The family then turned their attention to the fertile coastal regions in the northwest and east of the peninsula. Pulakesin II, who succeeded about 610, acquired parts of Gujarat and Malwa and defied the north Indian ruler Harsha of Kanauj, the boundary between them being fixed on the Narmada (Narbada) river. He took Vengi about 624 from the Vishnukundins and gave it to his brother Kubja Vishnuvardhana, the first "Eastern Chalukya." During 641–647 the Pallavas ravaged the Deccan and captured Vatapi but the Chalukya family had recovered by 655 and had extended their power in Gujarat. By 660 they had acquired land in Nellore district (*q.v.*). Vikramaditya I took Kanchi (Kancheepuram; *q.v.*), then the Pallava capital, about 670 and, the Pallavas' submission proving unprofitable Vikramaditya II again captured, but spared the city in 742. Kirtivarman II was superseded by the Rashtrakuta dynasty in 757.

When the last Rashtrakuta fell about 975 Taila founded the second Chalukya dynasty named after the more central capital, Kalyana (mod. Kalyan). His great achievement was to subdue the Paramaras of Malwa. The Chola king, Rajaraja I, invaded the south Deccan about 993, and repeated Chola invasions of the plateau occurred until about 1021. After many vicissitudes the dynasty were supplanted by the Kalachuri family under Bijjala, who usurped the throne about 1156–84. Somesvara IV was restored only to lose the empire in 1189 to the Yadavas (or Sevunas) of Devagiri, the Hoysalas of Dorasamudra, and the Kakatiyas of Warangal, the rulers of the Telugu-speaking parts of the Deccan.

The descendants of Kubja Vishnuvardhana had constantly to fight for the riches of Vengi, and were pawns in the struggle between the Deccan emperors and the Chola kings (*q.v.*). The Cholas eventually adopted the family, and the two countries were united under Rajendra II (Kulottunga I) whose reign began in 1070.

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(J. D. M. D.)

CHALYBITE: *see* Siderite.

CHAM, a people who, in central Vietnam, are the surviving inhabitants of Champa (*q.v.*) and who, in Cambodia, are a mixture of Chams and Malays. In Cambodia they number about 100,000 and preserve some original traits, *e.g.*, the predominance of the maternal uncle, but otherwise they are entirely integrated as prosperous Cambodian-speaking weavers and traders. From the Malays they adopted Islam, which they practise faithfully. The Chams of Vietnam (about 16,000) are rapidly being assimilated by the surrounding Vietnamese, but some speak Cham, the link between the Thai-Kadai languages of southern China and Indonesian. They are of medium build and predominantly dolichocephalic, with brown complexions. Self-supporting rice cultivators, they also carry on a small bartering trade (salt, rare woods) between the hill tribes and the Vietnamese. The family is matrilocal and matrilineal. The cult of nature spirits is all important, since ancestors' souls are supposed to settle in the earth when the tomb—near the rice fields—is abandoned after seven years of worship. The Indian culture of ancient Champa left some influences; *e.g.*, in ancient Cham temples, "brahmanes," with female mediums, perform degenerated rites in honour of Po Rome, Po Nagar and Po Klaung Garai, deified heroes of the past.

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CHAMBA, a municipality and district in Himachal Pradesh, northern India. Chamba town (pop. [1951] 6,858), district headquarters, is on the right bank of the Ravi on two terraces; the lower, called Chaugan, has public offices and Bhuri Singh museum, and the upper has the residential area. A coeducational government degree college there is connected with Punjab (Panjab) university. Many temples, dating from the 10th century, are notable for their architecture. There are two cloth weaving factories.

Chamba District (area 3,135 sq.mi.) was formed from the princely state of that name after it merged with Himachal Pradesh in 1948. It forms the isolated northwestern tract of the province and is bordered north and west by Kashmir. The mountainous terrain of the whole district reaches elevations of over 17,000 ft. in the eastern, northern and central parts. The drainage is controlled by the upper waters of the two rivers, the Ravi in the south and the Chenab (there called Chandrabhaga) in the north. Forests abound in Himalayan silver fir, pine and deodar.

The population of the district was 210,177 in 1961. The economy depends entirely upon agriculture; maize (corn), wheat, barley; some upland rice and oilseeds are grown.

The former Chamba state was founded in the 6th century and was sometimes subject to Kashmir and later to the Mogul empire. It came under British influence in 1846 and remained under British paramountcy until its merger with Himachal Pradesh.

(S. S. Bh.)

CHAMBER, KING'S, or *camera regis*, was, in England, the earliest royal financial office, part of the royal household. In varying measure at different periods it retained financial and administrative importance until far into the Tudor period. In origin it was literally the bedchamber of the early Anglo-Saxon kings. The bedchamber, together with its adjacent wardrobe (*see* Wardrobes, The), was naturally the safest place in the household, inaccessible to all but trusted servants, for the custody and storage of valuables, jewels and cash as well as clothes, equipment and eventually records and documents. It could readily become the place for receipt and payment, and its primarily domestic staff, *bedthegns*, *cubicularii*, *camerarii* or chamberlains, became engaged also in financial administration. With the growth of the king's resources, other depositories or treasuries for the storage of cash and valuables had to be found, the most important of which, from the time of King Canute at the latest, was located at Winchester.

During the Anglo-Norman period, the increase in royal financial resources necessitated an elaboration of the machinery. By the time of Henry I the *camera* or bedchamber proper, under the supervision of the master chamberlain, remained as a private apartment; but the *camera curiae* under several chamberlains continued to be the king's privy purse and the financial office of the household, receiving payments and making disbursements and always following the king. The treasury at Winchester, under a treasurer, continued as the principal depository. By the very early 12th or possibly the late 11th century, a third finance office had come into existence, destined to be the great tribunal of account, the exchequer.

The king inevitably continued to need a private treasury close to his person at all times, into which immediate payments could be made in the course of his travels, in response to writs which diverted portions of the sheriff's debts from the normal course at the exchequer, the farms of castles in the king's hands, rents, fines and casual revenues. Possibly as early as the reign of Henry I certain "chamber manors" paid their profits directly into the chamber. Rolls of the chamber were kept from 1164 but they have been lost, and the evidence for chamber finance comes either from quittances recorded on the pipe rolls of the exchequer or from indirect sources. In any event, all revenue was the king's revenue, and he could dispose of it through any available channel, according to convenience or whim.

In the time of Henry II, perhaps earlier, the chamber developed in addition administrative and secretarial functions. This development turned largely upon the acquisition by the department of a seal of its own, which it may have achieved before the reign of John, when a small or privy seal, additional to the king's seal (which by contrast soon became known as the great seal), certainly existed and was used for chamber business. With a recognized seal in its custody, the chamber sent writs to chancery to authorize the issue of documents under the great seal and so became a second secretariat readily adaptable to any administrative need. At about the same time the wardrobe became more prominent as a financial and administrative organ, especially for military and diplomatic purposes, in which it tended to specialize. The chamber itself, with the king present, continued to be the place in or through which all the royal power and discretion could be exercised; the knights and clerks of the chamber could be the king's most intimate and confidential agents for every sort of business.

The circumstances of the long minority of Henry III brought changes in the administrative machinery, for no household office could function until a king became of sufficient age to possess a normal royal household and to move seals at his will. Henry III did not obtain a privy seal of his own until Dec. 1230, and within two years, for reasons which remain mostly conjectural, this seal came to be in the custody, not of the chamber, but of the wardrobe. This change induced a magnification of the financial and administrative importance of the wardrobe and a recession of the chamber, even though the latter remained essential as the organ of household finance and the place where the king's discretion was immediately exercised. This recession remained marked until well into the reign of Edward II.

A revival in the importance of the chamber occurred with the diversion to it of large funds accruing from loans and the profits from forfeited lands, including those of the Templars before 1310 and, for a time, of the "contrariants" or opponents of the king after 1322. These arrangements brought substantial financial resources into the chamber, while the emergence of another small seal, the "secret" seal, in its custody, gave the king an effective secretariat close to himself to compensate for the increasing remoteness and formalism of the privy seal in the custody of the wardrobe. The king's personal will could be implemented in any direction by use of the secret seal. The circumstances of the deposition of Edward II and the minority of Edward III brought about another recession of the chamber, to be followed once again by revival for about 20 years from 1333. Edward III reintroduced the reservation of lands to the chamber, so that the management of estates became a major part of its work, a task facilitated by the creation of a second chamber seal, the griffin seal. With these resources at its disposal, supplemented by substantial subventions from the exchequer, the chamber played a major role in financing the wars with France. This phase in chamber history was terminated by Edward III's decision, promulgated on Jan. 20, 1356, to transfer to the exchequer almost all the reserved lands. The griffin seal thereupon disappeared. The secret seal also became obsolete before Edward III's death, and was destined to be superseded as the king's personal seal by the signet (*see* Seals). In consequence the chamber rapidly lost most of its importance in administration. It continued to receive the *certum* or regular subvention from the exchequer for household expenses; its staff of knights and chamberlains remained close to the king and available for every kind of confidential business, but there was to be no notable revival of its administrative importance until late in the 15th century.

The need to rehabilitate finances after the civil wars of Henry VI's reign induced Edward IV and his successors to revive the chamber as the most effective instrument for the exercise of royal initiative. Most of the royal lands, other than the duchy of Lancaster, were made accountable to the chamber by Edward IV, so that the funds at its disposal once again became very substantial. This revival was continued by Richard III and the Yorkist scheme was ready to hand and carried still further by Henry VII. From about 1487 the treasurer of the chamber was the most important financial officer of the crown. Not only the profits from crown lands but many other items of revenue were diverted away from the exchequer into the chamber, including the profits of wardship and other feudal dues, the proceeds of the hanaper and the law courts, the pension from France and sometimes parliamentary grants. The exchequer was now left with little but the ancient revenue; *i.e.*, the farms of the counties and towns and the customs. The treasurer of the chamber was not accountable at the exchequer, but his accounts were closely supervised by Henry VII himself and periodically audited by councilors designated for the purpose. The system was continued far into Henry VIII's reign, and completed by the statutory recognition of boards of surveyors and auditors to supervise it. The establishment of a variety of other financial organs in the 1530s greatly reduced the chamber's resources and financial pre-eminence, however, while the radical reform and revival of the exchequer in the 1550s brought the chamber to an end as anything more than a household department dependent upon other sources for its only funds.

The use of a chamber for financial purposes was universal in most of Europe in the medieval period and later. Every king and reigning prince, bishops, abbots, secular magnates, most towns, the empire and the papacy all developed a *camera* for some financial purpose, and each possessed a history of its own, which differed materially from that of the kings of England.

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CHAMBERLAIN, SIR (JOSEPH) AUSTEN (1863–1937), British statesman whose long and distinguished career reached its climax in the foreign secretaryship from 1924 to 1929, was the eldest son of Joseph Chamberlain by his first wife, Harriet Kenrick. He was born at Birmingham on Oct. 16, 1863. After leaving Rugby school he went to Trinity college, Cambridge, and afterward studied in Paris and Berlin. He served first as his father's private secretary, entered parliament in 1892 and remained an M.P. until his death. He was civil lord of the admiralty (1895–1900), financial secretary to the treasury (1900–02) and postmaster general (1902) in the governments of Lord Salisbury and A. J. Balfour, while his father was colonial secretary.

When his father resigned as colonial secretary in 1903 in order to advocate a policy of tariffs which did not commend itself to most of his colleagues, Austen (a lifelong supporter of a protective tariff) remained in the government, with his father's blessing, and was made chancellor of the exchequer (1903–05). During the term of the Liberal government he was active in opposition, and on Balfour's resignation from the leadership of the Conservative party in 1911 he was a strong candidate for the succession. He and his rival, Walter (afterward Viscount) Long, being equally matched, however, both withdrew in favour of Andrew Bonar Law.

When H. H. Asquith formed the first coalition government in May 1915, Chamberlain joined it as secretary of state for India and remained in that post under David Lloyd George's prime ministership. He resigned in July 1917 as a result of criticism of his department for the deficiencies in medical and other supplies for the disastrous Mesopotamia campaign, though no blame attached to him personally. He re-entered the government in April 1918 as a member of the war cabinet, and in Lloyd George's peacetime coalition he became chancellor of the exchequer (Jan. 1919). In March 1921, on Bonar Law's retirement because of poor health, he was elected leader of the Conservative party and became lord privy seal and leader of the house of commons. He was a loyal supporter of Lloyd George and the coalition government, particularly over the Anglo-Irish treaty of Dec. 1921, in the negotiations for which he took a leading part. Discontent grew, however, among the Conservatives, and led to the Carlton club meeting of Oct. 19, 1922, at which the Conservatives decided to withdraw from the coalition and thus brought it to an end. Chamberlain opposed this decision and resigned the leadership, being succeeded by Bonar Law. He remained outside the government during the ministries of Bonar Law and Stanley Baldwin (1922–24), but returned to office as foreign secretary in Baldwin's second government (Nov. 1924–June 1929).

As foreign secretary, Chamberlain's greatest achievement was the Locarno pact (Oct. 1925) by which Germany's western frontiers were mutually guaranteed by Great Britain, France, Italy, Belgium and Germany, and Germany's entry into the League of Nations was assured. The "Locarno spirit," supplemented by frequent meetings of Chamberlain and the French and German foreign ministers, Aristide Briand and Gustav Stresemann, at sessions of the League of Nations, seemed to promise an era of peace. Chamberlain was rewarded with the knighthood of the Garter on Nov. 30, 1925. He was co-winner (with Charles Dawes) of the 1925 Nobel peace prize and Briand and Stresemann shared the award a year later. Later events clouded his popularity, among them the breaking-off of diplomatic relations with U.S.S.R. after a police raid in the building occupied by Arcos, the Russian state trading agency (May 1927), the failure of the Geneva conference on naval disarmament (Aug. 1927), the abortive and unnecessarily secret Anglo-French negotiations for disarmament in July 1928 and his dealings with China (1927) and Egypt.

When the national government of Ramsay MacDonald was formed in Aug. 1931 Chamberlain became first lord of the admiralty. His brief tenure of the office coincided with the naval mutiny at Invergordon against the scale of the economy cuts in pay (Sept. 15), for which he was not to blame. He held no office after the general election of Oct. 1931, but remained in parliament as a respected and influential elder statesman. He died in London on March 16, 1937. In appearance rather stiff (like his father, he always wore a monocle), Chamberlain was the most loyal of colleagues, hard working, shrewd and formidable in debate. He published two volumes of memoirs, *Down the Years* (1935) and *Politics From Inside* (1936).

See Charles Petrie, *Life and Letters of . . . Sir Austen Chamberlain*, 2 vol. (1939–40). (C. L. M.)

CHAMBERLAIN, CHARLES JOSEPH (1863–1943), U.S. plant morphologist and cytologist, was born near Sullivan, O., on Feb. 23, 1863, and educated at Oberlin college, graduating in 1888. Most of his life he was connected with The University of Chicago, from which he obtained the degree of Ph.D. in 1897 and Sci.D. in 1923. He became instructor there in 1901, after which he spent one year in Bonn, Ger., working in the laboratory of Eduard Strasburger. After his return to Chicago he was appointed assistant professor in 1907 and associate professor in 1911; he was professor of plant morphology and cytology from 1915 until his retirement in 1931. Chamberlain's work in organizing the university's botanical laboratories was fundamental, and he was in charge of them from the beginning. His interest in the morphology and life history of cycads caused him to make many exploring trips, which resulted in the assembling of a complete collection of living cycads in the greenhouses of the university. He visited Mexico in 1904, 1906, 1908 and 1910 and made a long journey in 1911–12 to New Zealand and Australia, returning through South Africa. In 1914 and 1922 he collected specimens in Cuba. He died on Feb. 5, 1943.

Chamberlain's publications include *Morphology of Spermatophytes* (1901), *Morphology of Angiosperms* (1903) and *Morphology of Gymnosperms* (1910; 2nd ed., 1917), all in collaboration with J. M. Coulter; among his other works are *Methods in Plant Histology* (1901; 5th ed., 1932) and *Gymnosperms, Structure and Evolution* (1935).

CHAMBERLAIN, HOUSTON STEWART (1855–1927), British-born political philosopher, whose theories on the racial superiority of the so-called Aryan element in European culture influenced the development of National Socialism (*q.v.*), was born in Southsea, Eng., on Sept. 9, 1855, the son of an admiral and nephew of Sir Neville Bowles Chamberlain. Prevented by ill-health from entering the army, after going to school at Cheltenham and in Paris, he studied natural science at Geneva (1879–84) and in Vienna. He became an ardent admirer of Richard Wagner and his first book, published in France in 1892, was *Notes sur Lohengrin;* other books on Wagner included *Das Drama Richard Wagners* and a biography emphasizing the Teutonic element in Wagner's thought. In 1908 he settled in Bayreuth, and married, as his second wife, Wagner's daughter, Eva.

Chamberlain's most important work, *Die Grundlagen des neunzehnten Jahrhunderts*, a brilliant though biased historical resumé of the whole range of European thought and culture, was published in 1899; an English translation, *The Foundations of the 19th Century*, with an introduction by Lord Redesdale, appeared in 1911. In it Chamberlain expounded what he meant by the quality "Germanism," which he regarded as being the source of all that is best in the European tradition. The Germans, for him, included all those belonging to the western Aryan group of peoples, and were, he felt, the nation best suited to establish a new European order. His anti-Semitism, which was developed and exploited by later thinkers, was based on the idea that the Jews introduced an alien note into European history and tended to debase the culture of those with whom they became assimilated. His theories, which owed much to the writings of the comte de Gobineau (*q.v.*), gained force because they provided a rational basis for the prevalent emotional pan-Germanism and nationalism.

Chamberlain became increasingly German in feeling and supported Germany in World War I, becoming naturalized in 1916. He died in Bayreuth on Jan. 9, 1927. His other works include studies of Kant (1905) and Goethe (1912); and *Lebenswege meines Denkens* (1919).

CHAMBERLAIN, JOSEPH (1836–1914), British statesman, famous as the champion of imperial unity and tariff reform, was born in London on July 8, 1836. His father, Joseph Chamberlain, master of the Cordwainers' company, carried on a family business of boot and shoe manufacture, was a Unitarian in religion and a Liberal in politics. Young Joseph entered the family business in 1852, spent two years in his father's London office and was then sent to Birmingham to represent his father's interest in the firm of Nettlefold, screw manufacturers. He proved an exceptionally successful businessman and was able to retire in 1874 with a fortune of £100,000.

Local Politics.—Chamberlain entered the municipal and political life of Birmingham in 1868 when the local Liberal association was reorganized. He held advanced radical opinions and was in favour of a program of "free church, free land, free schools, free labour." He was elected to the town council in 1869 and from then till 1873 worked for the realization of various projects of municipal reform. In 1873 the Liberals gained control of the council and Chamberlain was chosen mayor, an office he retained by re-election until June 1876.

Chamberlain's work as mayor of Birmingham set an example which revolutionized English municipal life. The conference of local sanitary authorities summoned by him and held in Jan. 1875 was the beginning of the modern movement for better and healthier organization of town life. In Birmingham he carried through the municipalization of the gas and water supply and the improvement scheme by which slums were cleared away and 40 ac. laid out in new streets and open spaces. New municipal buildings were erected, Highgate park was opened for recreation and the free library and art gallery were developed. By his share in these reforms Chamberlain became not only one of Birmingham's most popular citizens but also a man of mark outside. He was a cool and hard-hitting orator, and his spare figure, incisive features and single eyeglass soon made him a favourite subject for the caricaturist. In private life he showed loyalty to his friends and what John Morley described as "a genius for friendship." His aggressiveness, however, made his actions and speeches the object of more controversy than was the lot of any other politician of his time. It may be added that his interest in Birmingham remained undiminished during his life. He was the founder and first chancellor of Birmingham university (1900). At his express wish, his family declined an offer for his burial in Westminster abbey so that he might be buried at Birmingham.

Parliamentary Beginnings.—At the general election of 1874 Chamberlain had stood unsuccessfully as parliamentary candidate for Sheffield. In 1876 he was returned to the house of commons, unopposed, as a member of parliament for Birmingham—John Bright's colleague. He had already shown much interest in education (having become chairman of the executive council of the new National Education league in 1870) and his maiden speech in the commons (Aug. 4, 1876) was on Lord Sandon's education bill. At this period, too, he paid considerable attention to the question of licensing reform.

After the general election of 1880 the prime minister, W. E. Gladstone, was compelled to recognize the services of the radicals in the election by the inclusion of Sir Charles Dilke and Chamberlain, who were sworn allies, in the new ministry. They had resolved together that one of them must be in the cabinet. Chamberlain, willing to give the preference to Dilke, was himself chosen as president of the board of trade. Dilke became undersecretary for foreign affairs but, at the end of 1882, he too entered the cabinet as president of the Local Government board, and the alliance between the two rising ministers was more powerful than ever. Gladstone, however, turned rather to his old friends, Lord Granville and Lord Spencer, and had little personal sympathy with the new men. Dilke and Chamberlain stood for more far-reaching social reforms at home than their elder colleagues, and they also differed on foreign affairs, demanding more vigorous measures in Egypt after the massacre at Alexandria (1882).

Irish Policy.—The deepest fissure, however, was on Irish policy. Chamberlain hated coercion, and in 1882 he was authorized to negotiate with the Irish Nationalist leader Charles Stewart Parnell. The result was the "Kilmainham treaty." Parnell, on May 2, 1882, was released from Kilmainham jail, having agreed to advise the cessation of outrages and the payment of rent, while Gladstone's ministry was to relax its coercive administration. Thereupon, W. E. Forster, the Irish secretary, resigned. His successor, Lord Frederick Cavendish, was immediately murdered in Phoenix park, Dublin. Chamberlain, conspicuously marked out for the post of danger, was prepared to face the risk but was not appointed. Eventually, in 1885, after indirect negotiation with Parnell through Capt. William O'Shea, he placed before the cabinet a plan which would have devolved extensive autonomous powers on the Irish government without weakening the imperial connection. When his proposals came before the cabinet (May 9) all the members of the house of lords except Granville voted against them; of the members of the house of commons only the marquess of Hartington (afterward duke of Devonshire) opposed them. Proposals for a Coercion bill and a Land Purchase bill were then put forward. Dilke and Chamberlain resigned, but the resignations did not take effect before the government was defeated on the budget (June 8, 1885). Both before and after the defeat Chamberlain associated himself with what was known as the "unauthorized program"; *i.e.*, free education, small holdings for agricultural labourers, graduated taxation and local government.

At the general election of Nov. 1885 Chamberlain was returned for West Birmingham. The Liberal strength in the nation generally was, however, reduced so that the Irish vote became necessary to Gladstone if he was to command a majority. Chamberlain had an open mind on the Irish question. He foresaw that between Home Rule and separation there was but a step, and in a letter written on Dec. 26 he went so far as to discuss a federalist scheme for the British Isles with five separate parliaments. In December it was stated that Gladstone intended to propose Home Rule for Ireland, and when the new parliament met in Jan. 1886 Lord Salisbury's ministry was defeated. Lord Hartington and some other Liberals declined to join Gladstone in view of the altered attitude he was adopting toward Ireland, but Chamberlain—stipulating for liberty of judgment on the prime minister's Irish policy when embodied in definite legislative shape—entered the cabinet as president of the Local Government board. On March 15, 1886, he resigned, explaining in the house of commons (April 8) that while he had always been in favour of the largest extension of local government to Ireland consistent with the integrity of the empire and the supremacy of the imperial parliament, he was unable to recognize that the scheme communicated by Gladstone to his colleagues maintained those conditions. In May the followers of Bright and Chamberlain, and those of Lord Hartington, decided to vote against the second reading of the Home Rule bill instead of pressing for modifications in committee, and on June 7 the bill was defeated, 93 Liberal Unionists—as they were generally called—voting against the government. Chamberlain was the object of bitter attacks from the Gladstonians for his share in this result. The ensuing general election, however, returned to parliament 316 Conservatives, 78 Liberal Unionists and only 276 Gladstonians and Nationalists. When the house met in Aug. 1886 it was decided by the Liberal Unionists, under Hartington's leadership, that their policy henceforth was essentially to keep Gladstone out. However, the old Liberal feeling still prevailing among them was too strong to permit their leaders to take office in a coalition ministry. Instead, Chamberlain determined to impose a progressive social policy on the Conservatives as the price of his indispensable support on the Irish question.

Chamberlain's view on domestic legislation transformed the Conservative party. Before 1892 he had the satisfaction of seeing Lord Salisbury's ministry pass such measures of social reform as those dealing with coal mines regulation, allotments, county councils, housing of the working classes, free education and agricultural holdings, besides Irish legislation like the Ashbourne act, the Land act of 1891 and the Light Railways and Congested District acts. In Oct. 1887 Chamberlain was selected by the government as one of the British plenipotentiaries to discuss the Canadian fisheries dispute with the United States, and a treaty was signed at Washington, D.C., on Feb. 15, 1888, which proved to be a real settlement.

At the general election of 1892 Chamberlain was re-elected for West Birmingham with an increased majority, but the Unionist party as a whole was narrowly defeated. The Irish Nationalist vote again held the balance in the house of commons and, with a small and precarious majority, Gladstone, on Feb. 13, 1893, introduced his second Home Rule bill. During the 82 days' discussion in the house of commons Chamberlain was its most unsparing critic.

Colonial Secretary.—In 1895, at his own request, Chamberlain became secretary of state for the colonies in Lord Salisbury's ministry. His influence in the Unionist cabinet was soon visible in the Workmen's Compensation act. However, after the Jameson raid (Dec. 1895) South Africa demanded the chief attention of the colonial secretary (*see* South Africa, Republic of; Transvaal). In his negotiations with Pres. Paul Kruger one masterful temperament was pitted against another. Chamberlain had a difficult part to play in a situation dominated by suspicion on both sides.

The report of a commons committee (July 1897) definitely acquitted both Chamberlain and the colonial office of any privity in the Jameson raid, but Chamberlain's detractors continued to assert the contrary. Opposition hostility reached such a pitch that in 1899 there was hardly an act of the cabinet during the negotiations with President Kruger which was not attributed to the personal malignity and unscrupulousness of the colonial secretary. The Bloemfontein conference of 1899 was a serious attempt to secure amicable agreement, but its failure did not deter Chamberlain from making repeated efforts to ensure peace. Once the South African War had begun, however, Chamberlain was the mainstay of British public opinion when nearly all the world was hostile. The "khaki" election, held at a moment of victory in 1900, was fought in effect under Chamberlain's leadership and on his policies.

Chamberlain's tenure of the office of colonial secretary between 1895 and 1900 must always be regarded as a turning point in the history of the relations between the British colonies and the mother country. In spirit he was an imperial federationist even before his separation from Gladstone. From 1887 onward he worked for the establishment of friendly relations between the different parts of the empire for purposes of defense and commerce. One of his successful achievements was the Australian Commonwealth act of 1900.

The support Great Britain received from the self-governing colonies during the South African War intensified Chamberlain's imperialism, and he became increasingly absorbed by the ideal of a united empire. The settlement after the war was full of difficulties, financial and other, in South Africa. In Nov. 1902 Chamberlain, bent upon a conciliatory settlement with the Boers, went to South Africa. He arranged with the leading Transvaal financiers that in return for support from the British government in raising a Transvaal loan they would guarantee a contribution of £30,000,000 which, by so much, should repay the British treasury the cost of the war.

Tariff Reform.—At the imperial conference of 1902 the attitude of the overseas premiers had shown that the only way toward a closer political union of the whole empire was on lines of mutually preferential commerce, deviating from the strict traditional doctrines of free trade. Chamberlain therefore decided to introduce a measure of imperial preference. As a first step he proposed that the shilling registration duty on imported grain, which had been reintroduced in the budget of 1902, should be remitted in favour of the colonies. C. T. (afterward Lord) Ritchie, the chancellor of the exchequer, demurred, but Chamberlain believed that he had convinced the rest of the cabinet and particularly the new prime minister, A. J. Balfour. While Chamberlain was in South Africa, however, Ritchie persuaded the cabinet members to change their minds, and Chamberlain returned, shortly before the introduction of the budget, to find that his proposal had been dropped. For the moment he remained in the cabinet, but the seed of dissension was sown. The first public expression of his views was given in an epoch-making speech to his constituents at Birmingham (May 15, 1903), when he outlined a plan for raising more money by a rearranged tariff, partly to obtain a preferential system for the empire and partly to produce funds for social reform at home. The fact that Chamberlain's policy involved the taxation of food gave his opponents a welcome opportunity to work up an extensive agitation against "the dear loaf." Chamberlain argued that since 1870 certain other countries (Germany and the United States) with protective tariffs had increased their trade in much larger proportion, while English trade had been chiefly maintained by the increased business done with British colonies. A scientific inquiry into the facts was needed. Balfour managed to hold his colleagues and party together by taking the line that particular opinions on economic subjects should not be made a test of party loyalty. However, the activities of the Tariff Reform league, founded to further Chamberlain's policy, aroused Chamberlain's free-trade colleagues inside the cabinet, and in Sept. 1903 the crisis came to a head. The public had its first intimation of impending events with the appearance on Sept. 16 of Balfour's *Economic Notes on Insular Free Trade.* The next day appeared the board of trade fiscal blue book, and on the 18th conflicting resignations were announced—not only of the more rigid free traders in the cabinet, Ritchie, Lord Balfour of Burleigh and Lord George Hamilton, but also of Chamberlain himself for the opposite reason.

A cordial exchange of letters between Chamberlain and Balfour was published. Chamberlain pointed out that he was committed to a preferential scheme involving new duties on food and could not remain in the government without prejudice while it was excluded from the party program. Remaining loyal to Balfour and his general objects, he could best promote this course from outside. Balfour, while reluctantly admitting the necessity of Chamberlain's taking a freer hand, expressed his agreement in the desirability of a closer fiscal union with the colonies, but questioned the immediate practicability of any specific plan. He was willing to adopt fiscal reform so far as it covered retaliatory duties, but thought that the exclusion of taxation of food from the party program was in existing circumstances necessary, so long as public opinion was not ripe. The fact that Chamberlain's son, Austen, remained in the cabinet and was promoted chancellor of the exchequer suggested that there was an underlying agreement between Chamberlain and Balfour and that the two would join forces again once Chamberlain had won over public opinion to his policy.

The tariff reform movement itself was now outside the purely official program, and Chamberlain (backed by a majority of the Unionist members) threw himself with impetuous ardour into a crusade on its behalf. On Oct. 6, 1903, he opened his campaign with a speech at Glasgow. His positive proposals were: (1) no tax on raw materials; (2) a small tax on food other than colonial, *e.g.*, two shillings a quarter (eight bushels) on foreign grain other than maize and 5% on meat and dairy produce excluding bacon; (3) a 10% general tariff on imported manufactured goods. To meet any increased cost of living, he proposed to reduce the duties on tea, sugar and other articles of general consumption. This speech was the type of others that followed quickly during the year. At Greenock he emphasized the necessity of retaliating against foreign tariffs: "Agriculture has been practically destroyed, sugar has gone, silk has gone, iron is threatened, wool is threatened, cotton will go! How long are you going to stand it?" On Jan. 18, 1904, Chamberlain ended his series of speeches by a meeting at the Guildhall, in the City of London, the keynote being his exhortation to his audience to "think imperially." In the session of 1904 he tried to persuade Balfour to go to the country in the autumn on a policy of tariff reform. He failed in this and, instead, launched a second public campaign.

In Jan. 1905 correspondence was published between Chamberlain and the duke of Devonshire relating to difficulties arising from the central Liberal Unionist organization's subsidizing local associations which had adopted the program of tariff reform. The duke objected to this departure from neutrality. Chamberlain retorted that this was a matter for a general meeting of delegates to decide. If the duke was outvoted he might resign his presidency. For his own part he was prepared to allow the local associations to be subsidized impartially, so long as they supported the government, but he was not prepared for the violent disruption, which the duke apparently contemplated, of an association so necessary to the success of the Unionist cause. The duke replied that the differences between them were vital, and he would not be responsible for dividing the association into sections, but would rather resign. Chamberlain then called a general meeting in February, when a new constitution was proposed. In May, at the annual meeting of the Liberal Unionist council, the "free food" Unionists, being in a minority, retired, and the association was reorganized under Chamberlain's auspices, Lord Lansdowne and Lord Selborne (both cabinet ministers) becoming vice-presidents. Meanwhile Chamberlain's supporters in the Conservative party succeeded at three successive party conferences (1903, 1904 and 1905) in carrying, by overwhelming majorities, resolutions in favour of tariff reform.

In reply to Balfour's appeal for the sinking of differences (Newcastle, Nov. 14, 1905), Chamberlain insisted at Bristol (Nov. 21) on the adoption of his fiscal policy; and Balfour resigned on

Dec. 4 on the ground that he no longer retained the confidence of the party. At the crushing Unionist defeat in the general election in Jan. 1906, Chamberlain was triumphantly returned for West Birmingham and all the other divisions of Birmingham returned Chamberlainite members. This, by contrast with the national disaster to the Unionist party as a whole, was one of the most astonishing events in British electoral history.

In the first weeks of the session of 1906 Chamberlain acted as leader of the opposition, but he had no desire to set himself up as leader in Balfour's place and a common platform was arranged between them on which Balfour should continue to lead the remnant of the party. A letter from Balfour of Feb. 14 admitted the necessity of making fiscal reform the first plank in the Unionist platform and accepted a general tariff on manufactured goods and a small duty on foreign grain.

Chamberlain's own political activity was cut short in the middle of the session of 1906. His 70th birthday was celebrated in Birmingham with immense enthusiasm, but the effort of this celebration on top of years of overwork proved too much. Immediately afterward he had a stroke of paralysis. For some time his adherents hoped that he might return to the house of commons, but he was never able to speak in public again and although he was returned unopposed at the general elections of 1910, he appeared in the commons on only two occasions.

He died at his house in London on July 2, 1914. In his last speech (July 9, 1906) he had uttered words which may fairly be given as his political testament: "The union of the Empire," he said, "must be preceded and accompanied by a better understanding, by a better sympathy. To secure that is the highest object of statesmanship now at the beginning of the 20th century; and if these were the last words that I were permitted to utter to you, I would rejoice to utter them in your presence, and with your approval. I know that the fruition of our hopes is certain."

In municipal, national and imperial politics alike, Chamberlain showed himself essentially a constructive radical, more concerned with getting things done than with theoretical considerations or party loyalties. His progress from the extreme left wing of Liberalism to the leadership of the imperialist movement epitomizes the rise of the industrial middle classes of Britain in the period between the first Reform bill and World War I. However, his championship of social reform, foreign alliances, imperialism and protection was, in each case, a direct challenge to the prevailing doctrines of *laissez faire*, "splendid isolation" and free trade. He was thus a forerunner and inspirer of the themes that were to dominate British politics in the generation following his death.

Chamberlain married three times: in 1861, Harriet Kenrick (d. 1863); in 1868, Florence Kenrick (d. 1875), a cousin of his first wife; and in 1888 Mary Endicott, daughter of the U.S. secretary of war in Pres. Grover Cleveland's first administration. His two sons, Austen (by his first wife) and Neville (by his second), both rose to political prominence and are separately noted.

See also references under "Chamberlain, Joseph" in the Index volume.

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CHAMBERLAIN, (ARTHUR) NEVILLE (1869–1940), British statesman whose name is closely associated with the policy of "appeasement" toward Germany in the years immediately preceding World War II, was prime minister from 1937 to 1940. He was born at Edgbaston, Birmingham, on March 18, 1869, the son of Joseph Chamberlain (*q.v.*) by his second wife, Florence Kenrick. Intended for a business career, he was educated at Rugby and at Mason college, Birmingham (later Birmingham university), and then went to Andros Island in the Bahamas, where for seven lonely years he struggled unsuccessfully to bring a sisal plantation of his father's to prosperity. On his return in 1897 he entered business in Birmingham. He was chairman and manager of two small but successful metalworking firms, active in the chamber of commerce and chairman of the general hospital. He entered the city council in 1911 and was lord mayor in 1915; Birmingham's unique municipal savings bank, started in 1916, was his creation. He was brought to London by David Lloyd George, then prime minister, as director-general of national service in Dec. 1916, but was given insufficient powers and resigned after seven months. His consequent dislike for Lloyd George was never forgotten, and was an important factor in the later careers of both men, spurring Chamberlain to vindicate himself in a political career.

Chamberlain entered parliament in his 50th year, being elected, as a Conservative, for the Ladywood division of Birmingham in the general election of Dec. 1918. When Lloyd George's coalition government fell in Oct. 1922, Chamberlain temporarily parted company with his half-brother Austen and joined the Conservative government of Andrew Bonar Law as postmaster general. In Feb. 1923 he entered the cabinet as minister of health, and in August he became chancellor of the exchequer in Stanley Baldwin's government (which fell in the following January). On the return of the Conservatives to power in Nov. 1924, he again became minister of health. As such, he was responsible for a notable program of legislation, particularly widows', orphans' and old-age contributory pensions (1925) and the Local Government act, 1929. His position as potential leader of the party in succession to Baldwin was now assured, and was strengthened by his reorganization of the Conservative central office as chairman of the party in 1930.

Chamberlain played a large part, as Baldwin's deputy, in the formation of the national government of Ramsay MacDonald in Aug. 1931, and was minister of health in it. After the return of the national government at the general election of Oct. 1931 he became chancellor of the exchequer. His main achievements during his five and a half years' tenure of this office were the maintenance of a balanced budget, the ending of the "economy cuts" in 1934–35, the conversion of £2,000,000,000 of 5% war loan to $3\frac{1}{2}$% in 1932, the beginning of rearmament in 1934 and the introduction of a general tariff—his father's old ambition—in the Import Duties act of 1932. He supported the policy of sanctions against Italy at the start of the Abyssinian war in 1935, but was the first member of the cabinet to advocate publicly their abandonment in 1936.

Chamberlain succeeded Baldwin as prime minister on May 28, 1937. His term of office was dominated by the aggressions of Hitler's Germany in Europe, which Chamberlain attempted to limit by diplomatic negotiations in which he took, for a prime minister, an unusually large and personal part. His policy of appeasement, generally popular at the time, aimed first to detach Italy from Germany (the Anglo-Italian agreement of April 16, 1938). It culminated in his three visits, by air, to Hitler in Sept. 1938 in order to prevent Germany's demands for the cession of the Sudeten territories by Czechoslovakia from leading to a general European war. The Munich agreement (Sept. 30) conceded to Hitler virtually all his demands and left Czechoslovakia defenseless. Chamberlain returned a popular hero, but the precariousness of the peace was shown by the great acceleration of rearmament which he immediately instituted. When Hitler seized the rest of Czechoslovakia on March 15, 1939, Chamberlain abandoned appeasement, and on March 31 announced that Great Britain would guarantee to Poland its assistance against a similar attack. Military conscription (for the first time during peace) was introduced in April. Chamberlain's efforts were now directed toward preparing for war while attempting to discourage Hitler from making it, both by warning him that Great Britain would fight and by attempting to negotiate a pact of mutual assistance between Great Britain, France and the U.S.S.R. in the event of war. The conclusion of the Soviet-German treaty on Aug. 23 frustrated this policy. When the Germans attacked Poland on Sept. 1, Chamberlain countered with Great Britain's declaration of war on Germany on Sept. 3.

Chamberlain remained prime minister during the period of the "phony war," reforming his cabinet to include Winston Churchill; Liberals and Labour refused to join it. After the failure of the

British expedition to Norway in April 1940, Chamberlain's policies were debated in the house of commons, and the defection of his Conservative critics so reduced his majority that he resigned on May 10 (the day of the German invasion of the Low Countries). He remained in Churchill's coalition government as lord president of the council until ill-health compelled him to resign this office and the leadership of the Conservative party on Sept. 30. He died at Heckfield, near Reading, on Nov. 9, 1940.

In appearance, Chamberlain was somewhat harsh and gloomy. He was an able executive, very clearheaded, rather autocratic in manner (particularly as prime minister) and intolerant of minds weaker than his own. He was perhaps too ready to believe Hitler's fair words and to sacrifice Czechoslovakia at Munich, but he strove hard and bravely to preserve peace, convinced that his policy was the only possible one, and he brought the British peoples into the war, when it came, united. His supporters claim that by the Munich agreement Britain gained valuable time for rearmament; his critics argue that the loss of possible allies in 1938 offset this advantage. His support of Churchill as his successor in 1940 was magnanimous and invaluable.

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CHAMBERLAIN, OWEN (1920–), U.S. physicist and Nobel prize winner, who with Emilio Segrè confirmed the existence of the antiproton, was born in San Francisco, Calif., on July 10, 1920. After he was graduated from Dartmouth college (1941), he served from 1942 to 1946 as a physicist with the Manhattan Engineering District, the project which developed the atomic bomb. He later worked at the Argonne National laboratory near Chicago, Ill., while completing studies for his Ph.D. in physics at The University of Chicago. In 1948 he joined the faculty of the University of California, where his research dealt with alpha-particle decay, neutron diffraction in liquids and high-energy nucleon scattering. He and Segrè, using the proton beam from the powerful bevatron at the University of California's radiation laboratory in Livermore, produced antiprotons (1955). A negatively-charged elementary particle, the antiproton had been long thought to exist, but its existence had not previously been proven. For their discovery, Chamberlain and Segrè were awarded the 1959 Nobel prize in physics.

CHAMBERLAIN, originally an officer of a sovereign's court, charged with the superintendence of certain domestic affairs. The functions of chamberlains, however, differed according to the two meanings acquired in the early middle ages by the Latin word *camera,* which might denote (1) the royal treasury or (2) the king's bedchamber. Whereas the *camerarius* of the Carolingian sovereigns of western Europe was their treasurer, the terms *camberlanus* and *cambellanus* came to be used in medieval Latin as synonyms for *cubicularius,* the proper designation of an official whose function was to attend on the king's person, as the *praefectus sacri cubiculi* ("prefect of the sacred bedchamber") had attended on the Roman emperors.

England.—The *hordere* (Lat. *thesaurarius*) under the Anglo-Saxon kings was the equivalent of the Carolingian *camerarius,* namely the royal treasurer. With the marshal, he was the principal officer of the king's court. After the Norman conquest the chamberlain's functions became manifold. As he had charge of the administration of the royal household, his office was of financial importance, for a portion of the royal revenue was paid, not into the exchequer, but into the *camera regis.* In time the office became hereditary and titular, but the complexity of the duties necessitated a division of the work, and the office was split up into three: the hereditary and sinecure office of *magister camerarius* or lord great chamberlain (*q.v.*); the more important domestic office of *camerarius regis,* king's chamberlain or lord chamberlain (*q.v.*); and the chamberlains (*camerarii*) of the exchequer, who were originally representatives of the chamberlain at the exchequer and afterward in conjunction with the treasurer presided over that department. In 1826 the last of these officials died, when by an act passed 44 years earlier they disappeared.

The modern English representatives of royal chamberlains in the sense of *cubicularii* are the gentlemen and grooms of the bedchamber.

France.—The successor of the Carolingian *camerarius* in the French kingdom was the *grand chambrier de France,* whose *chamberie* came to be held as a fief of the crown. Held by great nobles seldom at court, this office became more and more honorary until it disappeared with Henry II's accession to the crown (Henry himself had previously held it). Meanwhile its functions had long been overshadowed by the growing power of the *chamberlains* (Lat. *cubicularii, cambellani,* but sometimes even *camerarii* also), who had originally been men of low birth in attendance on the king's person. As the office of the *grand chambrier* declined, so the *chamberlains* advanced in numbers and in rank until, in the 13th century, one of them emerges as a great officer of state, the *chambellan de France* or *grand chambellan,* who at times shares with the *grand chambrier* the revenues derived from certain trades in the city of Paris. The office of *grand chambellan,* which in its turn soon became purely honorary, survived till the Revolution. Among the prerogatives of the *grand chambellan* was the right to hand the king his shirt at the ceremonial levee. The offices of *grand chambellan, premier chambellan* and *chambellan* were revived by Napoleon, continued under the Restoration, abolished by Louis Philippe and restored by Napoleon III.

Germany.—The *Erzkämmerer* (*archicamerarius,* "archchamberlain") of the Holy Roman empire represented the Carolingian *camerarius* in later times. This office was a hereditary perquisite of the electors of Brandenburg from 1415. The term equivalent to *cubicularius* was *Kämmerer* in Austria and in Bavaria, *Kammerherr* or *Kammerjunker* elsewhere in Germany. These personal chamberlains used to carry a golden key attached to the back of their coats as insignia of their office.

The Vatican.—In the Roman curia the apostolic chamberlain (*camerarius;* It. *camerlengo*) is at the head of the treasury of the Holy Roman Church and, in the days of the temporal power, not only administered the papal finances but possessed an extensive civil and criminal jurisdiction. During a vacancy of the Holy See he is at the head of the administration of the Roman Catholic Church. The office dates from the 11th century, when it superseded that of archdeacon of the church. The various privy chamberlains of the papal *famiglia,* on the other hand, are *cubicularii* (It. *camerieri; see* VATICAN, THE).

Other Uses of the Term.—Monasteries and cathedrals used also to have chamberlains, in imitation of the courts of secular princes. These chamberlains had charge of the finances, gave notice of chapter meetings and provided the materials necessary for religious services. Likewise, corporations appoint a chamberlain. The chamberlain of the corporation of the City of London, for instance, is the treasurer of the corporation, admits persons to the freedom of the City and, in the chamberlain's court, of which he and the vice-chamberlain are judges, exercises concurrent jurisdiction with the police court in determining disputes between masters and apprentices. Formerly nominated by the crown, after 1688 he was elected annually by the liverymen.

CHAMBERLAYNE, WILLIAM (1619–1689), English poet whose heroic verse romance *Pharonnida* (1659) offers to those who brave its complexities and length some treasures of poetic invention and imagery. Born in 1619 at Shaftesbury, Dorset, he practised there as a physician, fought on the royalist side in the Civil War, being present at the second battle of Newbury, and died at Shaftesbury in Jan. 1689. His royalist feeling is shown in his tragicomedy, *Love's Victory* (1658), which has fine lines hidden among its bombast, and in *England's Jubile* (1660), a poem in honour of the Restoration. The poet Robert Southey and the critic George Saintsbury both praised Chamberlayne, and the latter reprinted *Pharonnida* in his *Minor Poets of the Caroline Period,* vol. i (1905). S. W. Singer also reprinted *Pharonnida* and *Love's Victory* in 1820.

CHAMBERLEN, the name of a family of English medical men, whose claim to remembrance is the parts they played in the introduction of the midwifery (obstetrical) forceps.

William Chamberlen, the founder of the family, went to England as a Huguenot refugee in 1569. His son Peter Chamberlen the elder (d. 1631) was a surgeon at Southampton and later in London, where he was admitted to the Barber Surgeons' company. He enjoyed a great reputation as an accoucheur and attended the queens of James I and Charles I. In spite of his connection with the court, he was in constant conflict with the College of Physicians because of his alleged irregular practice. Peter Chamberlen the younger (1572–1626), his younger brother, practised as surgeon and man midwife in London and was also often in conflict with the licensing authorities. In 1616 he put forward an unsuccessful scheme for the incorporation of the midwives in London. Peter Chamberlen (1601–83), son of Peter Chamberlen the younger, one of the physicians to Charles II, attempted to revive his father's scheme for a company of midwives and was also known as an advocate of public baths. Hugh Chamberlen the elder (1630–?), his eldest son, is best known as the originator of various projects relating to land banks, state medical services and the prevention of plague. His eldest son, also Hugh Chamberlen (1664–1728), was a fashionable physician who numbered among his patients Dean Swift and Bishop Atterbury. There is a monument to him in Westminster abbey. Paul Chamberlen (1635–1717), the second son of Peter, practised as an accoucheur in London and invented a quack remedy known as the "anodyne necklace" to facilitate the cutting of babies' teeth.

It is probable that the first Peter Chamberlen was the inventor of the midwifery forceps, but Hugh Chamberlen the elder was the chief exploiter of the family secret and by his position as accoucheur at the court and his contacts abroad did most to spread the use of the forceps. The forceps themselves were lost to the world for more than 100 years until in 1813 four sets were discovered in a box hidden under a floor board at Woodham Mortimer hall, near Maldon, Essex, a house occupied by Peter Chamberlen in the time of Charles II. The secrecy which the Chamberlens maintained in regard to the nature of their invention has been strongly condemned.

See W. Radcliffe, *The Secret Instrument: the Story of the Chamberlen Forceps* (1947). (W. J. Bp.)

CHAMBERLIN, THOMAS CHROWDER (1843–1928), U.S. educator and geologist, is noted as the author of the planetesimal hypothesis of the origin of the planets. Born at Mattoon, Ill., on Sept. 25, 1843, he graduated from Beloit college, Beloit, Wis., in 1866 (A.B.) and returned to the college in 1873 as professor of geology. He served also as assistant state geologist of Wisconsin until 1876, when he was made chief geologist of the Wisconsin geological survey (1876–82). From 1882 to 1887 he served as U.S. geologist in charge of the glacial division; from 1887 to 1892, as president of the University of Wisconsin, Madison; from 1892 to 1919, as head of the geological department of The University of Chicago, retiring as professor emeritus in 1919. He studied glaciers in Switzerland in 1878 and in Greenland in 1894, as geologist to the Peary relief expedition. His principal scientific work in later years was the study of fundamental problems of geology, particularly as related to the origin and growth of the earth. His planetesimal hypothesis was that a passing star might have caused eruptions from the sun; solid particles would gravitate and, falling like snow, produce the earth without melting. Others argued that there must be melting or dispersion.

His chief publications are *Geology of Wisconsin*, 4 vol. (1873–82); *Reports of the Glacial Division U.S. Geological Survey* (1882–87); a three-volume treatise on geology (with R. D. Salisbury, 1906); reports on researches on certain fundamental problems in geology to the Carnegie Institution of Washington, *Year Books* 2 to 27; *The Tidal and Other Problems* (1909); "Diastrophism and the Formative Processes," numerous articles in the *Journal of Geology*, vol. xxi (1913–21); *The Origin of the Earth* (1916); *The Two Solar Families: the Sun's Children* (1928).

CHAMBER MUSIC, a term usually applied to music written for from two to nine or ten solo instruments, each playing an independent part equal in importance with the rest, and generally though by no means invariably planned on the lines of the four-movement sonata (*q.v.*). The "classical" age of chamber music began in the late 18th century with the string quartets of Franz Joseph Haydn, and the string quartet (two violins, viola and 'cello) has been the favourite and most important combination ever since, but intimate music for small instrumental ensembles had flourished for centuries before Haydn.

Pre-Classical Chamber Music.—The phrase *musica da camera* seems to have appeared first in Italy in the latter part of the 16th century to indicate any kind of music not intended for use in church or for a dramatic or festive purpose; it was not limited to instrumental music and the first publication to which the English term was applied—Martin Peerson's *Mottects or Grave Chamber Musique* (1630)—consisted of "Songs of five parts . . . fit for Voyces and Vials, with an Organ Part." There was at this period still no sharp differentiation between vocal and instrumental music (other than that written for lutes or keyboard instruments) and vocal ensemble music was commonly performed partly or wholly on instruments, yet even the middle ages had been acquainted with purely instrumental compositions other than those written for dancing; a 13th-century manuscript at Bamberg contains three-part instrumental motets ("In seculum viellatoris") and the 15th-century Trent codices have preserved at least one indisputably instrumental trio. In the collections printed from the 1530s onward by continental and (later) English publishers as "suitable to sing and play on any sort of instrument" or "apt for the Viols and voices," unmistakably instrumental pieces appear; the style of these *ricercari*, *canzoni* and *fantasie* (in English, "fancies") is based on vocal motets or polyphonic chansons but was modified more and more by considerations of instrumental technique. Such are the two "Fantazias," one for four (no. 15), the other for six viols (no. 26), of the *Psalmes, Songs, and Sonnets* published in 1611 by William Byrd.

The favourite combination was the homogeneous "consort" of viols, though mixed ensembles (broken consorts) were also common, but no particular instruments were specified by composers until the last years of the 16th century: by Giovanni Gabrieli in some of the *canzoni da sonar* of his *Sacrae symphoniae* (book i) (Venice, 1597) and Thomas Morley in his *First Booke of Consort Lessons, Made by Diuers Exquisite Authors for Six Instruments* (1599).

Although the viols were gradually superseded by the violin family and the polyphonic style was succeeded by one in which one or two melodic lines were accompanied by a bass (*basso continuo*) over which a keyboard player or lutenist filled out the harmony in accordance with a shorthand of figures, the "sonatas" of the early 17th century were still modeled to some extent on vocal prototypes. However, the development of violin technique brought complete emancipation. Just as the vocal monody was paralleled by the solo sonata, the then-favourite form of the vocal duet with continuo suggested a type of instrumental canzone or "sonata" in which two instruments duetted in the same way; indeed the duet sonata appeared (in Salomone Rossi's *Varie sonate*, 1613) before the solo (in Biagio Marini's *Affetti musicali*, 1617). The duet sonata has become universally known as the "trio sonata" from the circumstances that it was conceived in three "real" parts and that in the course of time the bass exchanged its merely supporting function for a more active role in the thematic interplay; it became the most important type of baroque chamber music. But while the instrumental combination remained constant, the structure underwent various changes. The connected sections of the *canzone*, with their contrasts of pace and rhythm, had become by the 1660s four or five separate, self-contained "movements"— as in the *Sonate*, op. 2 (1667), of the Bolognese violinist-composer, G. B. Vitali (*q.v.*). Generally consisting of two slow movements alternating with two quick ones and commonly used in Italy, like the earlier *canzoni* for preludes and interludes in church services, such sonatas were known as *sonate da chiesa* ("church sonatas"). At the same time another type of sonata derived from the dance suite was known as *sonata da camera* ("chamber sonata"). The two types reached classical perfection in the *sonate da chiesa* (1681 and 1689) and *da camera* (1685 and 1694) of Arcangelo Corelli (*q.v.*), the last and greatest of the Bolognese school. But there had always been some interchange between the two types; even Vitali's *sonate da chiesa* sometimes have gigue-like last movements; and after Corelli they became so assimilated that the distinction disappeared. The trio sonatas of Handel and his generation represent the final maturity of the form.

The trio sonata was originally and essentially an Italian form. Henry Purcell's two sets of sonatas (1683; 1697) were confessedly written in "imitation of the most fam'd Italian Masters" (in particular, Vitali); and although trio sonatas had been published in Germany (*e.g.* by Johann Pachelbel and Dietrich Buxtehude in the 1690s) the classic form seems to have been introduced there by the Veronese E. F. dall'Abaco, whose op. 3 (Paris, *c.* 1712) is outstandingly fine. The much earlier (1667) *Sonate da camera* of Johann Rosenmüller were five-part works, published in Venice. In France even Couperin fell victim to the fashionable "fureur de composer des sonates à la manière italienne" and, despite characteristic picturesque, even programmatic elements (as in *Le Parnasse, ou L'Apothéose de Corelli,* 1725), his chamber works are the most Italianate of all his compositions.

Trio sonatas and other instrumental compositions of the baroque period were normally performed by one player to each part other than the bass, which would be both played on a stringed instrument (or bassoon) and filled out by organist or harpsichordist. But there was no distinction between "chamber" music in the modern sense and orchestral music. A number of movements in Handel's trio sonatas figure, with or without additional viola parts, in his overtures and concertos, and as late as the middle of the 18th century passages in trio sonatas were sometimes marked *tutti*, indicating that trios could be converted into concertos by employing additional players for the passages so marked. Nor was there any differentiation between chamber and orchestral in the instrumental works—*divertimenti, quadri, quartetti* and the rest—in the new style that was replacing the baroque and was to lead to Viennese classicism. Johann Stamitz's op. 1 (Paris, *c.* 1755) consisted of *Sonates . . . ou a trois ou avec toutes* [sic] *l'orchestre*. Haydn's earliest "string quartets," op. 1 and 2 (composed in the 1750s), were not originally so called; they certainly need a double bass in addition to the 'cello; parts for oboes and horns exist for op. 1, no. 5, and horn parts for op. 2, nos. 3 and 5.

Classical Chamber Music.—It was principally in Haydn's hands that the quartet for solo strings established itself as a favourite form of instrumental music during the latter part of the 18th century, among the innumerable combinations of strings and wind (with or without *continuo*) that flourished during the age of rococo. In his op. 17 set (composed in 1771) the virtuoso first-violin parts are unmistakably for a solo player; henceforth there was a real chamber style, distinct from an orchestral one. In op. 20 (1772) the other instruments in the quartet began to assert their individual voices, if not yet to claim equality with the leader, and in op. 33 (1781), "written" (as he himself pointed out) "in an entirely new manner," Haydn employed that fragmentation of thematic material and distribution of it among all four instruments that was to give the classical string-quartet style its character of a conversation between equals.

The keyboard *continuo* disappeared from the string quartet but lingered on in other combinations long after it was redundant; characteristically, Johann Christian Bach's Quintets, op. 11, for flute, oboe, violin, viola and bass, were originally published about 1777 with the bass figured while another contemporary edition omitted the figuring. On the other hand, fully written-out keyboard parts now became more common. Johann Christian's father, Johann Sebastian, had written six sonatas for violin and *cembalo concertante:* that is, true duets for violin and harpsichord, not accompanied violin solos. Very typical of the midcentury are Franz Xaver Richter's *Sonate da camera* for flute (or violin), 'cello and harpsichord obbligato. But such works are not the true ancestors of the Viennese classical "violin sonata" (piano and violin duet) and "piano trio" (piano, violin and 'cello). These sprang from the keyboard sonatas, popular from the 1760s onward, which were provided with ad libitum parts for violin or violin and 'cello. Even Haydn seldom liberated the strings from this unaccustomed subordinate role; the process of gradual emancipation can be traced in Mozart but was really completed only with Beethoven.

Mozart took over the developed form of string quartet from Haydn, imbued it with his own personal qualities, above all in the sets dedicated to Haydn (1785) and to Frederick William II of Prussia (1791), and in turn influenced the last and greatest of Haydn's quartets, most of which (from op. 71 onward) were written after the younger composer's death. Beethoven's first six quartets, op. 18 (published 1801), already showed a strongly marked creative personality without adding anything remarkable to the medium as such, but in the three quartets, op. 59 (published 1808), dedicated to Count Razumovsky, the dimensions are enormously extended; in architecture, though not in texture, the "Razumovsky" quartets are really symphonic. Two quartets, op. 74 and 95, written in 1809 and 1810, return to more normal dimensions, though they are adventurous in style, and in the last five—six if the *Grosse Fuge* originally composed as the finale of op. 130 is included—the so-called "posthumous quartets" op. 127, 130, 131, 132 and 135 (composed 1824–26) Beethoven advanced into a world of sound that even he had never entered before and where the most sympathetic of his contemporaries were unable to follow him. Ellipsis, deliberate sketchiness of texture and disregard of euphony combined to puzzle the musicians of the next generation as well; it was not until 1853 that the C sharp minor Quartet, op. 131, was "made clear" to Wagner "for the first time."

While the string quartet was Beethoven's favourite chamber-music medium, he also embodied some of his finest music in duet sonatas for violin or 'cello with piano and in the piano trio. On the other hand, his only string quintet, though fine, is an early work whereas Mozart's string quintets are among the finest of his mature chamber compositions. They are scored with two violas whereas Schubert, in his great C major Quintet, op. 163, followed Luigi Boccherini (*q.v.*) in using two 'cellos. Schubert's chamber music is mostly for quartet or piano trio, but he also wrote a superb string and wind Octet, op. 166, deliberately as a companion piece to Beethoven's early Septet, op. 20, and the popular "Trout" Quintet, op. 114, for an *ad hoc* combination of violin, viola, 'cello, bass and piano.

The piano quartet (piano, violin, viola and 'cello) was taken over by Mozart from Johann Christian Bach and other composers of that generation but it never seriously attracted Beethoven; despite the popular Schumann specimen, op. 47, it was really left to Brahms, Dvořák and Fauré in the late 19th century to exploit its possibilities. As for the combination of piano with string quartet (piano quintet), which one might have expected to be popular, this was long left to minor masters such as Prince Louis Ferdinand of Prussia; the earliest example by a well-known composer is that (op. 44) by Schumann (1842), by whose time the piano had developed more power; next came op. 34 of Brahms (1864) and after that a small but distinguished series of successors by Franck, Fauré, Dvořák, Reger, Florent Schmitt and others. As for the "clarinet quintet" (clarinet and string quartet), the challenge of Mozart's great exemplar was never seriously taken up until Brahms ventured at the very end of his life (op. 115). Chamber-music composers tend to be conservative in their choice of media—in which they are wise since it is more difficult to find ensembles to play unusual combinations—and some innovations, such as Ludwig Spohr's double quartets (employing two string quartets antiphonally), have completely failed to establish themselves.

Post-Classical Chamber Music.—The chamber music of the middle and later 19th century has certain marked characteristics, notably domination by the piano even in the nature of the string-writing. This is very marked in Schumann and Mendelssohn, and is also perceptible in Brahms. Shorter and lighter forms were introduced, from Schumann's *Phantasiestücke,* op. 88, for piano trio to Glazunov's *Novelletten* for string quartet, op. 15. The true nature of chamber music was sometimes lost sight of as composers became conscious that their quartets and trios would be performed not only in intimate circles but also in fairly large concert halls; the fine workmanship of the classical quartet texture was too often forgotten and quasi-orchestral effects introduced, as in Tchaikovsky's Piano Trio, op. 50, composed in 1882 in memory of Nicholas Rubinstein. The Tchaikovsky Trio has as its second and last movement a gigantic set of variations, each of which is associated with an (unspecified) episode of Rubinstein's life; it is therefore program music with an enigmatic program. But, on the whole, the 19th-century vogue for program music left chamber composition untouched; the only really successful example is Smetana's autobiographical String Quartet in E minor, *From my Life* (1876), which is also marred by passages of quasi-orchestral writing. The true tradition of classical chamber music was preserved during the latter part of the century by Brahms and Dvořák in central Europe, Borodin and Taneev in Russia, and Franck, d'Indy and Fauré in France.

Chamber music, by its nature, is not in itself an experimental medium. The 20th century has seen the employment of unusual combinations such as Debussy's Sonata for flute, viola and harp (1916) and Webern's Quartet for violin, clarinet, saxophone and piano (1930), the co-option of the human voice to the string quartet as in Schönberg's op. 10 (1908) (as distinct from the use of chamber-music combinations to accompany the human voice, as in Vaughan Williams's song cycle *On Wenlock Edge*, 1909), and the introduction of new technical devices of string-writing in the quartet itself by Bartók, Stravinsky and others. It has seen a vogue—perhaps suggested by Wagner's *Siegfried Idyll* (1870)—for the chamber orchestra (an orchestra of solo instruments), which has been used not only in "chamber symphonies" such as Schönberg's two (1906 and 1939) but also in opera (*e.g.* Britten's *The Rape of Lucretia* [1946] and *Albert Herring* [1947]). Yet such innovations have proved no more than sidetracks leading to no very important consequences. Most of the important chamber music of the 20th century has been conceived for the established "classical" combinations, above all for the string quartet, which has proved the most adaptable of media and as suited to impressionism, neoclassicism, polytonality and 12-note serialism as to the idioms of the Viennese classics or those of 19th-century romanticism. Such profoundly different 20th-century masters as Bartók, Milhaud and Shostakovich have put much of the best of themselves into their series of quartets, and hardly any instrumental composer of any significance has failed to contribute at least one work to the literature. The duet sonata for piano and some other instrument (usually the violin) has remained almost equally popular—the various examples by Debussy, Hindemith, Janáček, Bartók and Copland (to take names almost at random) are among the established masterpieces of 20th-century music—and the other conventional combinations hardly less so: the piano quintet, piano trio and string trio have inspired outstanding works by musicians as diverse as Florent Schmitt and Shostakovich, Ravel, Roussel and Webern.

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CHAMBER OF COMMERCE: *see* Trade Organization.

CHAMBERS, EPHRAIM (*c.* 1680–1740), English encyclopaedist whose work inspired the 18th-century French encyclopaedists. He was born at Kendal, Westmorland, and apprenticed to a globe maker in London. The first edition of his *Cyclopaedia, or Universal Dictionary of Arts and Sciences* appeared in 1728, and its success led to Chambers' election to the Royal society. The *Encyclopédie* of Diderot owed its inception to a French translation of Chambers' work. Chambers also wrote for the *Literary Magazine* (1735–37) and translated the *Practice of Perspective* from the French of Jean Dubreuil and, with John Martyn, the botanist, the *History and Memoirs of the Royal Academy of Sciences at Paris* (1742). He died on May 15, 1740.

For a detailed description of the plan of his *Cyclopaedia, see* the article Encyclopaedia.

CHAMBERS, ROBERT (1802–1871), Scottish author, publisher and, with his brother William, founder of the firm of W. and R. Chambers and of *Chambers's Encyclopaedia*, was born at Peebles on July 10, 1802. In 1818 Robert began business as a bookstall keeper in Edinburgh, and became the friend of many literary figures, including Sir Walter Scott, who greatly admired his *Traditions of Edinburgh* (1825). Numerous other historical, literary and geological works followed, many based on his personal research. *Vestiges of the Natural History of Creation* (1844) caused great controversy, but was praised by Charles Darwin as having "done excellent service . . . in removing prejudice, and in thus preparing the ground for the reception of analogous views." In 1832 Robert and William together started *Chambers's Edinburgh Journal*, and this led to the establishment of the publishing firm of W. and R. Chambers. *Chambers's Encyclopaedia* was edited by Andrew Findlater but personally supervised by the brothers (*see* Encyclopaedia).

Robert died at St. Andrews, Fifeshire, on March 17, 1871. William continued as head of the firm until his death in 1883, when he was succeeded by Robert's son, Robert (1832–88). The management remained in the family.

CHAMBERS, SIR WILLIAM (1723–1796), British architect, was born at Göteborg, Swed., son of a merchant of Scottish descent. At 16, after education in England, he entered the service of the Swedish East India company; a voyage to Canton, China, supplied the materials for his *Designs of Chinese Buildings* (1757). In 1749 he left the sea to study architecture, first in Paris and then in Rome. Returning to England in 1755 he became architectural tutor to the prince of Wales, the future George III. This appointment led to an extremely successful career as an official architect, during which he became successively one of the two architects of the works (the other being his great rival Robert Adam; *q.v.*), comptroller of the works and surveyor general. In 1768 he helped found the Royal Academy, of which institution he was a pillar for the rest of his life; in 1770, upon receiving the knighthood of the polar star from the king of Sweden, he was allowed by George III to assume the rank and title of an English knight.

His best-known works are Somerset house, London; the casino at Marino, near Dublin; and the ornamental buildings (including the pagoda) at Kew palace, Surrey. In the last he went as far in the direction of romantic eclecticism as any architect of his time. But in general he was an architectural conservative who used a profound knowledge of European (especially French) architecture to give a new look to the accepted motifs of Palladianism. His books, notably *A Treatise on Civil Architecture* (first published 1759), had an influence which extended beyond the shores of England in space and after their author's death in time. He died on March 8, 1796, and was buried in Westminster abbey.

See H. M. Colvin, *A Biographical Dictionary of English Architects, 1660–1840* (1954); John Summerson, *Architecture in Britain, 1530–1830* (1954). (Ms. W.)

CHAMBERS, in law, the rooms of judges or judicial officers who deal with questions of practice and other matters not of sufficient importance to be dealt with in court. It is doubtful at what period the practice of exercising jurisdiction in chambers commenced in England; there is no statutory sanction before 1821, though the custom can be traced back to the 17th century. An act of 1821 provided for sittings in chambers in vacation (*i.e.*, between terms of the court), and an act of 1822 empowered the sovereign to call upon the judges by warrant to sit in chambers on as many days in vacation as should seem fit, while the Law Terms act, 1830, defined the jurisdiction to be exercised at chambers. The Judges' Chambers act, 1867, was the first act, however, to lay down proper regulations for chamber work, and the Judicature act, 1873, preserved that jurisdiction and gave power to increase it as might be directed or authorized by later rules of court. The term "chambers" is, in ordinary professional speech, applied to the rooms or offices where counsel practise. *See* Practice and Procedure.

CHAMBERSBURG, a borough of Pennsylvania, U.S., and the seat of Franklin county, is on a 615-ft. elevation in the broad, fertile Cumberland valley, 52 mi. S.W. of Harrisburg and 142 mi. W. of Philadelphia. Orchards, grain fields and dairies surround the borough, which has grain elevators, food-processing plants, other industries and one of the largest ordnance depots in the U.S.

Chambersburg was founded in 1730 by Benjamin Chambers. It became a borough in 1803. John Brown made it his headquarters while planning the Harpers Ferry raid in 1859 and Gen. Robert E. Lee massed Confederate troops there for the attack at Gettysburg in July 1863. Wilson college, a Presbyterian college for women chartered in 1869, and Penn Hall, a junior college for women established in 1906, are in Chambersburg. Caledonia State forest, Buchanan State park, Cowan's Gap State park and Pres. James Buchanan's birthplace are nearby. For comparative population figures *see* table in PENNSYLVANIA: *Population.* (A. J. Fo.)

CHAMBÉRY, a city of southeastern France, the old capital of the duchy of Savoy and now capital of the *département* of Savoie (*q.v.*), located between the massifs of Beauges and La Grande Chartreuse in the valley of the Leysse river, 112 km. (69.5 mi.) by road E.S.E. of Lyons. Pop. (1954) 28,872. The northwest part of the city was badly bombed in 1944 and has been rebuilt with wide streets; the southeastern section retains its 17th-century aspect and has many reminders of the 15th and 16th centuries. The cathedral of St. Francis of Sales dates from the 14th and 15th centuries; the church of Lémenc has a 9th-century crypt. The château of the dukes of Savoy was founded in 1232 and rebuilt in the 15th century; after a fire the building housing the prefecture was built adjoining it. The Sainte-Chapelle of the château contained the Holy Shroud from 1502 to 1578. Les Charmettes, the country house near Chambéry where J. J. Rousseau lived with Mme de Warens, retains its 18th-century atmosphere. The most characteristic street is the rue de Boigne, running from the château to the elephant monument (1838) of Gen. Benoît de Boigne, a benefactor of the city. There are a number of schools and technical colleges in Chambéry as well as many learned societies. The city is on the main railway line from Paris and Dijon to Modane and Italy. Chief industries are manufacture of aluminum, cement, shoes, skins and glass fibre.

The Roman station of Lemincum gave its name to the rock of Lémenc, which overlooks the town on the north. In the 14th century the counts of Savoy installed themselves in the château on the other slope of the valley and Chambéry became their capital. It was made capital of the *département* of Mont Blanc after the entry of revolutionary forces in 1792, but was returned to the house of Savoy by the treaties of Vienna and Paris. Savoy was finally joined to France after the plebiscite of 1860. In World War II Chambéry was occupied by the Germans from Nov. 1942 to Aug. 1944. (P. BA.)

CHAMBORD, HENRI CHARLES FERDINAND MARIE DIEUDONNÉ D'ARTOIS, COMTE DE (1820–1883), French pretender to the crown, the "Henry V" of the Legitimists, was born in Paris on Sept. 29, 1820, the son of Charles Ferdinand, duc de Berry (*q.v.*). Born seven months after his father's assassination, he was hailed as "l'enfant du miracle." He was created duc de Bordeaux and, in 1821, as the result of a subscription organized by the communes of France, received the château of Chambord, though he did not use the title until May 1839. His education was influenced by hatred of the French Revolution. After the revolution of July 1830, his grandfather Charles X abdicated in his favour and proclaimed him king as Henry V (Aug. 2, 1830), but the crown went instead to Louis Philippe, head of the house of Bourbon-Orléans. The young prince accompanied Charles X into exile and resided successively at Holyrood, at Prague, at Görz and, from 1844, at Frohsdorf in Austria. The death of Charles X in 1836 and that of his uncle, the duc d'Angoulême, in 1844 left him the last male representative of the elder branch of the Bourbons. On Nov. 7, 1846, he married Thérèse, eldest daughter of Francis IV of Modena, but the marriage was childless.

The comte de Chambord allowed the revolution of 1848 and the *coup d'état* of 1851 to pass without any assertion of his claims. The Italian war of 1859, with its menace to the pope's independence, roused him to activity. On Dec. 9, 1866, he issued a manifesto against Napoleon III's policy, declaring the cause of the pope to be that of society and liberty and holding out promises of civil and religious liberty "and above all honesty." On Oct. 9, 1870, after the fall of Napoleon III, he invited Frenchmen to accept a government "whose basis was right and whose principle was honesty." The ensuing elections placed the republican parties in a minority in the national assembly, and the abrogation of the law of exile against the Bourbons enabled the comte to return to France, where he spent three days at Chambord. It was thence that, on July 5, 1871, he issued a proclamation in which he publicly posed as king, but in which he refused to accept the tricolour of the Revolution. Such obstinacy made further negotiation pointless, and the comte left France.

The fall of Adolphe Thiers in May 1873 presented the royalists with an opportunity which they were quick to seize. The prime minister, the duc de Broglie, was an avowed adherent, and the president, Marshal MacMahon, was a benevolent neutral. Moreover, Louis Philippe's grandson, Louis Philippe Albert, comte de Paris, journeyed to Frohsdorf for a formal reconciliation of the two branches of the house of Bourbon (Aug. 5). After this, Lucien Brun and Pierre Charles Chesnelong were sent from Paris to interview the comte de Chambord at Salzburg and obtained satisfactory assurances. On his return to France, however, Chesnelong received a letter (dated Salzburg, Oct. 27) in which the prince declared that he had been misunderstood and that he would give no guarantees: he refused to inaugurate his reign by an act of weakness and become "the legitimate king of the Revolution." A last effort was made in the national assembly, in June 1874, when the restoration of the monarchy was formally moved. The motion was rejected by 272 votes to 79, and on Jan. 30, 1875, the republic was formally consecrated by Henri Wallon's amendment, which obtained a majority of one vote only. The comte de Chambord died at Frohsdorf on Aug. 24, 1883.

The comte de Chambord's publications include: *Mes idées* (1872), *Manifestes et programmes politiques, 1848–73* (1873) and *De l'institution d'une régence* (1874). The comte de Paris succeeded to his pretensions.

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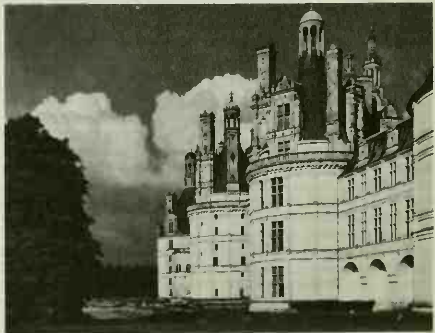
CHAMBORD, a village of central France, the only commune in France owned entirely by the state, in the *département* of Loir-et-Cher, is situated on the left bank of the Cosson river, 18 km. (11 mi.) E. of Blois by road. Pop. (1954) 170. The village lies in a park surrounded by walls 32 km. (20 mi.) in circumference. The great château of Chambord, one of the marvels of Renaissance architecture and originally a hunting lodge of the counts of Blois, was completely rebuilt by Francis I and Henry II, beginning in 1519 (*see* RENAISSANCE ARCHITECTURE: *France*). Stanislaw I Leszczynski lived at Chambord from 1725 to 1733, and the château was bestowed by his son-in-law, Louis XV, upon Marshal Maurice



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CHAMBORD CHÂTEAU: 16TH CENTURY

Saxe. Napoleon gave it to Marshal L. Berthier, from whose widow it was purchased by subscription in 1821 and presented to the duc de Bordeaux, who took the title of comte de Chambord. On his death it came by bequest to the house of Parma, from whom it was sequestrated in 1914. It was purchased by the state in 1932.

Chambord is not on a railway, the nearest convenient station being at Blois. The main industry is catering for tourists, for whom spectacles of "*son et lumière*" are presented. Occupied by the Germans for a few months in 1870–71, during the Franco-German War, Chambord was occupied by them again from June 1940 to Aug. 1944.

CHAMBRE ARDENTE, an extraordinary court of justice in France, mainly held for the trials of heretics (Fr. "burning chamber"). These courts were originated by John, cardinal of Lorraine, the first of them meeting under Francis I. The *chambre ardente* co-operated with an inquisitorial tribunal also established by Francis I, the duty of which was to discover cases of heresy and hand them over for final judgment to the *chambre ardente.* The court was abolished in 1682.

See N. Weiss, *La Chambre Ardente* (1889).

CHAMELEON, the common name for members of the remarkable lizard family Chamaeleontidae. Because of similar abilities to change colour, the name is misapplied to American lizards of the genus *Anolis,* particularly *A. carolinensis* of the eastern U.S. (*see* IGUANA), and to southeastern Asiatic lizards of the genus *Calotes,* especially the "bloodsucker," *C. versicolor* (*see* LIZARD: *Agamidae*). Of the 80 species of chameleons, which belong preponderantly to the genus *Chamaeleo,* half live in Madagascar and most of the rest in Africa south of the Sahara. The others include one species along the southern Mediterranean from Spain to Syria (the common chameleon, *C. chamaeleon*), two on the Arabian peninsula and one in Ceylon and southern India (*C. zeylanicus*).

Chameleons range in length from $1\frac{1}{2}$ in. to 2 ft. The body is compressed laterally; the head is short and often ornamented with occipital crests or dermal flaps and frontal horns or scaly processes. The limbs of these predominantly arboreal lizards are modified for climbing in having the digits fused into opposed bundles of two and three. The tail also is a grasping organ in *Chamaeleo,* but not in the other genera of the family (*Brookesia, Leandria* and *Evoluticauda*). The bizarre appearance of chameleons stems not so much from the foregoing specializations as from the large eye, which is enclosed by fused eyelids except for a small central opening. The eyes are independently movable, but when prey is noticed by one the other swivels into position to give binocular perception for accurate judgment of distances. Without this perception the chameleon's extraordinary use of its tongue for feeding would not be very efficient. The tongue has a large sticky tip and a tubular, elastic basal part. When at rest the latter is telescoped over an elongated projection of the hyoid. Ring muscles of the tubular section contract about this slippery spike of bone to propel the tongue outward, sometimes to a distance exceeding the body length. Prey is deliberately stalked until within range; the tongue is shot out and then rapidly retracted, usually with the intended victim adhering to the sticky tip. Most chameleons feed on insects but very large species are known to secure birds.

The renowned colour-changing of chameleons is not, as popularly supposed, maneuver for camouflage. It is actually dependent on several factors, including light, temperature and emotional stimuli. The mechanism involves dispersion or concentration of pigment in melanophore cells, which are under control of the autonomic nervous system (in contrast to hormonal control in *Anolis*).

The species differ in their ranges of colours and patterns, but many can assume green, yellow or cream, or dark brown, frequently with darker or lighter spots on the ground colour. Although not necessarily matching the background, the disruptive patterns, in combination with the compressed body shape, probably do provide concealment among forest shadows and leaves from snake and bird enemies.

Most chameleons are oviparous and are obliged to descend to bury their 2 to 40 eggs in the earth or rotting logs. Incubation lasts about three months. A few South African species bear young alive.

ISABELLE HUNT CONANT

(LEFT) AMERICAN "CHAMELEON" OR ANOLE (ANOLIS CAROLINENSIS); (RIGHT) AFRICAN THREE-HORNED CHAMELEON (CHAMAELEO OWENI)

The head ornaments are either better or exclusively developed in males. At least some are related to territorial defense: a dominant male of *C. dilepis* responds to an invading male by expanding the body, puffing out the throat and elevating or waving his occipital flaps. If this fails to bluff the intruder, the defender charges and snaps and usually drives him away.

See K. P. Schmidt and R. F. Inger, *Living Reptiles of the World* (1957). (G. B. R.)

CHAMFORT, SEBASTIEN ROCH NICOLAS (1740?–1794), French writer, famous for his wit and conversation. An illegitimate child, his parentage and date of birth are uncertain, but he was probably born during 1740. He was brought up in a small village near Clermont-Ferrand by the wife of a grocer, François Nicolas, and educated as a free scholar at the Collège des Grassins. After leaving school he made his way to Paris, where, supported by the hospitality of a worldly and sophisticated society which appreciated his conversational genius, he led a precarious existence until two comedies, *La Jeune Indienne* (1764) and *Le Marchand de Smyrne* (1770), established his reputation. Later he secured an introduction at court and when his *Mustapha et Zéangir* was performed before Louis XVI in 1776 he obtained a pension from the king. In 1781 he was elected to the Academy.

After 1789 he devoted himself wholeheartedly to the cause of the Revolution. Author of republican articles for the *Mercure de France,* he was a member of the *Club de 1789* and secretary of the Jacobin club. At first his Jacobinism was uncompromising, but later, under the excesses of Marat and Robespierre, his enthusiasm decreased and he became critical of the Convention. In July 1793 he was arrested and imprisoned for a few days. The threat of further imprisonment, two months later, was sufficient to make him attempt suicide. In this endeavour he was unsuccessful, but he never really recovered from the self-inflicted wounds and he died at Paris on April 13, 1794.

Chamfort is now known only by his *Maximes et Pensées* and *Caractères et Anecdotes,* published posthumously in 1795, of which there have been many editions. The best was published under the collective title *Produits de la Civilisation perfectionée* in 1953. His many other works possess no great literary value.

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CHAMILLART, MICHEL (1652–1721), the French statesman who was responsible for the financing and provisioning of the French army during the first half of the War of the Spanish Succession, was born in Paris on Jan. 10, 1652. After serving as intendant at Rouen, he was in 1690 summoned to Paris and made intendant of the finances of the kingdom. He was appointed *contrôleur-général* of finance on Sept. 5, 1699, minister of state on Nov. 29, 1700, and secretary of state for war on Jan. 7, 1701.

Chamillart was a sound economist and a competent administrator, whose favour with Louis XIV was variously attributed to honesty and to skill at billiards. He was forced by the exigencies of war to resort to unpopular and unsound financial expedients and so was unjustly blamed for the country's economic predicament. As minister of war he was also criticized for the loss of Catalonia in 1706 and for the mishandling of the siege of Turin, but he deserves praise for successfully reorganizing the French armies after each of the great defeats of 1704, 1706 and 1708. Chamillart soon recognized the impossibility of his task and tried to resign in 1706. Louis XIV then insisted on his retaining office, but allowed him to hand over the finances to Nicolas Desmarets in Feb. 1708 and to relinquish his remaining posts in 1709. Chamillart died in Paris on April 14, 1721. It is not improbable that he was the author of the *Mémoires* covering the years 1681–1712 usually attributed to the marquis de Sourches (L. F. de Bouchet, 1645–1716). (B. J. R.)

CHAMINADE, CÉCILE LOUISE STÉPHANIE (1857–1944), French composer and pianist known for her piano pieces in a light style, of which the well-known *Scarf Dance* is typical. Born in Paris, Aug. 8, 1857, she was a pupil of Benjamin Godard and became popular throughout Europe and the U.S. as a pianist in her own compositions. Charm and grace mark the style of her numerous piano pieces and songs. Her larger works include the symphony, *Les Amazones,* the ballet *Callirhoë* (both 1888), piano and flute concertos, chamber works and an unpublished *opéra-comique, La Sévillane*. She died at Monte Carlo, April 17, 1944.

CHAMISE (*Adenostoma fasciculatum*), a North American shrub of the rose family (Rosaceae), called also chamiso, found in the chaparral belt on foothills and mountain slopes in California, ranging up to 5,000 ft. altitude. It grows from two to ten feet high, with shreddy brown bark, slender twiggy branches, resinous, narrow leaves in bundles or fascicles and small white flowers in panicled clusters. Chamise is the most abundant and characteristic small shrub of the higher foothills west of the Sierra Nevada, where, between the lower foothills and the yellow pine belt, it often forms a distinct zone called chamisal. *See* also Chaparral.

CHAMISSO, ADELBERT VON (Louis Charles Adélaïde Chamisso de Boncourt) (1781–1838), German writer and botanist, a leading member of the north German group of romantic poets, was born Jan. 30, 1781, at the château Boncourt in Champagne. During the French Revolution the family fled to Würzburg and then to Berlin, where Chamisso became page to Queen Louise, went to the famous Französische *Gymnasium* and in 1798 entered a Prussian infantry regiment. He remained in active service when his family returned to France, studied philology and philosophy and fell in love with a governess, Cérès Duvernay, and, although his love was unrequited, it awakened his poetic talent. Together with Baron de la Motte Fouqué, J. E. Hitzig and Varnhagen von Ense, he edited, during 1804–06, the *Berliner Musenalmanach,* in which his first poems appeared. In 1804 he founded the Nordsternbund, a society of Berlin romanticists.

Chamisso took part in the war of 1806, left the army after the capitulation of Hameln, stayed in France from 1807 to 1808, where he fell in love with the writer Helmina von Chézy, and was a member of the circle of Mme de Staël, there and in Switzerland. He then returned to his studies at Berlin and in 1813 wrote his *Peter Schlemihls wundersame Geschichte,* the story of the man who sold his shadow to the devil, which allegorized his own situation as a man without a country and his inner disunion during the German war of independence against France. The most famous of his works, it has been translated into most European languages. During 1815–18 Chamisso was botanist to the Russian ship "Rurik," which Otto von Kotzebue commanded on a scientific voyage round the world; his diary, *Reise um die Welt mit der Romanzoffischen Entdeckungs-Expedition* (1821), is a classic of its kind. In 1818 he became custodian of the botanical gardens at Berlin and in 1819 married Antonie Piaste. During 1828–32 he wrote his most important poems—song cycles, ballads, narrative verses and *terza rimas*—published mainly in the *Deutscher Musenalmanach,* of which he became editor in 1832. He died at Berlin on Aug. 21, 1838.

The model for Chamisso's poetry is to be found in the lyrics of Goethe and Ludwig Uhland; it aims at freshness and popularity and is at its best in expressing simple human feelings as in the lyrical cycle "Frauenliebe und -leben," which has become world famous set to music by Robert Schumann. His ballads deal with national legends ("Das Riesenspielzeug") and with ethical and social problems ("Die Sonne bringt es an den Tag," "Die alte Waschfrau"), and show his romantic fondness for mournful subjects ("Vergeltung," "Salaz y Gomez"). His social and political poems are on subjects similar to those treated by Béranger, whose poems he translated in 1838. His later lyrics were more realistic, and were praised by Heine. As a scientist he is connected with the discovery of the metagenesis of certain mollusks. He also wrote *Bemerkungen und Ansichten* and *Übersicht der nutzbarsten und schädlichsten Gewächse in Norddeutschland* (1829). As a philologist he is known for his studies of Australasian languages.

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CHAMOIS, the Franco-Swiss name of a hollow-horned ruminant *Rupicapra rupicapra*. It is the only species in the genus, though every European range possesses a local race. It is the type of the tribe *Rupicaprini,* which includes several goatlike genera (*see* Bovidae). About the size of a roebuck, with a short tail, it is distinguished by the vertical, backwardly directed horns in both sexes, though these are larger in the male. Though differing in the shade of their hair, all the various races have black and white face markings and a black tail and dorsal stripe. The alpine race is chestnut brown in summer, lighter and grayer in winter. A thick underfur is developed in the cold weather.

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CHAMOIS (RUPICAPRA RUPICAPRA)

Chamois live in small herds, but the old males join these only during the rutting season (October), when they engage in fierce contests with each other. The period of gestation is 20 weeks, and the usual number of offspring is one. In summer the sure-footed chamois ascend to the snow line, being exceeded in the loftiness of their haunts only by the ibex (*q.v.*); in winter they descend to wooded regions. Chamois hunting is a favourite sport of the Swiss and Tirolese and of amateurs from all countries. As a result of this, the chamois has become rare in many of its old haunts, but it is now preserved in the Swiss National park in the Engadine. Exceedingly wary and astonishingly agile, the animal is very difficult of approach. It feeds in summer on mountain herbs and flowers, in winter on the young shoots of the pine.

The soft, pliant skin is made into the original "shammy" leather, though this is also made from the skins of other animals (especially sheep and goats). The flesh is prized as venison. During the 20th century the chamois was successfully introduced from Austria into New Zealand. The German name for the chamois is *Gemse* or *Gemsbock;* however, the latter name as gemsbok is applied to an antelope of southern Africa.

CHAMONIX, a town of southeastern France, *département* of Haute-Savoie (*q.v.*), is a well-known Alpine tourist resort situated on the Arve river 60 mi. (96 km.) W. of Annecy at an elevation of 3,416 ft. Pop. (1962) 5,412. The valley of Chamonix, running from northeast to southwest, is watered by the Arve, which rises in the Mer de Glace, largest of the Mont Blanc glaciers. On the southeast towers the snowclad chain of Mont Blanc, and on the northwest the rugged chain of Brévent and Aiguilles Rouges. Chamonix is the best starting point for the exploration of the glaciers of the Mont Blanc chain, as well as for the ascent of Mont Blanc itself. It is connected with Geneva by a railway.

The valley is first mentioned about 1091, when it was granted by the count of the Genevois to the great Benedictine house of St. Michel de la Cluse, near Turin, which by the early 13th century had established a priory there. In 1786 the inhabitants bought their freedom from the canons of Sallanches, to whom the priory had been transferred in 1519. The first party to publish (1744) an account of its visit was that of R. Pococke, W. Windham and other Englishmen who visited the Mer de Glace in 1741. The development of tourism is modern. In World War II Chamonix was occupied by the Germans from Nov. 1942 to Aug. 1944. *See* also MONT BLANC.

CHAMPA, an ancient kingdom of Indochina extending over the southeastern coastal region of modern Vietnam from Tourane in the north to Cape Varella in the south. It was occupied by the Chams, a people of Indonesian stock and Indianized culture; for their modern descendants *see* CHAM. Probably autochthonous, the Chams belonged originally to the Dong-son Neolithic culture. Later they came in contact with the higher civilizations of the Chinese then ruling Tongking and of Indian merchants from overseas. This latter influence prevailed and Champa became a powerful state, second only to Cambodia.

Appearing during the 2nd century A.D. under the name of Lin-yi in Chinese histories, Champa first comprised four small states named after Indian regions: Amaravati (Quang-nam); Vijaya (Binh-dinh); Kauthara (Nha-trang); and Panduranga (Phanrang). Unified later under strong dynasties, they disappeared one by one in the same order (from north to south) in the course of 14 centuries during which the Chams retreated under the pressure of the Vietnamese. Eventually the race was almost completely annihilated.

After obscure struggles against the Chinese colonies in Tongking, Bhadravarman emerged about A.D. 400 as the first great king of an already completely Indianized country, and the founder of Mison, for centuries to come the national shrine. The Chinese, in revenge for incessant Cham raids, destroyed their capital in 446, but under a new dynasty in the 6th century Champa threw off its allegiance to China and enjoyed peaceful prosperity. In the 8th century the centre of power shifted to the southern provinces where Cham culture made great progress despite renewed Chinese pressure, Javanese raids and the growing power of Cambodia. In 875 the Indrapura dynasty won back the crown of the unified country for Amaravati where they built magnificent temples, but their kings could not compete with the ambitious kingdom of Annam to which they were forced to relinquish Amaravati in A.D. 1000, ruling thereafter for a time in Vijaya. The Annamese, however, increased their pressure and between 1044 and 1069 annexed Vijaya also. For a short space only, between 1074 and 1081, Harivarman IV, the founder of a new dynasty, was able to resist them. In 1145, Champa was conquered by the kingdom of Cambodia but soon afterward was freed by Jaya Harivarman I (1147–66). His successor was even able, in 1177, to sack Angkor. Again between 1190 and 1220 the Chams were subject to Cambodia under its great king, Jayavarman VII, and were not freed until after his death. Then they were attacked by their worst enemies, the Tran kings of Annam, and in 1283 the Mongols raided the country.

During the 14th century the Cham kings became mere vassals of Annam despite the courage of their last heroic king, Che Bong Nga (1360–90). One by one their provinces were colonized until finally Champa was entirely absorbed. Nevertheless Cham culture played an important part, though this may have been unrecognized or minimized, in the formation of Vietnam.

The Chams were primarily a sea-going people—fishermen and, above all, pirates, who were dreaded by all ships sailing the seas between China and Indonesia. Ashore they grew rice, for the cultivation of which they created an ingenious irrigation system. They cremated their dead. They spoke Cham, an Indonesian language, which was written in Indian characters. The literary medium was Sanskrit. The élite enjoyed a brilliant syncretic culture the basis of which was largely Indian. Sivaism was predominant and Buddhism of both Vehicles played its part. Among the people, however, the worship of nature spirits was never superseded until the introduction of Islam from the 15th century onward.

Cham art is known only from the temples which were usually built by kings for their favourite gods. Architecture was confined to tiered brick towers. Sculpture was devoted to statues of the gods, the pedestals of which were adorned with figures in relief. From the subtle and smiling harmony of the Indian Gupta period Cham artists evolved a more personal style of sculpture. They created fantastic forms springing with wild energy as though the Indonesian spirit were gradually breaking free from foreign and enforced aesthetic standards. (*See* also INDIAN ARCHITECTURE: *Champa.*)

Practically unknown and often underrated, Cham culture is one of the most important human phenomena of ancient Indochina. It is the only culture of mainland Asia with Oceanic features. *See* also INDONESIAN ART and INDONESIAN ARCHAEOLOGY.

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CHAMPAGNE, an old province of France, corresponding to the modern *département* of Marne (*q.v.*) together with most of Ardennes, Aube and Haute-Marne and parts also of Aisne, Seine-et-Marne, Yonne and Meuse (*qq.v.*). It was bounded on the north by the bishopric of Liège and by Luxembourg, on the east by Lorraine, on the south by Burgundy and on the west by Île-de-France and by Picardy. Its westernmost extension was part of the region of Brie (*q.v.*). The name Champagne is derived from the great plains (Lat. *campi*) near Reims, Châlons-sur-Marne and Troyes.

Reims.—In the last century of the Roman empire the battle of the Catalaunian Plains against the Huns was fought in Champagne. From the beginning of the Merovingian period the diocese of Reims (*q.v.*) assumed a great significance in French national history, as it was the bishop of Reims, St. Remi, who baptized Clovis, and the archiepiscopal domain was always to remain independent of the counts of Champagne (*see* below). The custom whereby the French kings went to Reims for their coronation was established in early Capetian times. The college founded by the archbishops in the 10th century was made famous by Gerbert, the future Pope Silvester II.

Countship.—Counts of Troyes (*q.v.*) are recorded from the middle decades of the 9th century. From 877 they seem to have been hereditary vassals of Burgundy. About 940, however, Troyes came into the hands of Herbert of Vermandois (d. 942), and in 966 it passed to his younger son, Herbert the Old, who was already count of Meaux in Brie. These two countships became the nucleus of what was later called the countship of Champagne. The house of Vermandois, meanwhile, not only reduced to vassalage a number of adjacent territories but also was linked by marriage with the counts of Blois and Chartres (*see* BLOIS, COUNTSHIP OF), so that, when its male line died out (1019 or 1020, or perhaps *c.* 1023), Eudes II of Blois became count of Troyes and Meaux (he is reckoned as Eudes I of Champagne, though in fact the title "count of Champagne," which first appears in 1077, did not supersede "count of Troyes" as the principal designation for the Champagne inheritance until the beginning of the 13th century). For the next 100 years the Champagne inheritance was regarded as dependent on the Blois-Chartres countships, and Troyes and Meaux were even separated from one another in partitions of the combined Blois-Champagne inheritance from 1089 onward. In 1125, however, Thibaut IV of Blois became Thibaut II of Champagne, reuniting the family possessions, and on his death (1152), when another partition took place, Blois and Chartres went to the younger son, whose descendants thenceforth, until their male line died out, were regarded as depending on the counts of Champagne.

Thibaut and his successors in the 12th and 13th centuries raised the countship of Champagne to the apogee of feudal power. Henry I the Liberal, count from 1152 to 1181, married Mary, daughter of Louis VII of France and Eleanor of Aquitaine, and won renown as a crusader. His son and successor Henry II (d. 1197) went also on crusade and married Isabella, heiress of the kingdom of Jerusalem, in 1192, thus becoming recognized as the actual leader of the crusaders, though he never secured the royal title. Henry II's nephew Thibaut IV (*q.v.*), count from 1201 to 1253, was the most famous of these counts and a poet as well; he succeeded his maternal uncle Sancho VII as king of Navarre (Theobald or Teobaldo I) in 1234. His sons Thibaut V (d. 1270) and Henry III (d. 1274) succeeded as counts and as kings, but

Henry III left only a daughter, Joan. Joan in 1284 married Philip the Fair, who became king of France as Philip IV next year. On Joan's death (1305) Champagne passed to her son Louis, who united it to the crown on becoming king as Louis X (1314).

Fairs.—Apart, however, from the prowess of its counts, the great celebrity of Champagne, in the middle ages, lay in its fairs, particularly in the 12th and 13th centuries. At the crossing of the roads from Flanders, Germany, Italy and Provence, Champagne was indeed a convenient meeting place. Drapers from the north, wool merchants from England, importers of alum, dyes and spices from the Mediterranean ports, dealers in linen and in furs from Germany and leather sellers from Spain and Africa could easily meet there and bargain together. The great fairs lasted 49 days each and were six in number: one at Lagny, one at Bar-sur-Aube, two at Provins and two at Troyes. Each fair opened with a week devoted to the receiving of merchandise, four weeks then were spent in selling and the last fortnight in the settling of accounts. For this purpose, clearances and transfers of funds came more and more to be used between customers; and thus the fairs became regular banking centres, where people not connected with the trade itself might also transact business.

These fairs had special legislation, and special magistrates called "masters of the fairs" had control of the police. Because of the fairs, Champagne, rather a poor region at first because of the nature of its soil, became rich; and this accounts both for the opulence of its towns (particularly under Henry the Liberal and Thibaut IV) and for the emancipation of the cities, as well as for more violent movements.

From the end of the 13th century Champagne began to lose its pre-eminence, first commercially, then financially. Commerce was diverted to Paris, to Flanders and to Italy, and new trade routes were developed over the Alps and along the Rhine valley as well as by sea.

French Province.—Champagne suffered as a battlefield in the Hundred Years' War, and the treaty whereby Isabella of Bavaria surrendered France to Henry V of England was signed at Troyes (1420). Charles VII, however, was crowned at Reims after Joan of Arc's victories (1429). In the 16th century Meaux became the first great centre of the Reformation in France. Under Francis I of France, the territories of the countship were merged with the extensive domains that had formerly belonged to the bishops of Reims, of Châlons and of Langres to form the military *gouvernement* of Champagne. From the point of view of financial organization, the greater part of the province was included in 1542 in a *généralité* under an intendant whose seat was first at Reims, later at Châlons (hence the name *généralité* of Châlons); the western areas, however, were included in the *généralité* of Paris, and smaller areas in other *généralités*. As a frontier province, Champagne was exposed to invasion in the wars between the French and the Habsburgs, and it was in Champagne that the civil wars of religion between Catholics and Huguenots broke out (massacre of Vassy, 1562). The principality of Sedan was incorporated in Champagne on its annexation to France in 1642.

Economically Champagne prospered because of the textile industries of Reims and Troyes, the metallurgy of St. Dizier and its vicinity and the great vineyards (*see* WINE).

Dissolved into *départements* during the French Revolution, the country has been invaded whenever France has been attacked from the east—from the time of the battle of Valmy (1792) to the engagements of World Wars I and II.

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(MI. M.)

CHAMPAGNY, JEAN BAPTISTE NOMPÈRE DE, DUC DE CADORE (1756–1834), French statesman and diplomat, foreign minister under Napoleon, was born at Roanne on Aug. 4, 1756, of a noble family. Educated at La Flèche and at the École Militaire in Paris, he entered the navy and served as an officer during the American Revolution, being severely wounded in 1782. He resigned his commission in 1787. Elected deputy to the estates-general by the *noblesse* of Forez in 1789, he went over to the third estate on June 21. A member of the constituent assembly's committee for the navy, he occupied himself with the reorganization of the fleet. In 1793 he was imprisoned for some months as a former nobleman. Having been elected to the directory of the Loire *département* in 1795, he was nominated a member of the council of state by Napoleon Bonaparte in 1799 and appointed French ambassador to Vienna in 1801. In 1804, however, he was recalled to become minister of the interior. As such, he proved himself an excellent administrator.

In 1807 Champagny succeeded Talleyrand as foreign minister. In this capacity he was responsible for the annexation of the papal states, for the abdication of Charles IV of Spain, for the Franco-Russian negotiations at the congress of Erfurt (all in 1808) and for the peace of Schönbrunn between France and Austria (1809), for which he was made duc de Cadore. He also negotiated Napoleon's marriage to Marie Louise (1810).

In 1811 a disagreement with Napoleon led to Champagny's resignation as foreign minister, but he remained a minister of state and intendant general of the crown. A senator in 1813, he was made secretary general of the regency in that year and again in 1814. When the allies were invading France he accompanied Marie Louise to Blois and undertook a mission to the Austrian emperor.

Champagny went over to the Bourbons on the first Restoration and was made a peer of France, but rejoined Napoleon during the Hundred Days. Consequently he was excluded from the peerage at the second Restoration but he was readmitted in 1819. He supported Louis Philippe's cause in 1830 and died in Paris on July 3, 1834. His *Souvenirs* appeared posthumously in 1846.

One of his sons, FRANÇOIS DE CHAMPAGNY (1804–1882), wrote numerous books on Roman history. Another, NAPOLÉON JOSEPH DE CHAMPAGNY (1809–1872), published a *Notice biographique* of his father (1836) and a *Traité de la police municipale*, four volumes (1844–62).

See L. Mercier, *Nompère de Champagny* (1889); J. Valynseele, *Les Princes et Ducs du premier Empire* (1959). (J. Go.)

CHAMPAIGN, a city of east-central Illinois, U.S., located across a city street from the city of Urbana (*q.v.*), owes its origin to the building by the Illinois Central railroad of a branch line (which later became the main line). Surveyors laid out the railroad addition to Urbana in July 1853, 2 mi. W. of the older town where the unbroken prairie made laying of the tracks simple and inexpensive. Many citizens of the older town immediately built new homes in the vicinity of the depot and tried unsuccessfully to persuade others to abandon the Urbana site. In 1855 a bill incorporating the city of Urbana and including the depot within its limits was defeated in the legislature at the insistence of residents of the depot area. Two years later, separate incorporation was given to West Urbana and in 1860 West Urbana became the city of Champaign. The names Urbana and Champaign are memorials to early citizens who came from Urbana, Champaign county, O.

As in the case of Urbana, the University of Illinois provides the chief income for the city, but Champaign in the second half of the 20th century became increasingly industrial, manufacturing alloy castings, soybean oil, gloves, refrigeration and air-conditioning equipment, academic apparel and vegetable oil products. A council-manager form of government went into effect in 1958. For comparative population figures *see* table in ILLINOIS: *Population*.

(N. M. BE.)

CHAMPAIGNE, PHILIPPE DE (1602–1674), Belgian painter of the French baroque, whose work is characterized by a grave reality, depicted in harmonious sombre tones and severe design, was born at Brussels of a poor family. He was a pupil of J. Fouquières; and, going to Paris in 1621, was employed by N. du Chesne to paint with Nicolas Poussin in the palace of the Luxembourg. His best works are to be found at Vincennes and in the church of the Carmelites at Paris, where his celebrated Crucifix, a signal perspective success, is on one of the vaultings. After the death of Du Chesne, Philippe became first painter to the queen of France, and ultimately rector of the Academy of Paris. As his age advanced and his health failed, he retired to the religious community of Port-Royal, where he had a daughter cloistered as a nun, of whom (along with Catherine Agnès Arnauld) he painted a picture highly remarkable for its solid, unaffected truth. This, indeed, is the general character of his work. He produced an immense number of paintings. His portraits of Cardinal Richelieu are among his best-known works. He died on Aug. 12, 1674.

CHAMPARAN is a district in the northwest corner of Bihar state, India, between the Gandak and Baghmati rivers and Nepal. Area 3,553 sq.mi. Pop. (1961) 3,009,841. This roughly parallelogram-shaped district has in its northwest corner two Siwalik ranges, the Dun and Sumeswar hills. These hills of uncompacted and highly dissected sedimentary rocks are largely forested with sal (*Shorea robusta*). They cover 364 sq.mi. and are on the average 1,500 ft. above sea level. South of the hills is a narrow gravelly belt called the *Bhabar*, and below this is a marshy and grassy belt known as *terai*. The remainder of the district is a cultivated alluvial plain diversified by mango groves. The principal rivers are the Gandak, navigable all the year round, the Burhi Gandak, Lelbagi, Dhanauti and Baghmati. A chain of lakes occupying 139 sq.mi. and marking an old bed of the Gandak runs through the centre of Champaran. Three canals, the Teur, Dhaka and Tribeni, irrigate about 135,000 ac. in the north of the district. The Tribeni canal, from the Gandak, is the longest of these. The principal crops of Champaran are rice, maize (corn), wheat, barley, oilseed and sugar cane. Sugar cane has replaced the indigo plantations of the 19th century. Champaran has saltpetre refineries and leads other districts of Bihar in the number of sugar and rice mills.

The administrative headquarters are at Motihari (pop. [1951] 24,489), which is associated with the Champaran *Satyagraha* of Mahatma Gandhi in 1919 against indigo planters. There are nine other towns, the largest being Bettiah (pop. [1951] 35,634). The Nepalese treaty of 1815 was signed at the small town of Sagauli. The district contains three of the sandstone pillars engraved with edicts which Asoka the emperor (*q.v.*; *c.* 250 B.C.) erected to promote Buddhism. These are at Lauriya Nandangarh, Lauriya Araraj and Rampurva. (E. AH.)

CHAMPION. In the judicial combats of the middle ages in western Europe, women, minors and persons disabled by age or infirmity were allowed to nominate champions. Hence the word has come to be applied to anyone who champions, or contends on behalf of, any person or cause. The clergy, as individuals or corporations, were represented by champions; and in France and the empire that function was part of the duties of the *advocatus* who acted for bishops and abbots. Trial by battle was a recognized institution in Anglo-Norman law.

The office of king's champion (*campio regis*) is peculiar to England. His function was to ride, clad in complete armour, with the high constable on his right and the earl marshal on his left, into Westminster hall during the coronation banquet and challenge to single combat anyone who should dispute the king's right to reign. The challenge was repeated three times—at the entrance to the hall, in the centre and at the foot of the dais. On picking up his gauntlet for the third time, the champion was pledged by the king in a covered gilt cup, which was then presented to him as his fee. If he had had occasion to fight and had been victorious, his fee would have been the armour he wore and the horse he rode, the second best in the royal stables, but no such occasion ever arose. This ceremonial was not performed after George IV's coronation (1821), when the last coronation banquet took place.

Scrivelsby manor in Lincolnshire is held in grand sergeanty by the service of acting as the king's champion. The first recorded claim to the office was put forward by Henry Hillary in 1327, at the time of Edward III's coronation, and it is not known if he was successful. Hillary based his claim on tenure of Scrivelsby manor, which he had acquired by marrying Joan, daughter of Sir Philip Marmion. There is no evidence that the office of king's champion existed before 1327, or that any member of the Marmion family ever laid claim to it. Moreover there is no mention of grand sergeanty in the post-mortem inquisitions taken on the death of Sir Philip Marmion in 1291, and Scrivelsby manor was found to be held by barony. Nonetheless the court of claims allowed Sir John Dymoke (who had married Joan Marmion's granddaughter and heiress) to act as king's champion at Richard II's coronation (1377), and Dymoke's descendants, as lords of Scrivelsby manor, exercised the office at subsequent coronations down to 1821. After 1902 they carried the standard of England.

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CHAMPLAIN, SAMUEL DE (*c.* 1567–1635), French explorer, colonizer and first governor of French Canada, known as the "father of New France," was born about 1567 at Brouage on the Bay of Biscay, the son of a sea captain. As a youth he fought under Henry of Navarre (Henry IV) in the religious wars, but in 1598 he took service under the king of Spain and, having been brought up to the sea, enlisted in an expedition to the West Indies and Central America. He was gone for more than two years, and visited all the principal American ports, pushing inland from Veracruz to Mexico City. The manuscript account of his adventures was not published until the latter part of the 19th century, when an English translation was printed by the Hakluyt society in 1859. The French text was included in the edition of Champlain's works by the Abbé Laverdière in 1870. It has often been pointed out that in his narrative Champlain suggested the construction of a Panama canal, "by which the voyage to the South Sea (Pacific ocean) would be shortened by more than 1,500 leagues"; but it should be noted that he was not the first to make this suggestion.

The statement has been made that when Champlain returned to France in 1601 he was appointed royal geographer; but there seems to be no evidence for this. He was, however, appointed geographer to the expedition sent out to America in 1603 by Aymar de Chatte, on whom the king had bestowed a patent as lieutenant general of New France; *i.e.*, all the land in North America claimed by France. This was Champlain's first visit to the Gulf of St. Lawrence, and he explored the St. Lawrence river as far as the island of Montreal. Aymar de Chatte died in 1603; but the patent held by him was conferred by the king on the sieur de Monts (*c.* 1561–*c.* 1630) with whom Champlain revisited the new world in 1604. On this occasion he explored the coast of North America as far south as Cape Cod, seeking a site for a new settlement and making surveys and charts. His was no doubt the most accurate attempt to map the coast of Maine and New England made up to that date. Champlain's party first attempted a settlement on an island near the mouth of the St. Croix river, where they spent a disastrous winter; but eventually they settled at Port Royal (later Annapolis Royal, Nova Scotia) on the Bay of Fundy. The colony at Port Royal took root but in 1613 it was destroyed by the Virginians under Sir Samuel Argall. In 1607, however, Champlain had returned to France, and there he persuaded the sieur de Monts to found a colony on the St. Lawrence. He was given command of one of two vessels sent out and on July 3, 1608, he established at Quebec the first permanent white settlement in North America, north of Florida.

Champlain devoted the rest of his life to making this settlement a success. In 1609, in order to insure the fur trade with the Algonkins and the Hurons to the west, he took part in an expedition of these Indians against the Iroquois to the south of the St. Lawrence. He discovered the lake that bears his name, and near the southern end of the lake he secured for his Indian allies a victory over the Iroquois—a victory which ushered in a century of warfare between the French and Hurons on the one hand, and the Iroquois and English on the other. In 1611 Champlain established a trading post at Mount Royal (now Montreal), as an outpost against the Iroquois and in 1612 he was appointed commandant of New France. In 1613, lured by the false report of one of his men that the Ottawa river led to "the sea of the North" (presumably Hudson bay), he ascended the Ottawa as far as Allumette Island, but finding the story false, he turned back. It was on his ascent of the Ottawa that he lost his astrolabe, which was found two and a half centuries later by a farmer who turned it up while plowing at the site of the ancient portage. (*See* A. J. Russell, *On Champlain's Astrolabe*, pamphlet, 1879.)

In 1615 Champlain again ascended the Ottawa and, crossing over by the French river, reached Georgian bay. He spent the winter in the Huron country to the south of the bay, and in the spring was persuaded to accompany a war party of the Hurons across the eastern end of Lake Ontario, into the Iroquois country to the south of the lake. A few miles south of Lake Oneida, he had a second encounter with the Iroquois and was slightly wounded. He then returned to Quebec by way of the Huron country. This journey marked the end of his explorations. The rest of his life he devoted to the colony at Quebec. He became, in 1628, one of the "One Hundred Associates" of the Company of New France, appointed by Cardinal Richelieu to supervise the colony, and became, in effect, the deputy of the company in Canada. In 1629, Champlain was compelled to surrender Quebec to an English expedition under the Kirke brothers, and was taken a prisoner to England. In 1632 the colony was restored to the French by the treaty of St. Germain-en-Laye, and in 1633 Champlain returned to Quebec. There he died on Christmas day, 1635. In 1610 he had married Hélène, 12-year-old daughter of Nicholas Boullé, secretary of the King's chamber. After his death she became a nun.

Champlain wrote and published a number of books, including *Les Sauvages* (1604), *Les voyages du Sieur de Champlain* (1613), *Voyages et découvertes faites en la Nouvelle-France* (1619), *Les voyages du Sr. de Champlain* (1620), and *Les voyages de la Nouvelle France occidentale* (1632).

See also references under "Champlain, Samuel De" in the Index volume.

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There are several biographies of Champlain but by far the best has been Morris Bishop, *Champlain: The Life of Fortitude* (1948). There is no contemporary portrait of Champlain known to be in existence; the portrait of him which has been repeatedly reproduced is a portrait of an entirely different person copied by an obscure artist in 1854, and palmed off as the portrait of Champlain. *See* also H. P. Biggar, "The Portrait of Champlain," *Can. Hist. Review.*, vol. 1 (1920).

(W. S. WA.)

CHAMPLAIN, LAKE, with a total length of 125 mi. from north to south, forms the boundary between Vermont and New York for most of its length. It extends from Missisquoi bay and the Richelieu river in Canada southward to South bay near Whitehall, N.Y. It has a maximum width of 13 mi. and a total area of 490 sq.mi., consisting of 435 sq.mi. of water surface and 55 sq.mi. of islands. The lake empties into the St. Lawrence river through the Richelieu river.

Lake Champlain is extensively utilized for commercial and pleasure boat navigation. Most of the lake is 100 to 335 ft. deep and there are few shoals. The navigation season is limited to eight months, however, by ice conditions. The lake is a link in the international waterway between New York harbour and the lower St. Lawrence. It is connected with the harbour by the narrows of Lake Champlain (a national, improved waterway at the southern end of the lake), Champlain canal and the Hudson river, with a controlling depth of 12 ft. The St. Lawrence may be reached from Lake Champlain by way of the Richelieu river and Chambly canal, with a controlling depth of 6½ ft. Commerce along the lake consists largely of petroleum, newsprint and fertilizer. The most important ports are Burlington, Vt., and Rouses Point, Plattsburgh and Port Henry, N.Y. Plattsburgh air force base occupies the site of a former (1815–1946) army post.

Lake Champlain fishing is popular; the catch includes trout, salmon, bass and walleye (pike perch). The tributaries and their branches—Otter creek and the Mettawee, Poultney, Winooski, Lamoille, Missisquoi, Bouquet, Ausable, Saranac and Great Chazy—are fished for trout.

The Champlain lowland, the widest in Vermont, spreads across 25 mi. in the north. It slopes from an average elevation of 300 ft. in the south to 120 ft. in the north, and is underlaid by limestones, dolomite, shale and sandstone, and largely covered by post-glacial lake deposits and glacial till. The lowland's flat or rolling topography and dairy and fruit farms contrast with the abrupt, sharp rise of the fronts of the Green and Adirondack mountains with their high peaks and forested slopes. The Champlain valley is the major dairy region in Vermont and the most-traveled route from southern New York to Canada. Its highways lead summer vacationers and skiers to famous resorts at its mountainous border.

History.—Lake Champlain was discovered in 1609 by the French explorer and soldier Samuel de Champlain, from whom the lake takes its name. During the early period of settlement, Lake Champlain was the gateway between French Canada and the English colonies. It played an important part in all the wars during which hostile peoples faced each other across the lake. The first engagement ended when Champlain, with an expedition of about 80 friendly Algonquin and Huron Indians, defeated the Iroquois on its shores in 1609. Thus began the long struggle between the French and the Five (later Six) Nations. (*See* also IROQUOIS.)

In 1731 the French built a fort at Crown Point, N.Y., and in 1755 another at Ticonderoga; both were important strategic points during the French and Indian War and the American Revolutionary War. They controlled the easiest and most natural route between Canada and New York. During the French and Indian War (*q.v.*), English and colonial expeditions twice failed to capture Crown Point. Ft. Ticonderoga was the scene of the severe repulse administered to Gen. James Abercrombie by General Montcalm in 1758. Both forts were finally occupied by Gen. Jeffrey Amherst. During the American Revolution Ethan Allen's Green Mountain Boys captured both points early in the war. Allen took Ticonderoga in a surprise attack. When asked by the British commander by what authority the surrender of the fort was demanded, Allen made his historic reply, "In the name of the great Jehovah and the Continental Congress." During the subsequent years of the war the fort changed hands several times. On Oct. 11, 1776, the first battle between an American and a British fleet, the battle of Valcour Island, was fought on the lake. Benedict Arnold, the American commander, with a decidedly inferior force, inflicted severe damage on the enemy and then escaped during the night. Although overtaken two days later he again, after a fight of a few hours, made a successful retreat, saving all his men.

At the beginning of the War of 1812 the U.S. naval force on the lake, though very small, was superior to that of the British, but on June 3, 1813, the British captured two U.S. sloops in the narrow channel at the northern end and gained supremacy. Both sides then began to build and equip vessels for a decisive contest. By May 1814 the Americans had regained supremacy. Four months later a British land force under Sir George Prevost and a naval force under Capt. George Downie confronted a U.S. land force under Brig. Gen. Alexander Macomb, strongly entrenched at Plattsburgh and a U.S. naval force in Plattsburgh bay under Commodore Thomas Macdonough. The British opposed about 11,000 men to the Americans' 1,500, and 16 vessels of about 2,400 tons with 937 men and 92 guns to 14 American vessels of about 2,240 tons with 882 men and 86 guns. The naval battle occurred on the morning of Sept. 11, 1814. Although the weight of the metal thrown by the guns of Macdonough's fleet was greater than that of the British fleet, the latter had more guns of long range. Knowing that in a battle in the open lake he would be at a disadvantage, Macdonough anchored his fleet in a manner that forced Downie to pass between him and the land and prevented Downie from anchoring his fleet out of range of the U.S. guns. Downie was killed early in the fight, and the British fleet was soon driven out of action. As the lake was entirely in the control of the Americans, Prevost was forced to retreat during the night of Sept. 12–13, leaving his sick and wounded behind. The British gave up further efforts to invade New York. *See* also WAR OF 1812.

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CHAMPMESLÉ, MARIE (née DESMARES) (1642–1698), French actress, creator on the stage of a number of Racine's heroines, was born in Rouen. In 1666 she married the actor Charles Chevillet de Champmeslé (1642–1701), and by 1669 both were members of the Marais theatre in Paris. In the following year they joined the Hôtel de Bourgogne, where Mlle Champmeslé had her first success when she was allowed to play Hermione in Racine's *Andromaque*. Only with difficulty could Racine be persuaded by his friends to see the newcomer's debut, but after the performance he swore to write more roles for her. Thereafter Mlle Champmeslé celebrated her greatest triumphs in creating such Racinian parts as the title role of *Bérénice*, Roxane in *Bajazet*, Monime in *Mithridate* and the heroines of *Iphigénie* and *Phèdre*. Racine, who was also her lover, coached her and imparted to her the system of musical declamation he had developed. Mlle Champmeslé indeed is credited with having founded the French tradition of the "touching voice." The art with which she employed her voice elicited applause from many playgoers, most of whom came, according to Mme de Sévigné, to admire the actress, not the play. In 1679 she left the Hôtel for the amalgamated Molière-Marais company, which was to form the nucleus of the Comédie Française (1680). At the height of her fame she taught acting to her niece Christine Antoinette Charlotte Desmares and to Mlle Duclos, who, after 1693, served as her understudy and who inherited Mlle Champmeslé's roles when the latter died in Auteuil on May 15, 1698. *See* also RACINE, JEAN. (A. M. N.)

CHAMPOLLION, JEAN FRANÇOIS (1790–1832), French Egyptologist and founder of scientific Egyptology, called LE JEUNE to distinguish him from J. J. Champollion-Figeac (*q.v.*), his elder brother, was born at Figeac, in the *département* of Lot, on Dec. 23, 1790. At the age of 16 he read before the academy of Grenoble a paper in which he maintained that Coptic was the ancient language of Egypt. He soon after moved to Paris. In 1809 he was made professor of history in the Lyceum of Grenoble. His first decipherment of hieroglyphics dates from 1821. In 1824 he was sent by Charles X to visit the Egyptian antiquities in the museums of Italy, and on his return was appointed director of the Egyptian museum at the Louvre. In 1828 he was commissioned to conduct a scientific expedition to Egypt in company with I. Rosellini. In March 1831 he received the chair of Egyptian antiquities, which had been created specially for him, in the Collège de France. He was engaged with Rosellini in publishing the results of their Egyptian researches when he died at Paris on March 4, 1832. Champollion's brilliant discoveries met with great opposition, much of it acrimonious and personal, chiefly from scholars reared in the classical tradition who resented the prominence given by these discoveries to an ancient "barbarian" nation. The rival claims of the contemporary Englishman, Thomas Young, really amount to very little and have since been dismissed by those who are competent to judge.

Champollion's writings included: *L'Égypte sous les Pharaons*, two volumes (1814); *De l'écriture hiératique* (1821); *Précis du système hiéroglyphique, etc.* (1824); *Panthéon égyptien, ou collection des personnages mythologiques de l'ancienne Égypte* (incomplete, 1823–25); *Grammaire égyptienne* (1836–41), and *Dictionnaire égyptien* (1842–43), edited by his brother; *Lettres écrites d'Égypte et de Nubie* (1833). Champollion also wrote several letters on Egyptian subjects. *See* also ROSETTA STONE.

See H. Hartleben, *Champollion, sein Leben und sein Werk*, 2 vol. (1906); *Lettres de Champollion le Jeune*, 2 vol. (1909).

CHAMPOLLION-FIGEAC, JACQUES JOSEPH (1778–1867), French archaeologist, elder brother of the Egyptologist Jean François Champollion, was born at Figeac in the *département* of Lot, on Oct. 5, 1778. He became keeper of manuscripts at the Bibliothèque Nationale in Paris and professor of paleography at the École des Chartes. In 1849 he became librarian of the palace of Fontainebleau, where he died on May 9, 1867. His works include: *Nouvelles recherches sur les patois ou idiomes vulgaires de la France* (1809), *Annales de Lagides* (1819) and *Chartes latines sur papyrus du VI^{e} siècle de l'ère chrétienne*.

His son AIMÉ (1812–1894) became his assistant at the Bibliothèque Nationale and, in addition to a number of historical works, wrote a biographical and bibliographical study of his family in *Les Deux Champollion* (1887). (J. WH.)

CHANCEL, strictly, that part of a church close to the altar and separated from the nave (*q.v.*) by cancelli or screens. This space, originally known as the space *inter cancellos*, or *locus altaris cancellis septus*, came itself to be called the chancel. Later the word came to include the whole of that part of the church occupied by altars, communion tables and all the officiating clergy and singers, *i.e.*, the presbytery (*q.v.*), the chancel proper and the choir. The term "choir" is also sometimes applied to this part of the church; otherwise, it pertains to only the space designated for the singers.

In basilican churches, the chancel is set apart only by a low railing; *e.g.*, S. Clemente, Rome. Such divisions correspond more to the altar, communion or sanctuary rail of a modern church than to the developed medieval chancel screen. In the highly organized medieval church, the chancel is clearly differentiated from the nave by the raising of the floor level, and by the chancel or rood screen (*see* JUBE). This screen is frequently continued on each side, behind the choir stalls, and around the east end of the cathedrals of sanctuary, as in Paris, Bourges and Amiens. At the side, such screens form the back of the choir stalls. The chancel screen in front of the altar is sometimes only a low parapet, sometimes a light, openwork structure of wood or metal, but often, especially in the large cathedrals and abbeys of England, a massive and solid stone structure, frequently carrying the organ. In collegiate and monastic churches, these screens thus completely separated the spaces reserved for services for the members of the clerical community from the spaces for popular services, for which a second altar was usually set up to the west of the screen, as formerly in Westminster abbey.

Chancel sizes vary enormously. On the European continent they usually extend from the east end to the crossing, as in many modern churches, but in abbey churches, and generally in English medieval churches, they comprise also several bays of the nave. In the churches of Paris the chancel is relatively small. The chancel screen becomes more open and its main function is to support a crucifixion group; it is, therefore, primarily a rood screen. In small churches the chancel is sometimes lower and narrower than the nave. The size of the chancel is determined by ecclesiastical

A. F. KERSTING

EARLY ENGLISH CHANCEL OF ST. MARGARET'S CHURCH, LEICESTER, ENG.

developments as well as architectural styles, particularly by the amount of emphasis placed upon the sacrament of the Eucharist.

CHANCELLOR, RICHARD (d. 1556), English seaman whose famous visit to Russia laid the foundations of English trade there, is said to have been brought up by the father of Sir Philip Sidney. When in 1553 Sir Hugh Willoughby fitted out an expedition in search of the northeast passage to China, Chancellor was appointed pilot general. It was arranged that the expedition should meet at Vardö, but because of unfavourable weather Chancellor's was the only one of the seven ships that arrived. He therefore went on alone into the White sea and thence overland to Moscow, where the tsar showed him great hospitality and gave him a letter for the sovereign of England granting very favourable conditions for English trade. Chancellor rejoined his ship in the summer of 1554 and went back to England. His successful negotiations with the emperor resulted in the foundation of the Muscovy company in 1555. Chancellor left England again for Moscow in 1555, arriving in November of that year. He lost his life in a wreck on the return voyage, on Nov. 10, 1556, off Pitsligo on the coast of Aberdeenshire.

CHANCELLOR. The title of chancellor is given to a group of widely assorted offices held by persons of most diverse ranks. These varieties of office and rank are easily accounted for by the diversity of the functions exercised from the Roman period by those who bore this title and by the development of these functions according to country or institutions.

Origins.—The word chancellor, *cancellarius,* was first applied to the minor officials of the Roman law courts who used to stand near the balustrade or bar, *cancellus,* erected in the courts to separate the tribunal from the public. They were responsible for ensuring order during the hearings and were also the intermediaries between magistrates and those to be tried and so, like the *notarii* or clerks, were entrusted with official functions. In palace business the Roman emperors employed officials of the same kind who worked in the offices (*scrinia*) that constituted what is now called the imperial chancellery, although that expression was not used at the time. The barbarian kingdoms that emerged from the dismemberment of the Roman empire took up this form of administration in their turn. In the Frankish kingdom during the Merovingian period continuity of administration was secured by the appointment of a *summus referendarius* ("chief clerk"), always a layman, who was confirmed in his office by the committal to him of the king's seal. Several of these clerks could hold office at the same time. They disappeared at the accession of the Carolingians whose chancellery was directed by a single head, always an ecclesiastic, and who, during the 9th and 10th centuries, bore the title of *summus sacri palatii cancellarius* or *archicancellarius.* This archchancellor was first recruited from among the subordinate officials but became in time one of the most important officials of the palace. The office was held, from the reign (814–840) of Louis the Pious, by the archbishop of Reims, the abbot of St. Denis, members of the imperial family or men of great learning.

Ecclesiastical Chancellors.—The popes, from the earliest centuries of the church, used departments modeled on the imperial chancellery. But, although the office existed, the title of *cancellarius* was not retained; business was dispatched by the *bibliothecarius* ("librarian"). The title of chancellor reappeared in 1027, but only for one century, and from the end of the 12th century the cardinal head of the chancellery was always called the vice-chancellor. Since the decree *Sapienti Consilio* of June 29, 1908, the chancellery, one of the three offices of the Roman curia, has as president a cardinal who once again bears the title of chancellor and has power to issue *litterae sub plumbo* ("letters under seal").

As did the pope and the great lay lords, the bishops also provided themselves with administrative staffs, and each diocesan curia required a *cancellarius* to maintain the records of the curia, register them, keep the bishop's seal and sign official documents. The signature of the chancellor or vice-chancellor began to appear from the 10th century onward.

The Chancellor as a Great Officer of State.—The chancellorship in England developed on different lines from the chancellorships on the continent of Europe. For the history of the English office of chancellor *see* Lord High Chancellor; Equity. (*See* also Chancellor of the Duchy of Lancaster; Chancellor of the Exchequer.)

France.—The title of chancellor, which was found among the institutions of the French monarchy until its final suppression in 1848, was borne by people performing widely differing functions. Under the early Capetians and up to the reign (1180–1223) of Philip Augustus, it is possible to distinguish between two officials: on the one hand, the archchancellor or archchaplain, nearly always the archbishop of Reims, himself head of the chapel royal; and on the other the chancellor proper, the head of the chancellery offices whose staff, *notarii,* was recruited from among the clerks of the chapel. As such, the chancellor, always an ecclesiastic, was at the head of the administration at the royal palace and responsible for the issue of royal documents and charters; but he was also invested with judicial powers, charged with the control of the ecclesiastical affairs of the kingdom and even with foreign affairs. Fearing the excessive power of the holder of this office (who, under Louis VI, exercised simultaneously with it the offices of seneschal and steward) the kings from 1127 onward often left the position unfilled, and Philip Augustus did not appoint a holder after 1185. It was re-established in 1223 by Louis VIII for the benefit of Brother Guérin, bishop of Senlis, who held it until his death in 1227 but had no successor. The office of chancellor was held from that time until 1314 by a "warden of the seal," *custos sigilli* or *vice-cancellarius,* always of the lower clergy. Philip the Fair was the first to confer the office upon laymen (Pierre Flote from 1298 to 1302, Guillaume de Nogaret from 1307 to 1313) but when, even during his reign, it reverted to ecclesiastics, these were once more bishops. It seems also that in current usage the warden of the seal was once again called chancellor. Thenceforth, and until the suppression of his office in 1790, the chancellor of France, the last great crown officer to survive, saw his functions grow in importance until they made him the second personage of the kingdom. The chancellors were chosen by the king (with the assent of the council of state from the reign of Charles V). In the 16th and 17th centuries they were eminent jurists, and in the 18th century great personages, although the king did not hesitate to relieve them of their duties on occasion. Louis XV *tiendra les sceaux en sa personne* ("will himself hold the seals") from 1757–61.

The office, suppressed at the Revolution, was re-established in 1804 by Napoleon, but in imitation of its form under the Germanic Holy Roman empire, with the title of imperial archchancellor bestowed on J. J. R. Cambacérès. The office of chancellor was re-established in May 1814, its duties now making of its holder a real minister of justice. It remained vacant from 1830–37. Until suppression of the office in 1848, the chancellor assumed the functions of president of the house of peers.

The orders of chivalry (St. Michael, the Holy Spirit) had likewise at their head a chancellor who assisted the king in the creation ceremony by delivering their insignia to the new knights. The existing orders of the Legion of Honour and of the Liberation both have at their head a grand chancellor.

The title of *chancelier* continues also to be used in France for the large class of officials who discharge notarial duties in some public offices, in embassies and consulates. They draw up diplomas and prepare all formal documents, which they issue on payment of a fee (*droits de chancellerie*), and superintend the registration and preservation of the archives.

Spain.—The office of chancellor emerged in the reign of Alfonso VII of Castile (1126–57) who, in imitation of the French kings, entrusted to one of his secretaries, thenceforth called the chancellor, the custody of the royal seal and the charge of legalizing with it all official documents and letters. Alfonso XI, who reigned from 1312 to 1350, conferred the titles of *canciller de Castilla* and of *Maestro del Real Archiva* on the archbishop of Toledo. The king's private seal was kept by the *Canciller del sello de la puridad;* this office was suppressed in 1496. Laymen also were entrusted with the office, which the minister of pardons and justice exercised for a time between 1873 and 1875. The *Gran Canciller de Indias* headed the council in the governor's absence and issued all decrees concerning the American possessions. This office was abolished in 1873.

The Holy Roman Empire, Germany and Austria.—The archbishop of Mainz, chancellor of the kingdom of Germany, exercised from 965 the functions of archchancellor of the empire, *Erz-Kanzler*, until the suppression of this office in 1806. His jurisdiction never extended to Italy which, during the 12th century, depended for this purpose on the archbishop of Cologne, while the archbishop of Besançon became in 1045 archchancellor of the kingdom of Burgundy. At the beginning of the 14th century the archbishop of Trier bore the title of archchancellor of the kingdom of Arles. These last titles however became purely honorary and only the archbishop of Mainz preserved effective authority. Nevertheless, the direction of the chancellery of the Reich was held not by the archchancellor but by the chancellor, *cancellarius aulae imperialis* (*regalis*), who was always an ecclesiastic and often a bishop. As immediate collaborator of the sovereign he was present everywhere, at councils and tribunals, in the internal administration of the Reich as on the occasion of diplomatic missions. Karl von Dalberg, archbishop of Mainz and last archchancellor of the empire, became chancellor of the confederation of the Rhine. The confederation of North Germany had a *Bundeskanzler*, the title which Bismarck bore when the empire was re-established in 1871. Thereafter Bismarck called himself the *Reichskanzler*, acting at the same time as president of the council to the Prussian government, and concentrating in his own hands the direction of all branches of the administration. The constitution of Weimar (Aug. 1919) made the *Reichskanzler* head of the government; nominated by the president of the Reich, he appointed ministers and was responsible to the Reichstag for the government. Hindenburg nominated Hitler to this office on Jan. 30, 1933. After 1949 the constitution of the German Federal Republic established a *Bundeskanzler* appointed by the federal diet on the proposal of the federal president.

In the German states as in France the title of chancellor was also given to government and diplomatic officials who performed notarial duties and had charge of archives. The title of chancellor has naturally been widely used in the German and Scandinavian states, and in Russia since the reign of Peter the Great. It has there, as elsewhere, wavered between being a political and a judicial office. Frederick the Great of Prussia created a *Gross-Kanzler* for judicial duties in 1746. But there was in Prussia a state chancellorship on the Austrian model. It was allowed to lapse on the death of Karl August von Hardenberg in 1822. The Prussian chancellor after his time was one of the four court ministers (*Hofämter*) of the Prussian monarchy.

The Habsburg house of Austria in their hereditary dominions, and in those of their possessions which they treated as hereditary, even where the sovereignty was in theory elective, made a large and peculiar use of the title of chancellor. In the family states the administration was based upon a group of councils. Until the March revolution of 1848 it was conducted through boards presided over by a chancellor. There were three aulic (*i.e.*, court) chancellorships for the internal affairs of their dominions, "a united aulic chancellorship for all parts of the empire (*i.e.*, of Austria, not the Holy Roman) not belonging to Hungary or Transylvania, and a separate chancellorship for each of those last-mentioned provinces." There were also a house, a court and a state chancellor each for the business of the imperial household and of foreign affairs, who were not, however, the presidents of a board. These officers were in fact secretaries of the sovereign, and administrative or political rather than judicial in character, although the boards over which they presided controlled judicial as well as administrative affairs. In fact, the Austrian chancellors controlled all state policy from the time when the direction of the various chancelleries or departments was united in one person such as W. A. von Kaunitz or C. von Metternich.

Chancellor of a University.—From the time of the foundation of the principal European universities during the 12th and 13th centuries, their heads were called chancellors; even before the foundation of the Sorbonne this title had been borne at Paris by the head of the chapter school of Notre Dame. In the bishop's name, the chancellor had general charge of the teaching, conferred degrees and exercised jurisdiction over all members of the university. But from the end of the 13th century his powers were so limited that the title had become a mere form; authority and the conferment of degrees had devolved upon the rector. In the Italian universities, which were of private origin, the chancellor was appointed by the popes or the emperors. Likewise Oxford and Cambridge, where the office still exists, had no chancellor before the mid-13th century. From the 16th century every university would have besides its rector a chancellor who, in the cathedral towns, was the bishop. The functions of the chancellor in the Catholic universities were made uniform by the decree *Deus scientiarum* of May 24, 1931.

In England the chancellorship of the universities is conferred on noblemen or statesmen of distinction, whose principal function is to look after the general interests of the university, especially in its relations with the government. The chancellor is represented in the university by a vice-chancellor, who performs the administrative and judicial functions of the office. In the United States the heads of certain educational establishments have the title of chancellor.

Miscellaneous.—The judicial institutions of some countries still include a chancellor who may be only a minor legal official concerned with the drafting and conservation of acts, such as the *canciller registrador* in Spain, or the clerk of a court elsewhere, or an official whose functions may on the other hand permit him to intervene in the pronouncement of judgment, as in Great Britain and Italy.

In Scotland the foreman of a jury is called its chancellor. In the United States the chancellors are judges of the chancery courts of the states (*e.g.*, Delaware and New Jersey) where these courts are still maintained as distinct from the courts of common law. In other states (*e.g.*, New York since 1847) the title has been abolished. There is no federal chancellor in the United States.

In diplomacy generally the chancellor of an embassy or legation is an official attached to the suite of an ambassador or minister. He carries out the duties of a secretary, archivist, notary and the like, and is at the head of the chancery, or chancellery, of the mission. The functions of this office are the transcribing and registering of official dispatches and other documents and, in general, the transaction of all minor business, *e.g.*, marriages, passports and the like, connected with the duties of a diplomatic agent toward his nationals in a foreign country.

See also references under "Chancellor" in the Index volume.

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CHANCELLOR OF THE DUCHY OF LANCASTER, the representative of the crown in the management of its lands and the control of its courts in the duchy of Lancaster. These lands and privileges have always been kept distinct from the hereditary revenues of the sovereign, whose palatine rights as duke of Lancaster were distinct from his rights as king. The Judicature act of 1873 left only the chancery court of the duchy, but the chancellor can appoint and dismiss the county court judges within the limits of the duchy. He is responsible also for the land revenues of the duchy and keeps the seal of the duchy. As the judicial and estate work is done by subordinate officials, the office is usually given to a minister whose assistance is necessary to a government, but who is not burdened with the duties of an important department.

CHANCELLOR OF THE EXCHEQUER, the minister in charge of the British treasury. His principal duty is to prepare and present in the house of commons the budget for each financial year. The speech in which the chancellor presents his budget summarizes the government expenditure estimated for the coming financial year and outlines his proposals for raising the revenue necessary to meet it. It is also, in modern practice, an analysis of the general economic situation. Since the Victorian era the treasury has exercised a large measure of administrative control over the claims and expenditures of other departments, in relation to which the chancellor is thus in a particularly powerful position.

Historically the name of this office derives from the separation of the chancery from the exchequer in the reign of Henry III. The office has grown to its present importance since the board of the treasury ceased to sit as such and the first lord of the treasury came to be, by invariable practice, the prime minister who is ordinarily divorced from day-to-day responsibility for the treasury. *See* also EXCHEQUER. (W. T. Ws.)

CHANCELLORSVILLE, a village in Spottsylvania county, Va., situated almost midway between Washington, D.C., and Richmond, Va. It was the central point of one of the greatest battles of the American Civil War, fought from May 1 to 4, 1863, between the Union army of the Potomac under Gen. Joseph Hooker, and the Confederate army of Northern Virginia under Gen. Robert E. Lee. (*See* AMERICAN CIVIL WAR; WILDERNESS.) Gen. "Stonewall" Jackson was mortally wounded in this battle.

CHANCERY, in English law, refers to the court presided over by the lord high chancellor and hence, in a broader sense, to the practices and principles of this court, commonly known as equity. In 1873 the court of chancery, along with the other superior courts, was consolidated in the supreme court of judicature, where it comprises the chancery division of the high court of justice (*q.v.*). For the history of the court and its jurisdiction *see* EQUITY: *England;* LORD HIGH CHANCELLOR; ENGLISH LAW.

In the United States, chancery is generally used as a synonym of equity, and chancery courts are equity courts in the few jurisdictions where such tribunals are separately maintained (*see* EQUITY: *United States*).

For the diplomatic sense of chancery (chancellery), *i.e.*, as the office of a chancellor or as a place for issuing and recording official documents, *see* CHANCELLOR; DIPLOMATIC.

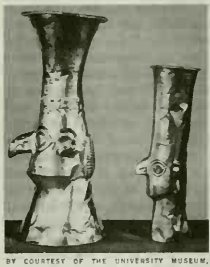
CHAN CHAN, a great ruined and deserted pre-Inca city on the north coast of Peru, once (about A.D. 1420) the capital of a populous, powerful and relatively advanced civilization known as the Chimú.

The City.—Chan Chan lies in the Moche valley, about 300 mi. N. of Lima, between the Pacific ocean and the modern city of Trujillo. The ruins cover six to ten square miles, thick with the remains of buildings of adobe mud bricks, with mud surfacing often decorated with relief arabesques in repetitive textile designs. Because of the almost entire absence of rain, the ruins are remarkably well preserved; some of the walls which formerly surrounded the city as well as its component parts still reach a height of about 30 ft. It is divided into about ten well-planned quadrangular "wards," relatively similar, each with straight parallel streets, rows of gable-roofed houses, pyramidal temples, stone-lined reservoirs, gardens and cemeteries. The population was certainly very great. In its prime the city must have been verdant, but today, the irrigation ditches neglected, not a leaf is to be seen.

In spite of the size and importance of Chan Chan as one of the major archaeological sites of Peru, no full scientific description and no plan had been published by the early 1960s.

The People.—Before the explosive establishment of the Inca "empire" the Chimú had what was probably the largest and most important "kingdom" in Peru; they were the principal rivals of the Inca. They were the descendants—culturally at least—of the earlier population, the Moche or Mochica, formerly known as the "Proto-Chimú." The Chimú domain had been extended by conquest from Piura to Paramonga and Casma in the south. Two Spanish chroniclers recorded their historical and partly mythological traditions; the Chimú, like all the aboriginal Peruvians, had no system of writing. They were overcome in A.D. 1465–70 by the great Inca conqueror Pachacútec and his son Topa Yupanqui, who assembled a great army to subdue them. Accounts of the war differ, but that most generally accepted is that the Chimú ruler's councillors convinced him of the futility of resisting Inca might.

Chimú culture was based on agriculture, aided by immense and admirable works of irrigation engineering. They were skilled craftsmen and did excellent work in textiles and in gold, silver and copper. Pottery types tended to be standardized, with quantity production, made in molds, and generally of a plain black ware. The language, known as Yunca (Yunga) or Mochica, now extinct, was very different and probably entirely distinct from that of the Inca.



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SILVER AND GOLD VESSELS OF THE CHIMÚ CULTURE, PERU

The Chimú culture flourished in what is sometimes described as the Urbanist or City-builder phase of Peruvian cultural development, variously estimated as lasting two to four centuries preceding A.D. 1450. There seems to have been considerable social stratification from peasant to nobility, and probably all the basic elements of the contemporary Inca civilization were present on a slightly smaller scale. *See* also ANDEAN CIVILIZATION.

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(J. A. MN.)

CHAN-CHIANG (Cantonese TSAM-KONG), a port city on the east coast head of the Luichow peninsula, on Kuang-chou wan (Kwangchow bay), Kwangtung province, south coast of China. Pop. (1953 census) 166,000. Communist China began to enlarge the port in 1954, to create a major south-coast seaport, and in July 1955 completed a 200-mi. branch railway from Li-t'ang in Kwangsi to Chan-chiang. Highways link the port with the peninsula and the hinterland. Its landlocked harbour with water depths of more than 30 ft. lies behind a group of offshore islands.

In the 19th century Kuang-chou wan was a pirate base. To protect its possessions in Indochina and eliminate piracy France in 1898 exacted from China a 99-year lease on an approximately 300-sq.mi. area, including a strip of mainland, the deepwater mouth of the small Ma-ch'ih river, the bay and the offshore islands, which became internationally known as Kwangchowwan. France returned the area to China in 1946. The French base, Fort Bayard, grew into a French colonial city with a population of about 25,000. Nearby was the Chinese-built trade centre of Tche-kam, a settlement of about 50,000. The leased area had a population of about 300,000 in 1946. The French had developed an airport, hospitals and naval and port facilities for medium-sized ships, which served as the basis for further port enlargement. *See* also KUANG-CHOU WAN. (J. E. SR.)

CHANCRE is a term formerly used loosely to designate any sore or ulcer, especially one of a corroding nature or venereal origin. It is now applied almost exclusively to the primary lesion of syphilis, which used to be called a hard, indurated or Hunterian chancre. It appears at the site of inoculation in from one to seven weeks after exposure, and is most commonly found on the external genitals, but sometimes on the lip, tongue and other parts. A small, hard, translucent swelling appears at the infected spot, becomes gradually larger (up to one inch), and often breaks in the centre, leaving a shallow ulcer. This lesion is the chancre and represents the first reaction of body tissues to the causative agent, *Treponema pallidum*. Diagnosis is established by finding the organism in scrapings from the ulcer. *See* VENEREAL DISEASES.

CHANCROID, an acute, localized infection, usually of the genital area, acquired in most instances through sexual contact.

The causative agent is a microorganism called the Streptobacillus of Ducrey. The sulfonamide drugs are effective in its treatment. *See* Venereal Diseases.

CHANDA (ancient Chandrapur, "city of the moon"), a town in Maharashtra state, India, headquarters of Chanda district, is near the confluence of the Wardha (*q.v.*) and Erai rivers, 85 mi. S. of Nagpur. It was the capital of a Gond tribal dynasty from the 12th to 18th century, and must once have had a much larger population than it had at mid-20th century, as shown by the 5½-mi. circuit of its old city walls. Pop. (1951) 40,744. Chanda is on the Central railway, connected southward with Hyderabad and Vijayavada, and northward with Wardha on the Nagpur-Bombay line. A narrow-gauge line of the Southeastern railway runs northeast via Nagbhir to Nagpur. Chanda is noted for silk fabrics, ornamental slippers and similar minor manufactures. A large annual fair is held. Bhandak, a village near Chanda, was the capital of the Hindu Vakataka dynasty from the early 4th to the early 6th century A.D. The Vakataka kings controlled Madhya Pradesh and much of the central and western Deccan, and were the patrons of several of the cave-temples at Ajanta (*q.v.*).

Chanda District has an area of 9,200 sq.mi., but this includes 4,000 sq.mi. of wild and thinly populated country, and 2,700 sq.mi. covered by government forest reserves, including the Tairoba game and national park in the north. The forests yield valuable teak and other timber and contain large bamboo jungles. Coal of poor quality is found in the west at Ballarpur, Warora and Ghugus, and high-grade iron ore is found in the east near Alewahi on the Chanda-Nagbhir railway line. Rice is the main crop, followed by large areas of jowar (sorghum) and small millets, and some sugar-cane and garden crops. On the northwest border cotton and wheat are grown. Irrigation is effected by numerous tanks and large storage reservoirs.

Chanda is a picturesque part of the country, with varied scenery, wooded hills and interesting archaeological remains, old temples and forts, notably at Bhandak, Markandi and Wairagarh. But the climate is unpleasantly hot and the forests malarial.

The Marathi language spoken in the northwest of the district gives way to Telugu in the south and to Hindi (Chhattisgarhi dialect) in the northeast. In all the wilder tracts aboriginal tribespeople predominate, and Gondi and other tribal dialects are common. The total population of the district in 1961 was 1,238,701. (D. G. Na.)

CHANDELIER is a frame of metal, wood, crystal or glass suspended from the roof or ceiling for the purpose of holding lights—lamps, candles, electric lamps, etc. *See* Candlestick; Lamp.

CHANDERNAGORE (Chandarnagar), a former French settlement in India, situated on the right bank of the Hooghly, 21 mi. above Calcutta with which it is connected by rail. Pop. (1961) 67,534 (including the southern suburb of Gourhati). Chandernagore became a French settlement in 1674 and, though captured twice by the British, remained under the French until 1950 when it was incorporated into India following a plebiscite. It was then included in Hooghly district, West Bengal, and made a municipal corporation in 1954. Its magnificent buildings, including the former Government house (now a museum and art gallery), stretch along Quai Dupleix, overlooking the river. There is a large, fine Roman Catholic church, built by the French in 1880, and a college. Cotton weaving and furniture making are the principal industries. One of the largest jute mills of West Bengal is located there. (S. P. C.)

CHANDIGARH, the capital of the Punjab, India, is situated a few miles south of the Siwalik range in the plain between the Sukhna and Patiala streams, 151 mi. N.N.W. of Delhi by rail. Pop. (1951) 5,294. The city with a projected population of 150,000 was planned by Le Corbusier (*q.v.*) in collaboration with Indian architects, to replace the former capital city lost to Pakistan when India achieved its independence. The site was selected in 1948. Construction started in 1950, and the broad layout of the city was completed by the early 1960s. Chandigarh is divided into 30 rectangular sectors, 24 of which are residential. Each sector has an area of 250 ac. and a housing capacity of 15,000 and is self-contained in civic amenities. The grid of the roads is so planned that the fast moving traffic is segregated from the internal traffic of the sectors. The high court, nine-storied secretariat, the legislative assembly chamber, and Raj Bhavan (governor's house) are all situated in the northern portion of the city. To the northeast is a large artificial lake. In the southeast is the sector allotted for industrial establishments, separated from the city by a 400-ft. green belt. The city is also the seat of Panjab university, which occupies another sector, together with all the post-graduate departments which include natural and social sciences, languages and humanities.

Chandigarh is connected by rail with Ambala and Delhi on the one hand and Kalka and Simla on the other. It is also connected with all the important towns of the Punjab by direct bus routes. (O. P. B.)

CHANDLER, ZACHARIAH (1813–1879), U.S. politician, was born at Bedford, N.H., on Dec. 10, 1813. In 1833 he moved to Detroit where he became a prominent dry-goods merchant and amassed a fortune. After serving as Whig mayor of the city (1851–1852) he ran unsuccessfully for governor of Michigan in 1852. Two years later he took part in the founding of the Republican party at Jackson, Mich.

Chandler was elected to the U.S. senate in 1857 and during the American Civil War played an important role on the joint committee on the conduct of the war. Because of his extremism, he clashed frequently with President Lincoln during the war and with President Johnson during the Reconstruction period. His advocacy of firm measures in dealing with the south was coupled with a consistent belief in sound money, protective tariffs and internal improvements. After being defeated for re-election in 1875 he was appointed secretary of the interior by President Grant (1875–1877). During the disputed presidential election of 1876 he served as chairman of the Republican national committee and vigorously upheld the claims of Rutherford B. Hayes. He was re-elected to the senate in Feb. 1879, but died on Nov. 1 of that year in Chicago. Chandler was an effective champion of emancipation and radical reconstruction whose methods were often ruthless, but whose skill was unquestioned.

See Wilmer C. Harris, *The Public Life of Zachariah Chandler, 1851–1875* (1917); T. Harry Williams, *Lincoln and the Radicals* (1941); "Zachariah Chandler: an Outline Sketch of His Life and Public Services," *Detroit Post and Tribune* (1880). (H. L. T.)

CHANDOS, BARONS AND DUKES OF. The English title of Chandos began as a barony in 1554, and was continued in the family of Brydges (becoming a dukedom in 1719) until 1789. In 1822 the dukedom was revived in connection with that of Buckingham, becoming extinct in 1880. However Oliver Lyttelton, a descendant of the Buckinghams, took the title on becoming a viscount in 1954.

John Brydges (*c.* 1490–1557), the son of Sir Giles Brydges (the name was variously spelled), served with Henry VIII in France and was knighted there in 1513. He was a prominent figure at the courts of Henry and his successors Edward VI and Mary I. In Mary's reign he took part in suppressing Sir Thomas Wyat's rebellion, and as lieutenant of the Tower of London (1553–54) he was the jailer of Lady Jane Grey and, for a while, of the princess Elizabeth. He was made Baron Chandos in 1554 and died at Sudeley castle, his home in Gloucestershire, on April 12, 1557.

John's three successors were all members of parliament. The 5th baron, Grey (*c.* 1580–1621), was lord lieutenant of Gloucestershire and was known as "king of the Cotswolds." His son George (1620–55), 6th baron, supported King Charles I against the parliamentarians. William (d. 1676), 7th baron, was succeeded by a kinsman, Sir James Brydges (1642–1714), 8th baron, who was English ambassador to Constantinople from 1680 to 1686.

The best-known member of the Brydges family was James (1673–1744), 1st duke of Chandos, who was born on Jan. 1, 1673, son of the 8th baron. He was paymaster general of the forces from 1705 to 1713 and, profiting from this lucrative office, he amassed a huge fortune. He was made Viscount Wilton and earl of Carnarvon in 1714 and marquess of Carnarvon and duke of Chandos in 1719. He is chiefly remembered for his connection with Handel, whom he employed for two years and who composed the Chandos anthems and the oratorio *Esther* in the duke's service. Chandos was also famous for Canons, the great house he built in Middlesex. Alexander Pope satirized its monotonous magnificence in the lines on "Timon's villa" in his *Epistle to Lord Burlington* (1731). Jonathan Swift called Chandos "a great complier with every court." After his death on Aug. 9, 1744, Canons was pulled down and on the death of his grandson, James Brydges (1731–89), 3rd duke, the title became extinct.

It was revived for Richard Grenville (1776–1839), marquess of Buckingham, husband of the 3rd duke's daughter Anna, when he was made duke of Buckingham and Chandos in 1822 (*see* Buckingham, Earls, Marquesses and Dukes of). Christian, the daughter of the 3rd duke of Buckingham and Chandos, married Sir Thomas Lyttelton, and their descendant, Oliver Lyttelton (1893–   ), a member of Winston Churchill's war cabinet from 1941 to 1945 and colonial secretary from 1951 to 1954, was created Viscount Chandos in 1954.

See C. H. Baker and M. Baker, *Life and Circumstances of James Brydges, First Duke of Chandos* (1949).

CHANDOS, SIR JOHN (d. 1370), English military captain, soldier of fortune and a founder member of the Order of the Garter (1349), was a lifelong follower and companion of the Black Prince, fighting under him at Crécy (1346), Poitiers (1356) and Nájera (1367). Given the lands of the viscount of Saint Sauveur in the Cotentin, Chandos was made constable of Guienne in 1362 and seneschal of Poitou in 1369. He had administrative talent, and was esteemed by friend and foe as an honourable negotiator. His great rival, the French captain Bertrand du Guesclin, was among his admirers. Wounded in a skirmish at Lussac-les-Châteaux near Poitiers, Chandos, who was unmarried, died at Mortemer on Jan. 1, 1370. His herald wrote a life of the Black Prince, a valuable source of contemporary information. (I. P. S.)

CHANDRAGUPTA (Chandragupta Maurya) (reigned *c.* 321?–*c.* 296 b.c.), Indian emperor, founder of the Maurya dynasty. He seized the throne of the important Indian kingdom of Magadha (in modern Bihar) from the last of the Nanda dynasty, and by conquest extended his dominions to include a great part of northern India. He thus laid the foundations of the first great empire in the history of India. The process of conquest and consolidation was carried on by his son Bindusara and his grandson Asoka (*q.v.*), under whom the empire attained its greatest extent.

The Puranas and the Pali chronicles of Ceylon agree in attributing a reign of 24 years to Chandragupta. The Greek accounts of the campaigns of Alexander the Great tell of a meeting between Alexander and an Indian called Sandrocottus, who at first supported Alexander and afterward quarreled with him. The identification of this Sandrocottus with Chandragupta of the Indian sources was of fundamental importance in establishing a chronology for early Indian history, for which it provided the first certain date. At the time of Alexander's invasion, Chandragupta had not yet won the kingdom of Magadha, and the exact date of his accession has been disputed. It is probable however that this event took place within a year or two of Alexander's death in 323 b.c.

During 305–304 b.c. Chandragupta defeated an attempt by Seleucus Nicator to win back some of Alexander's Indian conquests, and concluded a treaty with him by which Seleucus relinquished claim to satrapies covering a considerable part of what is now Afghanistan and Baluchistan.

According to tradition Chandragupta won his way to power with the aid of a Brahman politician Chanakya, also called Kautilya, to whom is attributed the *Arthasastra,* a treatise on statecraft. It is generally accepted that this text, though probably interpolated, contains a genuine nucleus of information about the organization of Maurya government. This information is supplemented by the account written by the Greek Megasthenes who was sent by Seleucus as ambassador to Chandragupta's capital Pataliputra (Patna, known to the Greeks as Palibothra). Unfortunately only portions of Megasthenes' work have survived in the form of quotations by later classical writers. *See* also India-Pakistan, Subcontinent of: *History.*

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CHANDRA GUPTA I (reigned *c.* a.d. 320–*c.* 335), Indian emperor, the son of Ghatotkacha and grandson of Sri Gupta, the earliest known ruler of the Gupta line. Chandra Gupta appears to have greatly strengthened the power of his dynasty, partly by conquest, but largely through his marriage with the princess Kumaradevi of the important tribe of the Licchavis of north Bihar. To commemorate this event special gold coins were minted, depicting both king and queen and mentioning the Licchavis on the reverse. Chandra Gupta was the first Gupta ruler to assume the title of emperor (*maharajadhiraja*), and his territory included most of the Gangetic plain from Allahabad to northern Bengal. He apparently abdicated in favour of his son Samudra Gupta. The chronology of the Gupta era, dating from a.d. 320, which was widely used in India for several centuries, is generally believed to be based either on Chandra Gupta's accession or on his marriage with Kumaradevi.

See R. C. Majumdar and A. D. Pusalker (eds.), *History and Culture of the Indian People,* vol. iii, *The Classical Age* (1954). (A. L. Ba.)

CHANDRA GUPTA II (Vikramaditya) (*c.* a.d. 376–*c.* 414), emperor of northern India, the son of Samudra Gupta and grandson of Chandra Gupta I. According to a later tradition he came to the throne after assassinating a weak elder brother, Rama Gupta, and married the latter's widow. Inheriting what was already a very large empire Chandra Gupta continued his father's policy of expansion by conquering the Saka rulers of Ujjain. The date of this conquest cannot be ascertained with precision, but on the evidence of dated coins it must have occurred between the years 388 and 409. To strengthen his southern flank Chandra Gupta concluded a matrimonial alliance with the powerful Vakataka kingdom of central India, his daughter Prabhavati Gupta marrying the Vakataka king Rudrasena II. Rudrasena died young, and for several years Prabhavati acted as regent for her sons, thus increasing Gupta influence in the south. Chandra Gupta also appears to have made a matrimonial alliance with the Kadamba dynasty of Mysore. He is almost certainly the king Chandra referred to in the inscription on the famous iron pillar at Mehrauli, near Delhi, but this appears to be a conventional panegyric, and is not sufficient to prove that he fought successfully in Sind and Bactria.

Among Chandra Gupta's numerous titles is *Vikramaditya* ("Sun of Valour"), which appears on some of his silver coins. This fact would suggest that he is the prototype of the king Vikramaditya of later Hindu tradition, who is said to have conquered Ujjain from the Sakas and established the Vikrama era in 57 b.c. Vikramaditya is further said to have been a most benevolent ruler, under whom India enjoyed peace and great prosperity, and also a great patron of art and literature, maintaining at his court the "nine jewels" (*navaratna*), chief of whom was the poet Kalidasa. Except for the date all these details are consistent with the identification of Vikramaditya with Chandra Gupta II, for the mildness of Chandra Gupta's government and the prosperity of his subjects are attested by the Chinese Buddhist pilgrim Fa-hsien, who traveled in India from about 400 to 411, while the internal evidence of Kalidasa's works suggests that he lived at about this time. The discrepancy in the dates may be explained as due to the erroneous association in medieval times of the Krita or Malava era, long current in the region of Ujjain, with the name of Vikramaditya.

See R. C. Majumdar and A. D. Pusalker (eds.), *History and Culture of the Indian People,* vol. iii, *The Classical Age* (1954). (A. L. Ba.)

CH'ANG-AN, an alternate name for Hsi-an (Sian) city, China, and for a district in which the city at times has been situated. Another name for Ch'ang-an Hsien (district) seat, a few miles south of Hsi-an, is Wei-ch'ü (sometimes erroneously Wang-ch'ü or Wangkü). China's capital during many dynasties from the Han to the T'ang was located in Ch'ang-an Hsien. *See* Sian. (H. J. Ws.)

CHANG CH'IEN (d. 114 b.c.), Chinese explorer, was the first man to bring back a reliable account of the lands of central Asia to the court of China. Dispatched by the emperor Wu Ti of the Han in 138 B.C. to establish relations with the Yüeh-chi people, he was captured by the Hsiung-nu, enemies of China, and detained for ten years. He finally managed to reach his destination and returned to China after 13 years absence. In his travels he visited Fergana, Bactria and Sogdiana and gathered information on Parthia, India and other states in the area. His mission brought the Chinese into contact with the outposts of Mediterranean culture, opened the way for exchanges of envoys between these states and the Han, and led to the introduction into China of a superior breed of horses and new plants such as grapes and alfalfa.

See Friedrich Hirth, "The Story of Chang Kien," *J. Amer. Orient. Soc.*, 37:106 (1917). (B. D. W.)

CHANG CHIH-TUNG (1837–1909), Chinese official and reformer, was one of a triumvirate of provincial officials who played pivotal roles in the affairs of the Chinese government in the late 19th century, the others being Li Hung-chang (*q.v.*) and Liu K'un-i. Born on Sept. 2, 1837, into an official family, and recipient of the highest civil-service examination degree, Chang served successively as governor-general of Kwangtung-Kwangsi (1884–89) and Hupeh-Hunan (1889–1907). In these posts he advocated a policy of synthesizing Confucianism with western technology and methods which he expressed in a famous slogan, "Chinese learning for fundamental principles, western learning for practical application." He founded China's first iron and steel mill, cotton mills, and promoted the construction of the Peking-Hankow railroad. Chang was respected as a scholar, and in an age of increasing official corruption died, on Oct. 4, 1909, a poor man.

See A. W. Hummel (ed.), *Eminent Chinese of the Ch'ing Period* (1943–44). (AL. F.)

CHANGCHOW (CH'ANG-CHOU), an old city about 60 mi. S.E. of Nanking, in Kiangsu province, China, on the Shanghai-Nanking railway. Pop. (1953 census) 296,500. Until 1949 both the names Changchow and Wutsin were used, but the Communist government officially returned to the 7th-century name. The city has a long history as an inland port, connecting local canals with the Grand canal. In the modern period divisional railroad shops have been located in a suburb to the south of the old city. Changchow has become an important modern centre of light industry, and is a regional trade centre. (J. E. SR.)

CHANG CHUN (1148–1227), also known under his monastic name of CHIU CHU-CHI, Chinese Taoist adept and alchemist, is famous principally for the journey which he made from China at the invitation of the great Mongol conqueror Genghis Khan to visit the latter in his camp in central Asia to the north of the Hindu Kush mountains. A record of the journey was kept by his disciple Li Chih-chang, who accompanied him. Chang Chun was born in 1148 at Chihsia in the province of Shantung. He became a Taoist monk and was a pupil of Wang Che, the founder of a sect distinguished by extreme asceticism and a special doctrine of the *hsingming* or "natural state" of man which had been lost but could be recovered by prescribed practices. In 1188 Chang Chun was invited to instruct the Kin dynasty emperor Shih Tsung then reigning over northern China. In 1215 Peking was captured by the Mongols and in 1219 Genghis Khan, who had heard of his reputation, sent a minister named Liu Wen to bring him to his court. Chang Chun went first to Peking, and thence, having received an invitation also from Tamuga, the younger brother of Genghis, who resided in northeastern Mongolia, crossed the Gobi desert northward and visited Tamuga's camp near Buir-nor. He arrived in Samarkand in the middle of winter (1221–22). In the following spring he went on to the camp of Genghis on the slopes of the Hindu Kush. He reached Peking on his return journey at the beginning of 1224 and remained there until his death in 1227.

See Li Chih-chang's account of the journey, the *Hsi Yu Chi*, translated with an introduction and notes by Arthur Waley under the title *The Travels of an Alchemist* (1931). For the geographical significance of Chang Chun's travels *see* C. R. Beazley, *Dawn of Modern Geography*, vol. iii (1906). (G. F. HN.)

CH'ANG-CH'UN, a Manchurian city in western Kirin province, 175 mi. N.E. of Mukden, 145 mi. S.W. of Harbin, on the main north-south Manchurian railway line, and on the bank of the I-t'ung river, a minor tributary of the Sungari. Pop. (1953) 855,200. The city began as a local trading centre for north Chinese settlers at the end of the 18th century. It expanded rapidly and from 1905 to 1935 was a major junction and transshipment point between the Russian-owned broad-gauge Chinese Eastern railway and the Japanese-owned standard-gauge South Manchurian railway. Ch'ang-ch'un was equipped with sizable railroad shops and also became the junction for railways extending westward into Inner Mongolia and eastward into northern Korea. The city became a regional capital for the Manchurian soybean industry.

In 1932 it was designated the new capital of Manchukuo by the Japanese and renamed Hsinking (Japanese Shinkyō). A large, well-planned, new city was constructed and the population increased from 90,000 (1930) to nearly 500,000 in 1945. Water was supplied from artesian and shallow wells and from a reservoir 22 mi. distant on the I-t'ung. Power supply came chiefly from the Hsiao-feng-man dam on the Sungari near Kirin city. In addition to administrative, commercial and transportation functions, the city was a centre for light industries (soybean and grain processing) and higher educational facilities. Severely damaged during the Chinese civil war, it declined in importance after 1945. Renamed Ch'ang-ch'un once more, it gradually regained its importance as the regional economic capital of central Manchuria.

It was designated by the Peking government as the automotive centre of China, and the first major truck factory began producing in 1956. (N. S. G.)

CHANGE OF LIFE: *see* MENOPAUSE.

CHANG HSÜEH-LIANG (1898–), Chinese war lord, was the son and successor of Chang Tso-lin (*q.v.*). He became the ruler of Manchuria in 1928 on the death of his father, but was expelled by the Japanese in 1931 because he acknowledged the authority of the Chinese government at Nanking. He withdrew into northwestern China, where he fought the Chinese Communists until 1937 when he detained Chiang Kai-shek at Sian until the Nationalist leader agreed to form a united front with the Chinese Communists against the Japanese. Chang Hsüeh-liang became a prisoner and was taken to Formosa when Chiang's government fled there in 1948. (D. G. G.)

CH'ANG-SHA, a city and capital of Hunan province, China, on the east bank of the middle Hsiang river at 28° 12′ N. lat., 112° 59′ E. long., has long been important as a gateway into the middle Yangtze valley and, in modern times, as the upstream limit of steam shipping. It was for many years a treaty port, westerners being attracted by the great tea production and the assumed buying power of the population in China's "rice bowl." Traditionally, Ch'ang-sha is famous for several handicrafts: coloured silk embroidery pictures, oiled paper umbrellas, grasscloth linen, brush pens and bamboo carvings, while the main basic industries were rice hulling, saw milling, boatbuilding and the smelting of antimony, manganese, lead and zinc—all for out-shipment. After World War II, factories were erected to make machine tools, mining and farm equipment, pharmaceuticals, fertilizers and rubber products.

Ch'ang-sha is well connected to the rest of China by water, by rail (the Peking-Canton, Chekiang-Hunan, and Hunan-Kweichou railways) and by a highway to Szechwan that bends south of the Yangtze gorges. In the second half of the 20th century, the city was again a busy river port with many wide, paved streets and modern buildings. Pop. (1953) 650,600. (TE. H.)

CHANG THANG, meaning "northern plain" in Tibetan, is a vast tract of flat highland forming the northern part of Tibet. It stretches 700 mi. from the Pamirs in the west to the Tsaidam marshland in the east and 300 mi. from the Kunlun range on the north to the Thanglha range on the south. It is an inhospitable waste of frozen desert dotted with innumerable lakes. The average altitude is 15,000 ft., and the climate is generally rigorous; its severity is aggravated by the winds which blow with gale force during the greater part of the year.

The Tibet tableland probably was once the bottom of the ancient Tethys sea; the numerous lakes are its remnants. Because of the absence of rain, the lakes over the centuries have shrunk greatly in size and their waters have become exceedingly saline. Salt crusts cover flats and ancient beaches on the hillsides.

hundreds of feet higher than the present level of the lakes. Rich deposits of borax and soda are found in the region. The exacting environment is unsuitable for permanent human habitation, and only a handful of hardy nomads with roving tents and cattle live on the grassland. (T.-L. S.)

CHANG TSO-LIN (1873–1928), was a Chinese war lord who dominated Manchuria and parts of north China during the period 1913 to 1928. He rose to power as the protégé of the Japanese and in return granted them vast concessions in Manchuria. This enabled them to undertake a program of investment and economic development that ultimately transformed Manchuria into one of the most heavily industrialized areas in Asia.

In the hope of becoming something more than the viceroy of Japan in Manchuria, Chang interested himself in north Chinese politics. In 1920 he helped the so-called Chihli clique of militarists expel their rivals from Peking. Upon finding that his allies were unwilling to share their new power with him he tried to seize the capital, but was defeated and driven back into Manchuria by the Chihli armies under Wu P'ei-fu (*q.v.*). In 1924 he renewed the war and this time he was victorious, largely because Wu was deserted by his principal lieutenant, Feng Yü-hsiang. After defeating an attempt by Feng to bring about his overthrow, Chang enlisted the support of Wu and with his assistance routed Feng's army. By 1928 he was established in Peking, where he assumed the powers of a military dictator, perhaps with the intention of founding another imperial dynasty.

Chang's plans were thwarted by the armies of the Kuomintang, which in 1927 invaded north China under the leadership of Chiang Kai-shek. Disheartened by military reverses and frightened lest the Japanese desert him in order to protect their position in Manchuria, he ordered his troops to abandon Peking to the advancing Nationalists. He died on June 3, 1928, when his train was destroyed by a bomb planted by Japanese extremists, who hoped that his death would provoke the Japanese army into occupying Manchuria. His son Chang Hsüeh-liang (*q.v.*) succeeded in command of his forces. (D. G. G.)

CHANNEL FERRY: *see* FERRY.

CHANNEL ISLANDS (French ÎLES NORMANDES), an archipelago in the English channel, lies west of the Cotentin peninsula of France at the entrance to the Gulf of St. Malo, and 50–100 mi. S. of Weymouth, Eng. Except for the Roches Douvres and the Îles Chausey, the Channel Islands are British (crown dependencies), having been attached to the English crown since the Norman conquest; they do not form part of the United Kingdom. The four main islands, Jersey, Guernsey, Alderney and Sark (*qq.v.*), total nearly 75 sq.mi.

There are several lesser islands and a labyrinth of rocks and reefs. In the north, the Casquets, a group of jagged rocks 7 mi. W. of Alderney, formed a menace to shipping until a lighthouse was established on the highest rock in 1877. Burhou and Ortac are uninhabited rocky islets between Alderney and the Casquets. Lihou (38 ac.), close to the west coast of Guernsey, was the site of the church of Notre Dame de Lihou regarded as sacred by fishermen who, even 100 years after the Reformation, still lowered their sails in salute when passing. Herm (320 ac.), between Guernsey and Sark, was the site of a religious house founded in the 12th century from St. Helier abbey, Jersey. It had a Franciscan friary in 1440 and became for a while the last refuge of Roman Catholics when the Reformation overtook the islands. Later, governors of Guernsey used it as a game preserve. In the 19th and early 20th centuries the island was let to private tenants, one of whom raised wallabies there. In 1946 the states (legislature) of Guernsey bought Herm for use as a resort. A tidal eddy at the north end has thrown up a beach half a mile long formed wholly of sea shells of about 40 genera with 200 varieties. Just south of Herm is Jethou (44 ac.), a circular island privately owned; it is botanically interesting as the home of a white pimpernel and a yellow forget-me-not said to be peculiar to the island. Brecqhou (74 ac.) is separated from the west coast of Sark by the dangerous 70-yd. channel of Le Gouliot. It has a mansion and cottages and is privately owned. The Ecréhou rocks are 5 mi. N.E. of Jersey. The Minquiers, about 15 mi. S. of Jersey, is a large rocky reef of which one peak (Maîtresse Île) is large enough for habitation. The Roches Douvres, 28 mi. W.S.E. of Jersey, are under French jurisdiction, as are the Îles Chausey which lie 10 mi. W.N.W. of the port of Granville, France.

Physical Characteristics.—The Channel Islands were detached from the Armorican massif by erosion and by postglacial submergence. The isobath of 150 ft. encloses the whole group, which submarine hollows subdivide into five parts. Alderney is linked to the Casquets by Burhou, Ortac, and various banks; additional shallows occur in the Race of Alderney between the island and Cap de la Hague. Guernsey, with Lihou and off-lying rocks to the west, is separated by the Little Russel strait from Herm and Jethou, and these from Sark and Brecqhou by the Great Russel. La Déroute strait intervenes between the Guernsey group and the Ecréhou rocks, Paternosters (Pierres de Lecq), and Jersey itself, from which shoals run east-southeast toward the mainland. The Minquiers and the Îles Chausey form the fourth group, the Roches Douvres the fifth. Tidal ranges are everywhere great and tidal streams strong.

The islands have strong geological affinities with nearby parts of northwest France. They are composed largely of schistose, gneissose and coarsely crystalline rocks (granitic and syenitic types). Lavas and intrusives outcrop widely in east Jersey. All these rocks are regarded as Pre-Cambrian. The coarse, massive conglomerate of northeast Jersey may be Permian, while the sandstone of east and southeast Alderney is Lower Cambrian.

Indurated and slightly metamorphosed graywackes, equated with the Phyllades de St. Lô of the mainland, outcrop in Jersey between St. Ouen's and St. Aubin's bays; similar rocks protrude in the extreme southeast and southwest of Guernsey. In southwest Jersey, the metasediments end against the granite and granulite which enclose St. Brelade's bay, while granite borders them on the north. To the east they are overlain by bulky lavas, andesitic below and rhyolitic above; well-developed spherulitic texture distinguishes the rhyolites. A complex array of intrusive and metamorphic rocks projects into southeast Jersey. Most of south Guernsey is based on dioritic and granitic gneisses; the crystalline rocks of the north, ranging from hornblende-gabbro through diorites to granite, display the effects of progressive granitization, which is perhaps also identifiable in the rocks of the south. Alderney is composed of granitic and allied rocks in the southwest, syenite in the centre and sandstone in the east, the outcrops being complicated in detail by faulting. Sark and Brecqhou are cut in hornblende-schist, gneiss and granite, while Herm, Jethou, and the Îles Chausey are entirely granitic. The remaining groups of shoals are formed of granite or of diorite-gneiss. Intrusive dikes of dolerite abound throughout the archipelago; dikes of mica-lamprophyre are found in Guernsey, and dikes of granite-porphyry in west Alderney and southeast Jersey. Vein minerals in Sark include amethyst.

The Channel Islands were incorporated in the Armorican folds. There is some evidence for folding along northeast to southwest axes, but fold structures are much obscured by faults. The main islands may themselves be fault blocks, Guernsey being tilted northward and Jersey southward. Frequent minor earth tremors indicate continuing activity along some fault lines.

The highest parts of the islands are strikingly flat. Jersey, Guernsey and Herm reveal very clearly the results of marine notching at various levels. Notching has also taken place on Alderney, but Sark rises abruptly from the sea. Old bay floors, backed by curving lines of old cliffs, are conspicuous in the west of Guernsey and along the south coast of Jersey, where intermittent falls of base level of amplitude 20–30 ft. are recorded. The old marine features all belong presumably to the Pleistocene (*sensu lato*); raised beach deposits are known at about 120 ft., 60 ft. and 25 ft. above present sea level, the last two series being important archaeologically through their association with bone-bearing and implementiferous caves. All the streams on Jersey and Guernsey have been intermittently rejuvenated by falls in base level, and those of Jersey have developed bold valley-in-valley forms enclosing incised meanders. The limited catchments on the smaller islands nourish few permanent streams.

Climate.—Climate is maritime throughout the Channel Islands, which are well exposed to influences from the Atlantic ocean. About half the recorded winds are westerly, averaging about 10 m.p.h. Mean annual range of temperature is low—about 17° F. for Guernsey, and slightly higher for Jersey, which is somewhat more subject in winter to the spread of cold air from the mainland. August is the warmest month and February the coldest; temperatures are strongly affected by sea surface temperatures to the west. Snow is uncommon; killing frosts are rare; and the growing season is very long. The air is unaffected by pollution, sunshine exceeds an average of five hours a day the year around and atmospheric humidity is consistently high. All these circumstances greatly favour cropping.

Rainfall is reliable throughout the islands. July, the driest month, averages little less than two inches of rain. October is the wettest month, with 4½ in. or more; rainfall subsequently declines slowly through November, December and January, and then drops more steeply in February. The considerable spatial range of mean annual rainfall in Jersey and Guernsey has been analyzed in detail. The total exceeds 40 in. in north-central Jersey, falling below 35 in. in the southwest and below 30 in. in the extreme southeast. The west and north fringes of Guernsey have less than 30 in., while parts of the southern plateau record more than 35 in. Local effects of shelter occur in some enclosed valleys.

Heavy demands on water supply are made both by domestic and agricultural consumers, especially on Guernsey where numerous greenhouses demand irrigation. Public supplies from reservoirs impounded in incised valleys and from boreholes trapping deep aquiferous fissures are supplemented by shallow wells on the plateaus, by water contained in abandoned quarries and (in Guernsey) by distillation of seawater. (G. H. D.)

Vegetation.—The sunny almost frost-free climate with adequate rainfall enables many more southern and Mediterranean species to thrive despite the general absence of lime in the granitic soil. Fuchsia, japonica, camellia, acacia, mimosa, hydrangea, clematis, tamarisk, gunnera and columbine grow wild in the woods and wayside. About 700 wild flowering plants are recorded, 650 in Jersey. Species rare or absent in the British Isles include blue romulea (*Romulea parviflora*), broad-leaved thrift (*Armeria plantaginea*), loose-flowering orchis (*Orchis laxiflora*), the wall daisies *Erigeron canadensis* and *E. mucronatus*, the garlic *Allium triquetrum*, quillwort *Isoetes hystrix* and several grasses and sedges, including galingale (*Cyperus longus*), *Scirpus americanus* and *Milium scabrum*. Intensive cultivation of level and south-facing land has reduced woodland largely to north-facing slopes, where native trees, recorded in the analysis of pollen from Jersey peat deposits, still grow: oak, ash, wych-elm, beech, lime, birch, pine, alder, cedar and hazel. Introduced later, sycamore is now a fairly dominant tree. Characteristic of the sheltered lanes and cliff hollows are many species of ferns, mosses and lichens; wild daffodils (known as Lent lilies), foxgloves and gorse are abundant, as well as the showy purple bugloss *Echium plantagineum*, and on the cliff tops heather, ling, thyme, rockrose, autumnal squill and lady's-tresses (*Spiranthes spiralis*). Bulbs of *Nerine sarniensis* from South Africa were washed ashore from a ship wrecked off the islands in the 17th century; these plants, now known as Guernsey lilies, also flourish in Jersey. At low tide hundreds of acres of sand and rocks are exposed where the luxuriant growth of seaweed (vraic) is harvested as fertilizer for the early potato crops.

Animal Life.—The small size of the islands, their isolation since prehistoric times, and their dense human population have limited the number of terrestrial species. The rabbit is the largest wild animal, and with the hedgehog, wood mouse, house mouse and black and brown rats, is found on all the main islands. The mole is confined to Jersey and Alderney. Guernsey has an insular species of field vole *Microtus sarnius*, and Jersey a large docile bank vole *Clethrionomys caesarius*. The continental shrew *Crocidura russula* is universal; but in Jersey is confined to the coast, its place being taken inland by a variety of the common shrew *Sorex araneus fretalis*. The red squirrel, probably introduced a few centuries ago, is common in Jersey, where the stoat also survives, having lately disappeared from Guernsey. The fox was formerly hunted in Jersey, where the last one was killed about 1860. Bats are scarce, but the pipistrel and long-eared species are found, especially in Jersey's sheltered valleys. Common and Atlantic seals are rare visitors to the coasts, where porpoises, dolphins and sometimes turtles are recorded. Of reptiles the grass snake is found in Jersey only. The large green lizard *Lacerta viridis* inhabits Jersey and Guernsey, the wall lizard *L. muralis* and the common toad inhabit Jersey only. The Channel Islands frog *Rana dalmatina*, a southern species not found in northern France, the slow worm and the palmated newt, are widespread.

Breeding land birds are few and, like the mammals, continental rather than British in character; cirl bunting, Dartford warbler and Kentish plover are of special interest. Many species common to the British Isles pass through on migration. The cliffs and outer islets of the group support colonies of gannets (Alderney), cormorants, shags, storm petrels, common and Sandwich terns, kittiwake, herring gulls and great and lesser black-backed gulls, razorbills, guillemots, puffins and oystercatchers. Raven and peregrine falcon also nest.

The ormer *Haliotis tuberculata*, a succulent mollusk with a large iridescent shell, reaches its northern limit in the Channel Islands, where it is found at low tide, and is relished as a table delicacy. Lobster, crab and octopus are fished commercially. (R. M. Lo.)

Population.—Most of the inhabitants of the Channel Islands are of Norman descent, but there is a large admixture of Breton blood and the people of Alderney are of mainly English stock.

The population (1961 census 110,503) is concentrated chiefly in Jersey and Guernsey (pop. Jersey bailiwick 63,345; Guernsey bailiwick 47,158). The bailiwick of Jersey included no permanently occupied islands other than Jersey itself, although there are some inhabitable islands in the Ecréhou and Minquier groups. Guernsey island had 45,028 inhabitants in 1961, Alderney 1,472, and Sark and Brecqhou 560; Herm (90 inhabitants in 1961) has been continually occupied for more than a century, while Jethou (8 inhabitants in 1961) is occasionally, and Lihou usually, unoccupied. The Roches Douvres and the Casquets have lighthouses; on the Îles Chausey are a farm, church, hotels and a lighthouse.

Totals for the group were 50,581 in 1821; 90,739 (including a large garrison) in 1851; 95,618 in 1901; 96,772 (estimated from records) in 1939; and 102,776 (excluding visitors) in 1951. Since the mid-19th century natural increases and immigration have been more than offset by emigration, which is a long-standing practice. About 70% of the inhabitants at the 1961 census were born in the Channel Islands; there is little interchange of people between Jersey and Guernsey, which cherish a traditional rivalry.

Settlement in Alderney is nucleated with most inhabitants living in St. Anne's overlooking Braye harbour; Newtown forms an appendage of St. Anne's at a lower level. Nucleation was associated with the holding of arable land in common; relics of a three-field system have been identified, and St. Anne's is still surrounded by the compact block of farmland called the Blaye. Sark is divided into farm holdings with fixed boundaries. In Jersey and Guernsey, centuries of subdivision of farmland among heirs have produced systems of tiny fields and scattered dwellings, which contrast strongly with the port towns. About half the population of Jersey lives in St. Helier (*q.v.*) on the south coast where Fort Regent dominates the harbour at the east end of St. Aubin's bay. St. Helier has spread across a naturally-filled lagoon on to plateau spurs descending between converging valleys; its influence is felt in nearby parts of St. Saviour and St. Clement parishes on the east. The east coast port of Gorey, and St. Aubin, a third port at the west end of St. Aubin's bay, each have about 1,500 inhabitants. More than two-fifths of the people of Guernsey live in the parish of St. Peter Port (*q.v.*); the town itself is on the coast, where valleys run down to the sea near the junction between the southern plateau and the northern lowland. Parts of the adjacent St. Martin parish, southwest of St. Peter Port, are rapidly becoming residential. St. Sampson in northeast Guernsey surrounds a harbour constructed in the former tideway which used to traverse the north of the island; serving as Guernsey's second port, it has about 2,225 inhabitants. (G. H. D.)

AUTHENTICATED NEWS

COBO BAY, ON THE WEST COAST OF THE ISLAND OF GUERNSEY, CHANNEL ISLANDS

History.—The land which was to form the Channel Islands was first inhabited by men of the Middle Paleolithic period whose remains have been found in Jersey. At that time Jersey was still attached to the mainland, though Guernsey, Sark and Alderney may already have been islands. There appears to be a long gap between the men of the Middle Paleolithic and the Neolithic people whose abundant remains, chiefly megalithic tombs, exist in most of the islands. From the 3rd millennium B.C. habitation appears to have been continuous. The Bronze Age is well represented in Jersey and Alderney, less well in Guernsey; toward the end of this period Celtic people first came to the islands. Their most striking memorial is the hoards of Gaulish coins found principally in Jersey. During Caesar's campaigns in Gaul, his legions probably drove many refugees into the islands and overwhelmed them there, but Roman remains are scanty. Fort Nunnery in Alderney was possibly a Roman defense against Saxon invasion and a structure at Le Pinacle in Jersey may be of Roman date.

The history of the islands during the 1st millennium A.D. is obscure. Memories of the Celtic saints Samson and Magloire, the apparently Saxon Marculf and the Frankish Helier suggest that the islands were the meeting place of Breton and Frank in the 6th century. In the 9th century they must certainly have been included in the Breton conquest of what was later western Normandy. Their place names indicate, however, that they were subsequently settled by the Northmen, although at what stage in their raiding and settlement there is no evidence to show. It is most likely that when the Cotentin and the Avranchin were ceded to William "Longsword," the second duke of Normandy, in 933, the islands were included in the transfer; and they may well have been the object of internal colonization by dukes of Normandy early in the 11th century. From the time of William the Conqueror until the early years of the 13th century the islands were as closely integrated into the social and political structure of the duchy of Normandy as if they were part of the mainland. Ecclesiastically they were in the Norman diocese of Coutances, much of their land was held by Norman monasteries or by Norman barons whose chief estates lay on the mainland, and they were included in the financial and judicial administration of the duchy. Since, for most of this time, the duke of Normandy was also the king of England, the islands were thus brought into contact with England.

In 1204, in the time of John, king of England and duke of Normandy, the conquest of continental Normandy by the king of France was completed; but, for some reason never satisfactorily explained, the islands remained in the possession of the king of England. They were, however, not incorporated into the kingdom of England, though annexed to the crown in 1254. When peace was made in 1259, Henry III did liege homage to the king of France for all the lands that he held south of the Channel, and there can be little doubt that the Channel Islands were thereby included, still, in the kingdom of France. The strains to which this situation gave rise led to prolonged although intermittent warfare between the two kingdoms, in which the islands suffered heavily and in the course of which they were detached *de facto* from the kingdom of France. They continued to be ruled by the law of Normandy with their own customs and administered by courts which, though held in the king's name, were staffed by local men and out of which the islanders gradually built up their organs of self-government.

The sufferings of the islanders under repeated French attacks (1294, 1336–40, 1372–77, 1403, 1406, with Guernsey, Alderney and Sark occupied 1338–40 and Jersey 1461–68) resulted eventually in their being accorded the privilege of neutrality, apparently recognized first by local custom and later ordained by papal bull in 1483. The privilege seems to have given the islands some protection during the wars of the 16th century, though it made them an important centre of political intelligence and espionage. This neutrality was not denounced by the English government until 1689. The Reformation was brought to the islands by French refugees in the reign of Edward VI and took Calvinist form. Churches were organized on the Presbyterian model in Jersey and Guernsey and the first interinsular synod met in 1564. Attempts were made to transfer the islands from the diocese of Coutances to Salisbury in 1496 and to Winchester in 1499; but it was not until 1569 that they were effectively detached from Coutances and put under the jurisdiction of Winchester. For the remainder of the century, however, Presbyterianism dominated the islands. Jersey was not brought into the Anglican fold until 1623; Guernsey not until 1663. Wesleyan Methodism made a great impression on the islands, where Anglicanism had no real force until the 19th century.

During the Civil War, Jersey was held for the king and Guernsey (apart from Castle Cornet) for Parliament. Charles II was first proclaimed in Jersey and stayed there on two occasions (April 17 to June 25, 1646, and Sept. 17, 1649 to Feb. 13, 1650). Elizabeth castle in Jersey and Castle Cornet in Guernsey did not surrender to parliamentary forces until Dec. 15, 1651. (New Jersey in the United States, granted in 1664 to Lord Berkeley and Sir George Carteret, was named in honour of the latter's defense of Jersey for Charles II.) Thereafter, apart from internal disturbances, the islands were left in peace until two French attacks were made on Jersey in 1779 and 1781—the last made famous by the heroic defense led by the young Maj. Francis Pierson. During the French Revolutionary Wars the islands must have seemed desperately insecure, particularly as they were active centres of counter-revolutionary activity and espionage; but the French made no further attacks. Vast sums were spent then and during the 19th century on fortifying the Channel Islands.

In World War I they made a proportionate contribution to the Allied cause, but they were not molested. By 1939 their strategic position as English outposts across the Channel no longer had any significance, and no attempt was made to defend them when German forces overran France. They were under German occupation from July 1940 until May 9, 1945, when the German garrison surrendered to the Royal Navy. (Le. P.)

Administration and Social Conditions.—The Channel Islands were part of the former duchy of Normandy, and were united with the English crown at the Norman conquest. Contrary to popular impression, however, ruling monarchs of the United Kingdom do not possess ducal status with respect to the Channel Islands, which are attached directly to the crown. The islands are not affected by acts of the parliament at Westminster unless specifically named therein, in which case the acts are registered by the island legislatures. Government is, in legal theory, effected by the monarch in council; in practice the islands have considerable freedom in the management of their affairs. Legislative and administrative arrangements are greatly complicated by differences from island to island, and by the enforcement of laws that derive partly from the ancient customary laws of Normandy.

Apart from one brief interval, the Roches Douvres and the Îles Chausey have always been French. The remaining islands are grouped into two distinct bailiwicks of Guernsey and Jersey. That of Guernsey consists of Guernsey itself (with Lihou, which is linked by a causeway to Guernsey at low spring tides), Alderney, Herm, Jethou, Sark (with Little Sark), Brecqhou and numerous tiny islets. The bailiwick of Jersey includes Jersey, the Ecréhous and the Minquiers. Sovereignty over the Ecréhous and the Minquiers was disputed between England and France for more than 300 years; in 1953 the International Court of Justice confirmed British sovereignty.

Lieutenant governors of Jersey and Guernsey are personal representatives of the sovereign; they may sit and speak in the island legislatures but may not vote; however they have the power to veto certain forms of legislation. The legislative bodies are known as the States (in Guernsey, the states of Deliberation), presided over by a bailiff appointed by the crown with rights of dissent and a casting vote. The states of Jersey consist of 12 senators, 12 constables and 28 deputies; the dean is an ex officio member but has no vote. The states of Guernsey consist of 12 counsellors, 33 people's deputies and 10 *douzaine* (parish) representatives. The states of Alderney have 9 popularly elected members. The Chief Pleas of Sark consist of 40 tenants and 12 elected deputies under the presidency of the seneschal; the Seigneur of Sark (in 1960, La Dame) is chief of the island, and can enforce such regulations as the prohibition of automobiles and of female dogs.

Jersey and Guernsey have stipendiary magistrates, but justice is administered on each mainly by a royal court, composed of the presiding bailiff and 12 jurats, who in Jersey are elected by an electoral college and in Guernsey by the states of election. Alderney has its own court.

Until 1949 the royal court of Guernsey had considerable legislative power. Post-World War II reforms of the legislatures and judiciaries of Guernsey, Jersey and Alderney simplified procedure without dislodging all the accretions of past centuries. Full-time paid police are maintained in St. Helier and St. Peter Port, but control in the country parishes is in the hands of parish officers, or elected unpaid constables. Ancient groupings of families are recorded in the status of *centeniers, vingteniers, douzainiers*, and corresponding divisions of land.

Rates of income tax, and of customs and excise, are significantly lower in the Channel Islands than in the United Kingdom; supertax, death duty, estate duty and purchase tax are not exacted. Hence the islands attract persons retiring on income, or who can become domiciled there before retirement. Household tenure is greatly complicated by the residue of customary law, including the intricate law of inheritance. Subdivision of holdings in Jersey and Guernsey has encouraged dense settling of the country districts, and pressure on land is severe; the resulting high prices of houses, combined with the cost of importing, raise the average cost of living.

Social security schemes, including pensions and family allowances, are in operation; family allowances were introduced in the Channel Islands earlier than in the United Kingdom, with a view to mitigating the effects of emigration on the age-structure of the population. The islands (excluding Sark) have reciprocal agreements with the United Kingdom regarding the provision of medical treatment and benefits. Primary and secondary education is provided by the states; there are also private schools, and Jersey and Guernsey each have two secondary boarding schools, one for boys and one for girls (including Elizabeth college for boys founded in Guernsey by Queen Elizabeth I in 1563).

The official language in Jersey is French, but English is commonly used; proceedings of the states and royal court of Guernsey are conducted in English. Official (Parisian) French differs considerably from the Norman-French patois still surviving in the country districts, while the patois itself varies from island to island and even from one part of Guernsey or Jersey to another.

In the 19th century Jersey and Guernsey struck their own copper coins, which circulate alongside English copper. Guernsey issues £1 and 10*s*. notes, interchangeable with English notes in the islands.

Economy.—The productive economy has long combined agriculture with other activities which have usually been complementary but occasionally competitive. Within agriculture the last two centuries have produced a combination of farming with specialized cropping, and farming itself has increasingly specialized on dairying.

During the middle ages the islands partook in the Gascon wine trade. Fishing was mainly of the inshore kind until the 16th century, when Channel Island craft entered the newly developing cod fishery of Newfoundland, establishing a connection that lasted 300 years. Domestic knitting throve in Tudor and Stuart times, when in addition to the garments named guernseys and jerseys, many stockings were produced. Local sheep farming was encouraged by the demands of knitters, but wool imports were also necessary.

Jersey and Guernsey developed a notable export trade in cider during the 18th century, when a quarter or more of the arable land was put down to orchards. During the Napoleonic wars sheep farming and orchards lost much ground to wheat and barley and to cattle raising. Shipowners engaged in privateering, which had become profitable during the American War of Independence, and in smuggling French wines into England. Orchard cultivation and cider making revived in the first half of the 19th century, especially in Jersey, and potato growing for export was established in Jersey, Guernsey and Alderney. Disastrous attacks of blight in the mid-19th century permanently curtailed production of potatoes in Guernsey and Alderney, but the Jersey trade recovered fully and later increased. Agricultural experiments in the 19th century eventually provided Guernsey with one of the world's greatest concentrations of greenhouses; greenhouse cultivation relied initially upon grapes, which were later replaced by tomatoes because of difficulties of packing and transport. By the 1960s, Guernsey excelled in the growing of tomatoes under glass and in the production of cut flowers, while Jersey favoured early potatoes and tomatoes grown in the open; the extent of greenhouses in Jersey was, however, increasing. Market garden produce went mainly to Great Britain. Alderney and the smaller islands are little concerned in growing for export.

Specialized cropping has much reduced the area of farmland, but the practice of double cropping impedes rigid distinction of farmland from market gardens. Cultivation of grains, roots and green crops on the remaining farms is ancillary to dairying; dairy farms in Jersey and Guernsey are located principally on the high ground. The two local breeds of Jersey and Guernsey cattle, renowned for their high grade of milk, had their characteristics fixed in the second half of the 19th century; these popular cattle are still bred for export (*see* CATTLE).

Agriculture and horticulture combined form the main employment of the men in the islands, while women are mainly employed in personal service. Manufacturing is little developed apart from the processing of local produce, but includes the manufacture of tobacco and textiles. Ships were built in Jersey and Guernsey during the 19th century, but the industry was destroyed by the advent of metal ships and by the decline of inshore fishing. Attempts to mine silver on Sark and copper on Guernsey proved either unsuccessful or uneconomical. Stone quarrying was extensive during the 19th and early 20th centuries, when large amounts of various crystalline rocks were exported. Although road metal and monumental stone are still quarried, the industry is well below its former peak.

Agriculture and horticulture apart, the present economy depends heavily on tourism, which is highly favoured by climate, customs status, scenery, advertising policies and passenger services by sea and air. Already well in evidence before World War II, the tourist trade greatly increased in the 1950s and 1960s. It leads to no more than slight seasonal unemployment in the winter months.

External freight traffic passes mainly through the ports of St. Helier and St. Peter Port; Gorey serves as an alternative port of arrival in Jersey, and St. Aubin has a small port trade. St. Sampson deals with heavy seaborne cargoes, including south Wales anthracite used in the furnaces of greenhouses. Alderney, Herm and Sark are served from Guernsey. Mails and increasing quantities of light parcels are carried by air; Jersey, Guernsey and Alderney have airfields.

Shipping services for passengers and cargo link Jersey and Guernsey with Southampton and Weymouth (Eng.) and with St. Malo (France). There are additional cargo connections with London and Liverpool. Airlines connect Jersey and Guernsey with England, Wales, Scotland, Ireland and France. Charter flights are made in addition to scheduled runs, and passenger movement by air exceeds that by sea.

Freight traffic is mainly between the islands and the United Kingdom. Imports consist mainly of foodstuffs, solid and petroleum fuels and building materials. Horticulturists import glass, fertilizers, chemicals, bulbs and packaging materials.

Jersey exports potatoes, tomatoes, vegetables, stone and scrap iron; Guernsey exports tomatoes, flowers, stone, tar and scrap iron.

Internal services are provided by interisland boats and by bus services centred on St. Helier and St. Peter Port. Narrow roads confined by earth banks or stone walls limit the size of vehicles. The islands are linked to the English mainland by telephone.

(G. H. D.)

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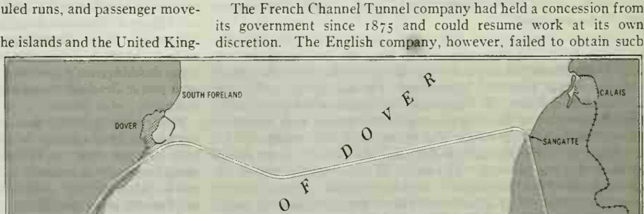
CHANNEL TUNNEL (ENGLISH CHANNEL). A tunnel under the English channel was first proposed by a French engineer, Thomé de Gamond (1807–75), who submitted a scheme for it to Napoleon III in 1856. He was joined in his work by the British engineers Isambard Brunel, Joseph Locke and Robert Stephenson, and later by Sir John Hawkshaw. The proposal was seriously considered by the railway companies on both sides of the channel, and a convention with the French government to regulate it was signed in 1875. Then the bitter rivalry of the South Eastern and the Chatham and Dover railway companies created difficulties and the scheme became a political question. W. E. Gladstone was a keen supporter, as were John Bright, Lord Lansdowne and Lord Salisbury, while Joseph Chamberlain and the war office opposed. The subject was referred to a joint select committee of the commons, which considered many reports by generals favouring the scheme and a memorandum by Lord Wolseley strongly resisting it. The committee decided against the proposal by 6 to 4, Lord Lansdowne, the chairman, voting for it. Thereafter succeeding British governments all opposed the scheme.

After Louis Blériot had flown the channel in 1909, a channel tunnel committee was formed in the house of commons, under the chairmanship of Sir Arthur Fell, which ultimately numbered more than 400 members of parliament. The Labour party joined en masse and Herbert Asquith promised to have inquiries made. World War I broke out and nothing could be done. After the war David Lloyd George promised to make more inquiries. Andrew Bonar Law and Stanley Baldwin did nothing. James Ramsay MacDonald, in July 1924, offered to consult all the living former prime ministers. The five met and rejected the scheme, although a two to one majority of M.P.'s supported it. So the channel tunnel scheme was shelved again but the idea did not die.

The French Channel Tunnel company had held a concession from its government since 1875 and could resume work at its own discretion. The English company, however, failed to obtain such



MAP OF PROPOSED TUNNEL SPANNING THE ENGLISH CHANNEL powers. In 1957 the channel tunnel project was revived. An agreement setting up a channel tunnel study group was signed in Paris on July 26 by representatives of the following groups. (1) a French group represented by the French state railways and the French Channel Tunnel company; (2) a British group, under the aegis of the Channel Tunnel Co., Ltd.; (3) the Suez Canal company; and (4) an American company, Technical Studies, Inc. The proposal most favourably considered in the past has been for twin railway tunnels following an alignment similar to that shown in the plan which, it was hoped, would allow all underwater tunneling to be carried out in the Lower Chalk which outcrops in the cliffs on each side of the channel.

There are several difficulties involved in providing a road tunnel under the channel. First, the cost of ventilation would be prohibitive; second, there are great difficulties in dealing with accidents or breakdowns in a tunnel of this length; third, many drivers would not be temperamentally capable of driving through such a tunnel.

There have been many developments in overcoming the technical problem in constructing a channel tunnel, since the channel tunnel committee reported to the British parliament in 1930.

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CHANNING, EDWARD (1856–1931), U.S. historian, whose claim to eminence rests largely on his monumental work covering the history of American development from discovery through the American Civil War, was born in Dorchester, Mass., on June 15, 1856. He was closely identified with Harvard university, where he took all of his collegiate work, including the Ph.D. degree (1880). As a teacher at Harvard between 1883 and 1929, he helped to train many students who later became prominent scholars and statesmen. He excelled as a historical detective unraveling historical episodes. Social Darwinist thought influenced his outlook and led him to stress the triumph of the forces of union over those of particularism as the dominant theme in American history. In emphasizing the significance of urbanization and of improvements in transportation, he challenged the frontier thesis of his illustrious colleague, Frederick Jackson Turner (*q.v.*). Although Channing was sometimes chided for his provincial New England bias, his six-volume *History of the United States* (1905–1925) ranks as a unique accomplishment in American historical writing because of its combination of chronological sweep, original research in sources, and freedom from slavish commitment to orthodox interpretations. The 6th volume was awarded the Pulitzer prize for history. Channing died Jan. 7, 1931.

See John A. DeNovo, "Edward Channing's 'Great Work'—Twenty Years After," *Mississippi Valley Historical Review*, xxxix, 257–274. (J. A. DeN.)

CHANNING, WALTER (1786–1876), U.S. physician, the first to use ether as an anesthetic in obstetrics, was born in Newport, R.I., on April 15, 1786. He was the brother of William Ellery and Edward Tyrrell Channing. He studied at Harvard university and at the medical school of the University of Pennsylvania, Philadelphia, where he received his M.D. in 1809. He then studied medicine in Europe before returning to Boston, Mass., in 1812 to set up practice as an obstetrician.

Three years later he was appointed first professor of obstetrics at Harvard, where later he was dean of the medical school (1819–47). In 1847 he first used ether in deliveries, and in the next year reported its successful employment in more than 500 obstetric cases.

Channing was one of the founders of the Boston Lying-In hospital in 1832 and was a co-editor of the *Boston Medical and Surgical Journal*. From 1822 to 1825 he was librarian of the Massachusetts Medical society, and from 1828 to 1840 acted as treasurer of the society. He died on July 27, 1876.

CHANNING, WILLIAM ELLERY (1780–1842), U.S. clergyman, author and leading spokesman for Unitarianism, spoke his mind on so many issues that, as Ralph Waldo Emerson remarked, his writings are almost a history of his times. Because those times were the incubation period of both Transcendentalism and organized movements to root out slavery, intemperance, poverty and war, Channing remains a figure of considerable interest. His moral earnestness, intense individualism and confidence in the goodness of human nature gave him an enviable reputation as a liberal. Actually he was more conservative, theologically, than Emerson, and far less certain that society could be improved by collective action than William Lloyd Garrison and Elihu Burritt.

He was born April 7, 1780, at Newport, R.I., into a prominent family forced to retrench after the father's untimely death in 1793. Sent to Harvard college, from which he graduated in 1798, he proved a good student, outstanding in writing and public speaking, but he was not strongly attracted to any vocation. In the autumn of 1798, distressed, apparently, by his obligations, he deserted a desultory reading of theology to become tutor to a dozen children in Richmond, Va. on the invitation of David Meade Randolph. In the Randolph household, he encountered John Marshall and other notables whose conversation and social grace he much admired. Slavery, viewed at first hand, he found detestable, corrupting both Negroes and whites. Serious, shy and homesick, he read, often far into the night, the available books—works by Voltaire, Rousseau, William Godwin and Mary Wollstonecraft. Deciding that man's most deadly sin is avarice, he momentarily considered joining a community rejecting personal property, but his social speculation gave way to a more typical New England absorption in the Bible. Before returning to Newport in July 1800, he had, as he wrote in his *Memoirs*, experienced a "change of heart" about religion and acquired an "ardent desire to serve mankind." His health, however, was permanently broken, for in his lonely soul searching he had feared that his sensual nature was getting out of control and had taken such steps against it as deliberate fasting and sleeping on the bare floor.

At home, he turned energetically to the study of theology, first in Newport's Redwood library and then at Harvard, where he returned in Jan. 1802. Soon he was supplying pulpits in the vicinity of Cambridge, Mass. Immediately successful as a preacher (he was not the first instance of the appeal of a keen mind in a frail body), he was installed as minister of the Federal Street church, Boston, on June 1, 1803, and remained there until his death. In 1814 he married a wealthy cousin, who helped him conserve his strength for the study and pulpit. After 1817 he had an assistant and was able to take much needed vacations, among them a year's travel in Europe in 1822–23 and a winter in the West Indies in 1830–31. He was 62 when he died of typhoid fever, in Bennington, Vt., on Oct. 2, 1842.

His early ministry was quiet but impressive, his congregation requiring a new and larger church by 1809. Tending to avoid abstruse points of doctrine, he preached morality, charity and Christian duties. He became Boston's most eloquent critic of Napoleon and of the unpopular War of 1812, and thereafter was in demand for the ceremonial occasions of New England Congregationalism—the fast, thanksgiving and election days, the ordinations and dedications, the formal lectures. Many of his discourses on these occasions were promptly published.

Channing reached an even larger audience by writing for the liberal Boston periodicals, first the *Monthly Anthology*, and then the *Christian Disciple*, which in 1824 became the *Christian Examiner*. The tone of these journals was offensive to such orthodox Calvinists as Jedidiah Morse, who founded the *Panoplist* in 1805 to wage war on liberal heresies. Channing was plunged into controversy in 1815 by a *Panoplist* denunciation of the Boston clergy as "Unitarians" rather than Christians. His defense, *A Letter to the Rev. Samuel C. Thacher* (1815), was followed by *Unitarian Christianity* (1819), a discourse at the ordination in Baltimore of Jared Sparks, and by two powerful articles in the *Christian Disciple:* "Objections to Unitarian Christianity Considered" (1819) and a review later reprinted as "The Moral Argument Against Calvinism" (1820). Reluctantly, but decisively, Channing accepted the label of Unitarianism (*q.v.*) and defended his faith as "a rational and amiable system, against which no man's understanding, or conscience, or charity, or piety revolts."

Channing's reputation in his time as a man of letters resulted from several long essay-reviews, among the first of their kind in the United States. One took Milton's *Treatise on Christian Doctrine* as a starting point (*Christian Examiner*, 1826), a second Scott's life of Napoleon (1827–28), and a third a book of selections from Fénelon (1829). All have a perceptibly moralizing tone and are valuable chiefly as evidence of the temper of the times. *Remarks on a National Literature* (1830), less widely read, is an interesting anticipation of Emerson's *The American Scholar.*

The most puzzling aspect of Channing is his attitude toward social reform. He sympathized with the abolitionists, the pacifists, the prohibitionists and with those who would change the system of education or of society, and a large proportion of his writings deals with the problems these reformers expected to solve. Channing could not bring himself, however, to join the organizations springing up all around him. "Remarks on Associations" (*Christian Examiner*, 1829) marshals the arguments for and against the collective approach, among the latter a still pertinent examination of the tendency toward bureaucracy in charitable agencies. "There is," he concluded, "no moral worth in being swept away by a crowd, even towards the best objects."

Bibliography.—The best book on Channing is David P. Edgell, *William Ellery Channing: an Intellectual Portrait* (1955). *See* also the more detailed *Always Young for Liberty* (1956) by Arthur W. Brown, and the basic source (most of the Channing manuscripts having been destroyed by fire), W. H. Channing's *Memoir*, 3 vol. (1848). R. L. Patterson's *The Philosophy of William Ellery Channing* (1952) is the fullest analysis of Channing's thought. (T. Hr.)

CHANSON is the French word for song, but, when used in English, normally refers to the medieval or renaissance art song cultivated in France and using French texts. The Latin theorists of the middle ages called it *carmen* or *cantilena*, while the Provençal writers spoke of the canso.

The troubadours were the first canso poets and composers, and the author of a 13th-century Provençal treatise considers the canso to be a love song that cannot be set to an existing melody but must have a new one. A 14th-century treatise, *Las leys d'amor*, is more precise and points out that the canso has from five to seven strophes. Such details prove mainly that the troubadour definitions referred to the content rather than the form of a song, for the *vers* also had five or more strophes, but its text was concerned with philosophical and intellectual matters.

The heyday of the southern French troubadours was the 12th century, that of the northern French trouvères the 13th. The latter imitated the troubadours to a great extent, but they have left some 1,500 pieces as against the troubadours' 300. The *chansons de geste* (*q.v.*) are, of course, one type of northern French *chanson*, but unfortunately only two melodies exist that can be associated with the long epic poems that flourished in the 11th and 12th centuries. Undoubtedly a single melodic phrase was used in these pieces for every line of the strophe, or *laisse*, except that a variant might be used for a concluding line in the manner of a coda. Johannes de Grocheo, writing in Paris about 1300, includes the rondeau among the *cantilenae*, *i.e.*, the type of dance song popular in the 13th century, which had the form $A\ B\ a\ A\ a\ b\ A\ B$ (the capitals represent refrain lines with identical text; the music consists throughout of the two phrases A and B). The typical 13th-century chanson derives from certain troubadour songs such as "Be m'an perdut" by Bernart de Ventadorn (Ventadour) with the verse form $a\ b\ a\ b\ c\ d\ b$. The identity of the two parts of the first half of the composition persisted in northern France, although the length of the strophe might vary, for instance in works by Thibaut IV, king of Navarre. In the 14th century this type developed into the popular ballade form, which was usually polyphonic. In fact this was the most important 14th-century development in the history of song. The music of the troubadours and trouvères had been monodic, and instrumental accompaniments were never written down.

The rondeau continued to be fairly popular, but attained its greatest favour as a polyphonic form in the early 15th century. Most of the other forms of early song disappeared, and the so-called fixed forms, ballade, rondeau and *virelai*, reigned supreme. The *virelai*, which had a basic form $A\ b\ b\ a\ A$, was much less frequently composed than the other two song types. These pieces were solos with an accompaniment of one, two or three instruments. The three-part work was standard till the end of the 15th century. However, four-part writing had become the norm in church music by the middle of the 15th century, so that it was only natural that about 1500 the style of mass and motet began to transfer itself to the chanson. At first the transference was very literal, and such men as Josquin Desprès and his Flemish contemporaries wrote chansons of a serious cast with learned counterpoint in four or five completely vocal parts. Antoine de Févin seems to have been the leader of a school of simpler chanson composition, often with folklike texts and in only three parts. From about 1530, however, it was the Parisian school that triumphed with a light-textured four-part type of chanson that employed two sorts of texts, the first fairly conventional love poems and the second definitely obscene verses. The two leading composers in the first half of the 16th century were Clément Janequin and Claude de Sermisy. Janequin is best known for his so-called program chansons, which can be paralleled by 14th-century *virelais* and works in canon called *chaces*. Such compositions, which imitate the sounds of battles ("La bataille de Marignan") and nature ("L'alouette"), are not typical of either the 14th or the 16th century, but must be taken into account in the history of song.

The second half of the 16th century revealed three new trends. One was the imitation of the ancients that led to the *chanson mesurée à l'antique*. Modern measures such as duple and triple time were abandoned and the quantitative prosody of longs and shorts produced music that alternated crotchets and minims without the feeling of a barline. The finest composer in this style was Claude Le Jeune, who also wrote in a more contrapuntal style than Janequin or Sermisy, sometimes in five or more parts and on a large scale. Orlando di Lasso was one of the greatest *chanson* composers, though his genius expressed itself in Italian madrigals, German *Lieder* and even Latin secular works as well. The last important *chanson* composer seems to have been Eustache du Caurroy (1549–1609). By the first years of the 17th century polyphonic secular music for unaccompanied voices was outmoded, and the new age demanded solo airs with lute accompaniment.

See G. Reaney, "The Middle Ages" and D. Stevens, "The Renaissance" in A. Robertson and D. Stevens (eds.), *A History of Song* (1960). (G. Re.)

CHANSONS DE GESTE (from Med. Lat. *gesta*, "deeds," "chronicles"), the title occasionally given by the authors themselves to about 80 medieval epic poems in Old French, largely anonymous, which form the core of the Charlemagne legends (*q.v.*). The *Chanson de Roland* is the greatest and best known (*see* Roland, Chanson de). This literature, dominated by feudal and aristocratic preoccupations, narrates the warring deeds of the great barons of Carolingian and sometimes Merovingian times, covering approximately the 8th and 9th centuries. Although contemporary poets (followed by modern scholars) sought to group these poems into three cycles they form, essentially, two groups. The first deals with the struggle between Christian France, with Charlemagne as emperor and champion of Christendom, and a strangely conventionalized, polytheistic and even idolatrous Islam; to this group belong the *Roland* and its related poems and the series relating to Guillaume d'Orange (*q.v.*), the only group that can be said to constitute a homogeneous cycle. Into the second series fall the poems of the barons, such as those concerning Girart de Roussillon, Doon de Mayence, Ogier the Dane, the Loherains or Raoul de Cambrai: ". . . turbulent barons who were not necessarily in rebellion against their sovereign, but transgressed against the moral code of their epoch by their behaviour one to another." (Jessie Crosland, *The Old French Epic*, Basil Blackwell & Mott Ltd., Oxford, 1951.) But even this division is to some extent arbitrary; the two themes were far from mutually exclusive and such was the popularity of many of the poems that characters from one were frequently borrowed and exploited by the author of another.

The poems all have in common their essentially heroic themes and treatment, with a particular predilection for the description of great battles—whether of Christians arrayed against hosts of "Saracens" eclectically recruited from the Moghreb to the Caucasus, or of the army of one great baron against another, father against son, brother against brother—and of single combats between individual champions. Such is the stuff of the earlier poems, those of the 12th century, but those of the 13th century and later have been much influenced by the themes of courtly love (*q.v.*) and by *romans d'aventures* and not infrequently introduce elements and material more appropriate to these genres, just as their authors sought to exploit the popularity of their heroes by composing poems devoted to their *Enfances*, or youthful exploits, and even created for them complete and quite fictitious lists of forebears and descendants.

Though the earlier poems contain a spark of historical truth, the historical background is of the flimsiest and is not infrequently distorted (the famous opening stanza of the *Roland* contains a magistral misstatement in every line); kings are confused (*e.g.*, Charles Martel and Charles II the Bald) and Guillaume d'Orange, whose death preceded that of Charlemagne, is portrayed as the loyal supporter of the emperor's successor, the pusillanimous weakling Louis the Pious. Despite such anachronisms, the principal protagonists are the recognizable contemporaries of the rulers of Carolingian France, engaged in actions which, if at times entirely fictive, at others have at least a vague basis in historical reality as revealed by the Latin chroniclers; but the authors of the *chansons de geste* were not chroniclers and their preoccupation is with the wars, the battles, the feuds, the legal and moral niceties of the feudal allegiances of their heroes, expressed in terms that often have a ring that is more Capetian than Carolingian. The theme of the conflict between personal ambition or passion on the one hand and feudal obligations on the other is too fundamental to be merely coincidental; more than one critic has suggested that the *chansons de geste* were written as propaganda in favour of the royal house of France and perhaps some of its great families, but on a much higher plane they glorify loyalty to national and religious ideals.

Despite their divergent provenance in both time and space, the poems as we possess them largely conform to a single pattern in form and style. This is originally an oral form of literature, the poems (or passages from them) being declaimed or, more accurately, intoned to a melopoeic accompaniment on a lute-type instrument by professional *jongleurs* to such audiences as they could command in baronial castles, at fairs, on the occasion of church festivals or to groups of pilgrims. The earliest were written in the well-characterized epic decasyllable with a caesura after the fourth syllable (more rarely after the sixth), which later gave way to the alexandrine, just as the original organization in assonating stanzas (*laisses*) of unequal and indeterminate length gave way to even longer rhymed stanzas. (Only one of the very early poems, the fragmentary *Gormond et Isembard*, composed in octosyllables, does not conform to this pattern; in both content and form it seems to have some affinity with the ballad.) The audience seems to have shared with the poets a taste for detailed descriptions of battles and single combats with their surrounding events and such descriptions had very early become stylized and conventional.

Although the subject matter is Carolingian and even Merovingian, the poems in their extant versions are very much later and few, if any, appear to have survived in their primitive forms. With rare exceptions, such as the manuscript of the *Roland* now in the Bodleian library, Oxford, the majority of manuscripts are late 13th century, frequently constituting great repertories, and appear to be library or collectors' pieces; such was the vogue, in that period, of cyclic collections, that some manuscripts have received the material addition of pages of interpolated text. Divergences between the various manuscripts of a given poem reveal that copyists allowed themselves some licence in the transcription of their texts, so that groups of manuscripts not infrequently appear as so many "editions," making the reconstitution of an original text conjectural. This instability of the textual tradition has its repercussions on the problem of the dating of the various poems, the manuscripts being in most cases as much as a century more recent than the texts they contain. In the almost total absence of any internal or external criteria linguistic evidence alone is available, and 19th-century editors and critics attempted on this basis to arrive at approximate datings. Some of their more categorical conclusions were later invalidated; it seems improbable that any such method can offer a guarantee of accuracy within a margin of less than several decades and the assertions of these editors, although still quoted, require to be accepted with some reserve. Within these limitations, and relying much on a subjective appreciation of narrative, style and structure, scholars agree that the most fruitful period for the development of the poems as they have survived was about the middle third of the 12th century.

It is against this background of textual instability and uncertainty that has to be debated one of the most complex problems of literary history, that of the origins of the *chansons de geste*.

Critics in the 19th century, deeply influenced by the ideals of German Romanticism, and headed by the great Romance scholars Gaston Paris and Pio Rajna, postulated an unbroken oral and popular tradition of lyric or epic poems composed under the immediate impact of the events which they narrated. In *Les Légendes épiques*, four volumes (1908–13), Joseph Bédier contested this "traditionalist" theory. Establishing the relationship between the *chansons de geste* and the sanctuaries on pilgrim routes in France, Spain and Italy and the collaboration between the monks and the *jongleurs*, he saw the poems as aimed at attracting pilgrims to the sanctuaries, but, more important, as being of relatively recent composition, not earlier than the 11th century. To the theories of uninterrupted epic transmission, he opposed that of "universal silence," and to that of spontaneous popular creation, the conscious and professional poet at work. For a quarter of a century alone among leading Romance scholars, Ferdinand Lot upheld the "traditionalist" view. (On this debate, *see* I. Siciliano, *Le Origini delle canzoni di gesta*, 1940; French trans. by P. Antonetti, *Les Origines des chansons de geste*, 1951.) However, in the 1940s and 1950s (Bédier died in 1938) there was some reaction against Bédier's "individualist" theory and a "neotraditionalist" school grew up; in France, René Louis revived the theory of uninterrupted transmission with particular reference to *Girart de Roussillon*, and Jean Frappier restated the traditionalist interpretation of the Guillaume d'Orange legend. In Spain the great medievalist Ramon Menéndez Pidal in his *La Chanson de Roland y el Neotradicionalismo* (1959) produced the manifesto of "neotraditionalism," based on the premise of the identity of transmission between the proto-*Roland* and the Spanish *romances*, and going so far as to identify individual lines as belonging to the most primitive version and others introduced at various stages.

The problem owes much of its complexity to the uncertain interpretation to be placed on occasional mentions by 11th-century or earlier Latin chroniclers in terms of a *canitur*, a *traditur* or a *cantilena* in the context of a historical event or personage forming the subject of a *chanson de geste*, and to similar Latin texts, including The Hague fragment. To the neotraditionalist, such allusions are proof of the existence of narrations closely akin to the *chansons de geste* which have come down to us. The "individualist" is more inclined to interpret such evidence as suggestive of local and oral traditions relating to the personages concerned, in short the raw material of the poems rather than the poems themselves. The debate has thus come to be centred on the problem of the "latent state" of the legends and it may be that through an attempt to discriminate more clearly between local oral traditions on the one hand and literary creations on the other, the two conflicting schools of thought may be reconciled.

See also references under "Chansons de Geste" in the Index.

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CHANT: *see* AMBROSIAN CHANT; CANTUS FIRMUS; CHURCH MUSIC; MOZARABIC CHANT; PLAINSONG.

CHANTAL, SAINT JANE FRANCES DE (Jeanne Françoise Frémiot, Baronne de Chantal) (1572–1641), French religious founder of the Visitation order, was born Jan. 28, 1572, at Dijon where her father was president of the *parlement* of Burgundy. In 1592 she married Baron de Chantal, who was accidentally killed hunting in 1601, leaving his widow with four young children. In 1604 she heard St. Francis de Sales preach, and placed herself under his direction. In 1610, after her eldest daughter had married and her 14-year-old son was provided for, she took her two remaining daughters to Annecy, where she founded the Visitation order. It counted 86 houses at her death in 1641 and 164 by 1767, when she was canonized. Aug. 21 is her feast day. (A. Fe.)

CHANTERELLE (Chantarelle), an edible mushroom known botanically as *Cantharellus cibarius* (family Agaricaceae), found in woods in summer. It is golden yellow, somewhat inversely conical in shape and about 2 in. broad and high. The cap is flattened above with a central depression and a thick-lobed irregular margin. Running down into the stem from the cap are a number of shallow thick gills. The substance of the mushroom is dry and opaque with a peculiar smell suggesting ripe apricots or plums. The flesh is whitish tinged with yellow. The chanterelle is common in coniferous woods in northeastern United States and Canada. It is sold in the markets of Europe, where it forms a regular article of food, but it seems little known in Great Britain. Before being cooked it should be allowed to dry, and then thrown into boiling water.

Care should be taken to distinguish the true chanterelle from the false chanterelle (*C. aurantiacus*), a closely related species, which is suspected of having caused poisoning. The latter species is more orange in colour, with thinner, broader and closer gills.

CHANTHABURI, the name of a province (*changwat*) and its capital in southeast Thailand. The province borders the Gulf of Siam on the southwest and Cambodia on the east. With an area of 2,337 sq.mi. and a population of 157,803 in 1960 it had a population density of 64 per square mile. Most of the province is hilly to mountainous and is covered with a rain-forest type of vegetation. The people live in farming villages near patches of alluvial soil on the flood plains and deltas of short rivers, and in fishing villages along the coast. Both the town and its *changwat* are connected to Bangkok, 135 mi. to the northwest, by an all-weather road and by ocean transportation. The town's deep-water port is Laem Sing on the gulf. Both the province and its capital are noted for rubber, rice and fruit. Although the Thais predominate, there are large numbers of Cambodians and Chinese in Chanthaburi. Originally a part of the Khmer empire, this area has belonged to Thailand for about four centuries. (T. F. B.)

CHANTILLY, a town of France, Oise *département*, is situated 25 mi. (41 km.) N. of Paris, by road. Pop. (1962) 8,106. The town, located near the forest of Chantilly, is a favourite holiday resort for Parisians. Formerly well known for its lace and porcelain manufacture and as the residence of the Condés, it is now even more celebrated for its château, park and the annual races of the French Jockey club. The château, on a small rocky island in an artificial lake, was originally built in the 14th century, but very few old parts have survived numerous restorations and rebuildings. The adjoining chatelet (*c.* 1560) was designed by Jean Bullant. Chief annexes are the stables, built (1719–35) to house 240 horses, and the Château d'Enghien, built in 1772 for the duc d'Enghien. The park and château (now an important museum) were bequeathed to the Institut de France by the duc d'Aumale in 1886, along with his library and collections. The station, Chantilly-Gouvieux, is on the main line from Paris to Calais, Brussels and Amsterdam. Chantilly is mainly residential, and its chief industry is catering for tourists. Film-making and forestry also are important.

In the reign of Charles VI the lordship of Chantilly passed to Pierre d'Orgemont, chancellor of France. In 1484 it passed to the house of Montmorency and in 1661 to the house of Condé. In 1830 the estate passed into the hands of Henri, duc d'Aumale.

Chantilly has been under German occupation several times: in 1870–71, during the Franco-German War; for a few days in Aug. 1914 in World War I; and from June 1940 to Aug. 1944 in World War II. French headquarters were at the Hôtel du Grande Condé from Nov. 1914 until March 1917. (M. du B.)

CHANTREY, SIR FRANCIS LEGATT (1781–1841), English sculptor and donor of the Chantrey bequest, was born on April 7, 1781, at Norton, near Sheffield. After receiving lessons in wood carving and painting, he went to try his fortune in Dublin and Edinburgh and in 1802 went to London, where he worked as a wood carver. His first commission for sculpture came in 1805 from Sheffield, but it was not until 1811 that he found fame and fortune with his bust of Horne Tooke, exhibited at the Royal Academy. Chantrey was elected associate of the Royal Academy in 1815 and Royal Academician in 1818 and was knighted in 1835. He died suddenly on Nov. 25, 1841. Under the terms of his will his fortune was left to his widow and after her death to the Royal Academy. The income from the bequest was to be spent chiefly on purchasing the most valuable works in sculpture and painting by artists of any nation residing in Great Britain at the time of execution. Chantrey's chief statues are Lord Melville at Edinburgh; George IV in Windsor castle and at Brighton; George Washington in the state house, Boston, Mass.; William Pitt in Hanover square, London; and the equestrian statues of Sir Thomas Munro at Madras, George IV in Trafalgar square, London, and Wellington outside the royal exchange, London. Chantrey's best-known monument is that of the Robinson children in Lichfield cathedral, but he considered that his figure of Lady Frederica Stanhope at Chevening, Kent, was his best work. Chantrey produced a large number of busts of which the finest is undoubtedly that of Sir Walter Scott at Abbotsford.

See R. Gunnis (comp.), *Dictionary of British Sculptors, 1660–1851* (1953). (R. Gs.)

CHANT ROYAL, a fixed form of verse developed by French poets of the 13th to the 15th centuries. It is first mentioned by the late 13th-century poet Rutebeuf, and has all the appearance of an extended ballade (*q.v.*), though it is not possible to determine which of the two appeared first. Its standard form consisted, in the 14th century, of five stanzas of from 8 to 16 lines of equal measure, without refrain, but with identical rhyme pattern in each stanza and with an *envoi* using rhymes from the stanzas. Guillaume de Machaut gives the *envoi* three lines, Eustache Deschamps from four to eight, but he occasionally omits it. In the 15th century the chant royal acquired a refrain and the *envoi* was normally about half the length of the stanza. This had usually from 10 to 12 lines, their number being dictated by the number of syllables in the refrain, both feminine and masculine decasyllabics allowing, however, stanzas of 11 lines. Jean Molinet, in his *Art et science de rhétorique* (1493), and Étienne Pasquier both stress the difficulties of the genre, and the latter considers it better suited than the ballade to solemn and pompous themes. Pierre Fabri, in his *Grand et vrai art de pleine rhétorique* (1521), gives detailed instructions about length of stanza and rhymes. Like the ballade, the chant royal admitted of variations: as the *serventois*, a poem in honour of the Virgin Mary, it early acquired, then lost, the refrain; similar varieties were the *amoureuse* (love poem), the *sotte amoureuse* (playful love poem) and the *sotte chanson* (comic poem).

Clément Marot was a master of this genre, and his *Chant royal chrétien*, with its refrain *Santé au corps et Paradis à l'âme* ("Health to the body and Paradise to the soul"), was famous. La Fontaine was the last exponent of the chant royal before its eclipse. It was revived in the 19th century but, as Théodore de Banville says, it essentially belonged to the ages of faith when its subjects could be either the exploits of a hero of royal blood or the processional splendours of religion. It was introduced into England only in the late 19th century, the first English chant royal being Edmund Gosse's *The Praise of Dionysus* (1877). It is practically unknown in any other literature.

See L. E. Kastner, *A History of French Versification*, pp. 268–271 (1903); G. Lote, *Histoire du vers français*, vol. ii, pp. 285–290 (1949). (F. J. We.)

CHANUTE, OCTAVE (1832–1910), U.S. aeronaut, whose work and interests had a profound influence on Orville and

Wilbur Wright and on the invention of the airplane, was born in Paris, France, on Feb. 18, 1832. He went to the United States with his parents at an early age. Chanute established a reputation as a civil engineer and had many years of experience as a builder of railroads and railroad bridges before he turned his attention to aviation. Attracted by the work of Otto Lilienthal (*q.v.*) and others in Europe who were experimenting with gliding flight, Chanute (then in his 60s) established a glider camp on the sand dunes of Lake Michigan near Chicago; there he and his associates made about 2,000 gliding flights without accident in machines of his own design. Chanute was particularly interested in problems of control and equilibrium, and the data he accumulated proved extremely useful to the Wright brothers in evolving their earlier designs. He was in constant correspondence with the Wrights, and on several occasions visited Kitty Hawk during the period (1901–02) of their gliding experiments which preceded their final success. Chanute died in Chicago on Nov. 23, 1910. (S. P. J.)

CHAO K'UANG-YIN (T'ai-Tsu) (927–976), first emperor of the Sung dynasty who unified China after a century of internecine warfare and laid the foundation for one of the most brilliant periods of Chinese history. Though he was addicted to liquor and was an unexceptional general without great ambitions, in the year 960 he was acclaimed emperor by his army, which was dissatisfied with a child on the throne. He thwarted any further army uprisings by stripping the military governors of their commands, promising them a quiet, pleasant life in the capital, and replacing them by civil servants. His centralization of military and financial power brought about final unification: one kingdom after the other surrendered or was conquered (central China in 963, the west in 965, the south in 971, the remaining provinces in 975). He died at K'ai-feng, Nov. 14, 976, and the task of unification was carried on by his younger brother and successor T'ai-Tsung. *See* also Sung. (Et. Ba.)

CHAO PHRAYA (Mae Nam): *see* Mae Nam Chao Phraya.

CHAOS, connected etymologically with the Greek verb *chaskein*, "to yawn," "to gape open," designates in early Greek cosmology either the primeval emptiness of the universe before things came into being or the abyss of Tartarus, the underworld. Both concepts occur in the *Theogony* of Hesiod. First there was Chaos, in Hesiod's system, and then Earth and Eros (Desire). Chaos does not generate or beget Earth; the offspring of Chaos are Erebus (Darkness) and Night. Night begets Aether, the bright upper air, and Day. Night later begets the dark and dreadful aspects of the universe; *e.g.*, Sleep, Dreams, Death, War, Strife, Famine, Grief. This ties in with the other early notion that saw in Chaos the darkness of the underworld.

In the later cosmologies Chaos generally designates the original state of things, however conceived. Aristophanes' *Birds* (11, 691 ff.) gives a parody of an Orphic cosmogony in which the birds claim to be descended from winged Eros and murky Chaos. In lyric poetry Chaos indicates the Aether or upper air (*cf.* Bacchylides, v, 27). Aristotle took Chaos in Hesiod as a prephilosophical way of designating space (*cf.* his *Physics*, iv, 1). Later philosophers, except for the Stoics, followed Aristotle. The Stoics identified Chaos with water after a false etymology from the verb *cheein*, "to flow." The later Stoics designated as Chaos the watery state which follows the periodic destruction of the universe by fire and which precedes its reconstruction. From Stoic sources undoubtedly came the picture of Chaos in Ovid's *Metamorphoses* (i, 7 ff.), the original raw and formless mass in which all is disorder and confusion, from which the maker of the Cosmos, the ordered universe, produces the elements, the forms of determinate being and the order and harmony of the universe. The popularity of Ovid in the Renaissance and modern times has made this the modern meaning of the word. This concept of Chaos also was applied to the interpretation of the Creation story in Gen. i (to which it is not native) by the Latin church fathers (*e.g.*, Lactantius and St. Augustine). (R. R. Pr.)

CHAOUÏA, a region of Morocco which comprises three *cercles* (districts) Chaouïa-Centre, Chaouïa-Nord and Chaouïa-Sud in Casablanca province. Chaouïa ("sheep raisers") is traditionally applied to tribes established between Fedala, Casablanca and Settat, a region originally called Tamesa and occupied by Masmouda Berbers who, after their conversion to Islam, fell into a heresy and are historically known by the name of Berghwata. The country, ravaged by their struggles with the orthodox Muslims, was repeopled by nomadic Arabs from the 12th century onward. In the 20th century there was a considerable influx of Europeans and the country has returned to its original role as farming land, producing principally cereals. (A. Am.)

CHAPAIS, SIR (JOSEPH AMABLE) THOMAS (1858–1946), Canadian lawyer, public official and historian, noted for his eight-volume history of Canada under British rule, was born at St. Denis-de-la-Bouteillerie, Que., on March 23, 1858, the son of Sen. J. C. Chapais, one of the "fathers of confederation." Chapais was educated at St. Anne's college and Laval university, Quebec, and was called to the Quebec bar in 1879. In March 1892 he was called to the legislative council of Quebec and he thereafter held various public offices until he retired in May 1897. From 1884 to 1901 Chapais edited *Le Courrier du Canada*, published weekly in Quebec. In 1907 he was appointed professor at Laval university. He published several works on history and law, including *Cours d'Histoire du Canada* (8 vol., 1919–35), a study of British colonial policy with emphasis on constitutional and political problems. On Dec. 31, 1919, he was called to the senate of Canada. He was knighted in 1935. He died at St. Denis on July 15, 1946.

CHAPARRAL, a mixed forest formation of low hard-leaved, stunted trees and shrubs resulting from short, wet, cool winters and long, arid, hot summers. The word is believed to have been derived from *chaparro*, the Spanish name for "live oak." Chaparral grows slowly and shrubs 25 years old will usually average not more than two or three inches in diameter and five or six feet in height. This type of forest growth occurs chiefly in southern California in the United States, along the coast of Chile, in Europe and Asia along the Mediterranean and as far east as Turkistan, in Africa near the Cape of Good Hope and on the southern and southwestern coasts of Australia and Tasmania. Its chief economic value lies in its ability to conserve ground water, which it accomplishes below the surface through its root system and above the surface by breaking the force of hot winds and shading the ground to prevent evaporation.

Of the 150 different species of woody plants believed to exist in the chaparral of southern California 20 dominant types—among them chamise, manzanita, ceanothus, sumac, sagebrush, scrub oak and buckthorn (*qq.v.*)—represent 90% of the growth. In former times the Indians used the nuts, berries and seeds of several of the plants for food. Some species were once in demand as fuel and others are still used for fencing. The bee industry flourishes in the chaparral region, several profusely flowering shrubs, such as the black sage, being excellent honey plants. It is estimated that there are 5,500,000 ac. of chaparral in the United States. Chaparral formations protect the upper watersheds of the coastal streams in California for about 450 mi.

CHAPBOOK, the name first given by early 19th-century book collectors and others to little stitched tracts formerly sold cheaply by itinerant dealers or chapmen in western Europe and North America. Chapbooks were mostly about $5\frac{1}{2} \times 4\frac{1}{4}$ in. in size and four or multiples of four pages long, illustrated with crude but vigorous woodcuts. They contained tales of popular heroes, legend and folklore, jests, notorious murders, ballads, almanacs, nursery rhymes, school lessons, farces, biblical tales, dream lore and other popular matter. The texts were mostly crude and anonymous but some may have been the anonyms of well-known writers; Thomas Bewick's first illustrations were for chapbooks. Though of little literary value, they formed the major part of secular reading and are a guide to the manners and morals of their times. The chapmen were supplied by printers in the larger towns. Most of the earliest English and German chapbooks derived from the French ones which began to appear at the end of the 15th century. In America they were both imported from England and produced locally. When religious and other more serious tracts appeared and cheap magazines developed in the early 19th century, chapbooks lost popularity and disappeared.

There are good collections in the British museum, London, the Bodleian library, Oxford, and, in the U.S., in the New York public library and Harvard university library.

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CHAPEL is a term variously employed to designate a Christian house of worship that for one reason or another is not entitled to the name "church."

Capella, the diminutive of *cappa*, "cloak," was the name given to the shrine in which the cloak of St. Martin was kept and carried about by the Frankish kings on their journeys and military campaigns. This peculiar use was transferred to any sanctuary containing relics, the priest of which was called *capellanus* or chaplain (*q.v.*). By a further extension, the word was identified with all places of worship that were not mother churches (*ecclesiae matrices*), so as to include a large number of miscellaneous foundations. Most nearly akin to the original meaning is the application of the term to the oratories, places of private worship, attached to royal residences. Thus the Sainte Chapelle, the palace chapel at Paris, a masterpiece of Gothic architecture consecrated in 1248, was built by St. Louis to enshrine the relic of the Crown of Thorns, which he had brought from Constantinople. In the next century, other *saintes chapelles* were founded by princes of the French royal house at Bourges, Riom and elsewhere. Such chapels royal were usually founded as collegiate establishments, and other collegiate chapels were founded by prelates and noblemen in connection with their castles and manor houses.

Traditionally, British usage since the Reformation has been reluctant to apply the designation "church" to any house of worship not belonging to the established Anglican church. Therefore Nonconformist meetinghouses, Wesleyan places of worship and even Roman Catholic churches have been called "chapels." In Ireland the term has clung persistently to Roman Catholic places of worship. But, apart from this, the modern tendency is to abandon the employment of the word for special classes of religious building and to give the title "church" to all, regardless of their denominational affiliation. Thus "chapel" has come to mean what it meant before the rise of Nonconformity: a subordinate house of worship that is auxiliary to or parallel with a church. In the United States "chapel" may sometimes mean simply a small church.

A. F. KERSTING

CHAPEL OF HENRY VII, BUILT FROM 1502 TO 1512, A ROYAL MORTUARY CHAPEL IN WESTMINSTER ABBEY, LONDON

Most frequently, however, the word is applied to three types of structure: a building in which religious services are conducted on the campus of a college or university (a usage dating to the 18th century in the United States and to the 17th century or even earlier in Great Britain) or in a hospital; the house of worship at a military base; and the room in an undertaker's establishment set aside for funeral services. *See* also Religious Architecture. (A. H. T.; J. J. Pn.)

CHAPEL, in the printing trade, the name of the fellowship of compositors (and, nowadays, of all crafts) in a printing works. The president is termed the "father of the chapel." In the United States he is called "the chairman." The name chapel is used not only of the fellowship itself but of the meetings it holds. At these meetings, the chapel discusses such things as the general welfare of the body, the conditions of work, relations with employers, and trade union matters.

The accepted version of the origin of the use of the word chapel in this connection is that it is derived from the fact that the famous English printer, William Caxton, first set up his press in or near Westminster Abbey. Writing in 1716, Myles Davies, in his *Athenae Britannicae* said, "William Caxton first practis'd Printing in the Abbey of Westminster, A.D. 1471, thence a Printing-Room came to be call'd a Chappell amongst our Printers." Another explanation is offered by Joseph Moxon, who in his *Mechanick Exercises* (1683) wrote, "Every Printing-house is by the Custom of Time out of mind, called a Chappel: and all the Workmen that belong to it are Members of the Chappel: and the oldest Freeman is Father of the Chappel. I suppose this stile was originally conferred upon it by the courtesie of some great Churchman, or men (doubtless when Chappels were in more veneration than of late years they have been here in England), who for the Books of Divinity that proceeded from a Printing-house gave it the Reverend Title of Chappel."

CHAPELAIN, JEAN (1595–1674), French poet and literary critic, who aimed to apply the precepts of empirical philosophy to literature, was born in Paris on Dec. 4, 1595. He first attracted the notice of literary circles in 1619–20, with a translation of *Don Guzman de Alfarache*. This was followed by a remarkable preface to Marino's *Adone*. Chapelain became a pupil of the aged François de Malherbe and a close friend of Claude de Vaugelas and Valentin Conrart, so that he was naturally one of the founders of the Académie Française, in which he came to exercise a major influence, as he caused his friends and followers to be elected members. In 1663, when Colbert decided to grant pensions to deserving writers, it was Chapelain who was entrusted with the naming of candidates. A number of writers, however, opposed his influence: Giles Menage had pamphlets written against him; Gilles Boileau, François Payot de Lignières and Antoine Furetière wrote criticisms and epigrams on him; Olivier Patru and his circle held him up to derision; and Luillier Chapelle, Racine, Furetière and the Boileau brothers composed a skit entitled *Chapelain décoiffé* (1663). Chapelain died in Paris on Feb. 22, 1674.

Chapelain's poetry and his literary criticism must be considered separately. As a poet, he began writing an epic, *La Pucelle*, in 1630 and published the first 12 cantos in 1656. This was a failure, and he decided not to have the final 12 cantos printed (they were eventually published in 1882). As a critic, however, he had great merits, as can be seen in various short works published by him and in his voluminous correspondence. A friend of Pierre Gassendi and a confirmed opponent of Descartes, he is the principal representative of the attempt to apply empirical philosophy in the sphere of literary criticism. He does not invoke Aristotle's authority through blind admiration for the *Poetics;* but 2,000 years of satisfactory results seemed to him to prove that the Aristotelian theory of tragedy was valid. Likewise, he recommends common sense, moderation and wisdom, the characteristic qualities of the empiricist; so that he stands aloof from the excesses of purism and shows a far more catholic taste than the doctrinaire classicists. He could equally enjoy medieval literature, Spanish picaresque novels and La Fontaine's *Contes.*

Bibliography.—For Chapelain's prose writings, see *Les Lettres de Jean Chapelain* ed. by Tamizey de Larroque (1880–83) and the *Jean Chapelain, opuscules critiques,* ed. by Alfred C. Hunter (1936). There is an excellent thesis on Chapelain by G. Collas, *Un Poète protecteur des lettres au 17^e siecle: Jean Chapelain* (1912). (Ae. A.)

CHAPELLE ARDENTE, the chapel or room in which the corpse of a sovereign or other exalted personage lies in state pending the funeral service. The name refers to the many candles lighted round the catafalque. This custom is first chronicled as occurring at the obsequies of Dagobert I (d. 639), the Merovingian king of the Franks.

CHAPLAIN in its origin and later usage is closely linked with chapel (*q.v.*). In the 4th century chaplains (Lat. *cappellani*) were so called because they kept St. Martin's famous half cloak (Lat. *cappella*). This cloak, preserved as a relic by the kings of France and carried with them when they went to war, gave its name to the tent and later to the simple oratory or chapel where it was preserved. To this precious relic were added other relics that were guarded by chaplains appointed by the king during the Merovingian and Carolingian period, and particularly during the reign of Charlemagne, who appointed clerical ministers (*capellani*) who lived within the royal palace. In addition to their primary duty of guarding the sacred relics they also said mass for the king on feast days, worked in conjunction with the royal notaries and wrote any documents the king required of them. With this extension of the duties of chaplains and the increase in their number their duties gradually became more identified with direct service to the monarch as advisers in both ecclesiastical and secular matters. This was due for the most part to the fact that the clergy were learned and well skilled in writing and in the Latin tongue at a period when few people could either read or write.

The practice of kings' appointing their own chaplains spread throughout western Christendom. Many of the royal chaplains were appointed to bishoprics and the highest offices in the church; and down to the present day the British monarchs have appointed their own royal chaplains. The duties of royal chaplains have varied throughout the centuries; appointment by the British sovereign to the Royal College of Chaplains is now chiefly an honour, carrying with it little more than the duty of preaching occasionally in the chapel royal. In the Church of England diocesan bishops appoint clergy to be domestic, examining or honorary chaplains on their own personal or diocesan staffs.

In modern usage the term chaplain is not confined to any particular church or denomination. Clergy and ministers appointed to a variety of institutions and corporate bodies—such as cemeteries, prisons, hospitals, schools, colleges, universities, embassies, legations and armed forces—usually are called chaplains. In some countries where the church is totally independent of the state, service chaplains are maintained, as for instance in the United States, but in others, as in France since 1905, they are not.

British Armed Forces.—Chaplains serve in each of the three services. They are drawn from the ministries of the major churches in the country: Church of England, Church of Scotland, Roman Catholic, Methodist, Baptist and Congregationalist. The chief chaplain in each service (the chaplain of the fleet in the navy, the chaplain general in the army, the chaplain in chief in the air force) bears the title of archdeacon and discharges his ecclesiastical functions under licence of the archbishop of Canterbury. There is a Roman Catholic bishop in ordinary to the forces, and the principal Roman Catholic chaplain in each service is a vicar general. There is a senior Jewish chaplain to the forces. (J. W. L.)

United States.—*Armed Forces.*—The continental congress made the first formal provision for chaplains in the armed forces of the colonies on July 29, 1775. The first army chief of chaplains was appointed (in the grade of colonel) in 1920; in 1944 the chief of chaplains was made a major general. As in the other services, the number of chaplains varies with the personnel strength of the army. The U.S. Army Chaplain school is located at Fort Hamilton, N.Y.

The navy chaplain corps traces its history back to Nov. 28, 1775, when the continental congress adopted navy regulations directing regular performance of divine service aboard ship. The first chief of the navy chaplain corps was appointed in 1917 (although the office of the chief of naval chaplains was not statutorily created until 1944). The U.S. Navy Chaplain school is located at Newport, R.I.

In 1942 an air chaplain was appointed to supervise the chaplains of the U.S. army air forces. The U.S. air force became an independent service in 1947, but the army and air force chaplaincies were not separated until May 10, 1949. The U.S. Air Force Chaplain school is located at Lackland air force base, Texas.

The duties of the chaplain in all three services are parallel. He must furnish or arrange for religious services and ministrations; advise his commander and fellow staff officers on matters pertaining to religion and morality; administer a comprehensive program of religious education; serve as counselor and friend to the personnel of the command; and conduct instruction classes in the moral guidance program of his service. Chaplains at higher command echelons exercise technical supervision over chaplains of subordinate headquarters. All three services supplement the services of active duty chaplains with auxiliary chaplains when necessary. Under international conventions, chaplains are protected personnel. They cannot be required to bear arms. The denominational distribution of chaplains reflects as far as feasible the size of the religious body concerned in the national population.

Other.—Since June 1945 the chaplaincy service of the Veterans administration has been organized on a national basis. Chaplains serve in the administration's hospitals under the supervision of a director, himself a chaplain, in the department of medicine and surgery. Though a majority are former military chaplains, their status is that of civil service employees. Denominationally they reflect the needs of the hospital to which they are assigned. Their ministry is of necessity chiefly to individuals. Chaplains are also appointed for both houses of the congress and for most state legislatures to lead the lawmakers in prayer at the beginning of each session. (A. C. Pn.)

CHAPLIN, CHARLES SPENCER (1889–), English motion-picture actor renowned for his portrayal of the little tramp, was born in London on April 16, 1889. His parents were music-hall performers, and he began his own stage career at an early age. In 1910 he went to the United States as a leading comedian in a Fred Karno production, and was engaged by Mack Sennett to make films with the Keystone Comedy Company in Los Angeles. The tramp character—a blend of comedy and pathos—first appeared in Chaplin's second film, *Kid Auto Races at Venice.*

In 1918 he formed his own company and began production of a series of films that placed him in the front rank of artists. Among them were: *A Dog's Life* (1918), *Shoulder Arms* (1918), *The Kid* (1921), *The Gold Rush* (1925), *The Circus* (1926), *City Lights* (1931), *Modern Times* (1936), *The Great Dictator* (1940), *Monsieur Verdoux* (1947), and *Limelight* (1952). With Douglas Fairbanks, D. W. Griffith, Mary Pickford, and others he was a founder of the United Artists Corporation. Notified in 1952 that his U.S. reentry rights would be questioned by the Justice Department, Chaplin surrendered his U.S. reentry permit at Geneva, Switz., in 1953; thereafter he lived in Europe.

See C. Chaplin, *My Autobiography* (1964).

CHAPMAN, FRANK MICHLER (1864–1945), U.S. ornithologist who did pioneer work in popularizing bird study, was born at Englewood, N.J., June 12, 1864, and had no formal education beyond academy. He joined the staff of the American Museum of Natural History, New York city, as assistant in 1887, served as assistant curator (1888–1901) and associate curator

(1901–08) of ornithology and mammalogy, and as curator of ornithology (1908–42) until his retirement.

Chapman originated the habitat bird groups and seasonal bird exhibits. Beginning in 1887 he traveled widely, collecting and photographing the birds of temperate and tropical America. He published his widely used *Handbook of Birds of Eastern North America* (1895), *The Warblers of North America* (1907) and a dozen other popular books. His technical papers covered life histories, geographical distribution, and systematic relationships of American birds, after 1911 dealing largely with the origin of Andean bird life and resulting in volumes on *The Distribution of Bird Life in Colombia* (1917), *Birds of the Urubamba Valley, Peru* (1921) and *The Distribution of Bird-Life in Ecuador* (1926). His field adventures are well presented in his *Camps and Cruises of an Ornithologist* (1908) and *Autobiography of a Bird-Lover* (1933). Chapman was founder and editor (1898–1935) of *Bird-Lore* magazine, president of the American Ornithologists union (1911–14) and vice-president of the Explorers club (1910–18). He was awarded the first Linnean medal (1912), the first Elliot medal (1918) of the National Academy of Sciences, the Roosevelt medal (1928) and the Burroughs medal (1929). Brown university, Providence, R.I., awarded him the Sc.D. degree in 1913. He died in New York city on Nov. 15, 1945. (G. F. Ss.)

CHAPMAN, GEORGE (1559?–1634), English dramatist, poet and translator of Homer and one of the most powerful and important Elizabethan writers, was the second son of Thomas Chapman, yeoman of the hundred of Hitchin, by his wife Joan, daughter of George Nodes of Shephall. His family appears to have been strongly Protestant, and well connected on his mother's side. Anthony à Wood, in his *Athenae Oxonienses,* claims that Chapman went to Oxford, but he took no degree. By 1585, he was in London in the service of "the wealthiest commoner in England," Sir Ralph Sadler, though himself in debt. He appears to have gone to the Low Countries, where he may have seen military service.

On Dec. 31, 1593, his first work, *The Shadow of Night . . . Two Poeticall Hymnes,* was entered in the stationers' register; it was followed in 1595 by the poem *Ovid's Banquet of Sense*. On Feb. 12, 1596, Chapman is mentioned in Henslowe's *Diary* (a mine of information on theatrical history for this period) as the author of *The Blind Beggar of Alexandria,* a successful comedy; other entries occur in 1597 and 1599. Later he wrote plays for performance by the children of the revels, the children of Paul's and the King's men. In 1603 he became server in ordinary to Prince Henry. From the first decade of King James's reign, about a dozen plays survive, of which *Bussy d'Ambois* (1607), *The Conspiracy and Tragedy of Charles Duke of Byron* (1608) and *The Widow's Tears* (1612) are his masterpieces. His translation of the *Iliad,* of which the first books appeared in 1598, was completed in 1611. It was encouraged by Prince Henry, whose death in 1612 deprived Chapman of his chief support; he sought a new patron in the king's favourite, the earl of Somerset, to whom he dedicated the two volumes of the *Iliad* and the *Odyssey* of 1616, although by this time Somerset was disgraced. In his later years Chapman appears to have written few plays, but completed "the work that I was born to do" by translating the minor Homeric poems. He died in London on May 12, 1634, and was buried in St. Giles-in-the-Fields, where Inigo Jones, who collaborated with him in producing at least one masque, performed in honour of the princess Elizabeth's marriage in 1614, erected a monument.

Chapman's views of the poet's task were lofty, and were early set out in the preface to *Ovid's Banquet of Sense,* addressed to Matthew Roydon, a follower of Sir Walter Raleigh. He wrote in praise of Raleigh a poem *De Guiana Carmen Epicum,* published with Lawrence Keymis' *A Relation of the Second Voyage to Guiana* (1596); he was also a friend of Christopher Marlowe, for whose *Hero and Leander* he wrote in 1598 a conclusion which amounts to a "correction" of its libertine views. Whether he were also the "rival poet" of Shakespeare's *Sonnets,* and whether Shakespeare caricatured Chapman as Holofernes in *Love's Labour's Lost,* is a matter of dispute; certainly the Southampton-Essex faction which Shakespeare appears to have supported was opposed to Raleigh, yet Chapman dedicated to Essex his first installment of the *Iliad.*

Though he clung to the older literary tradition of seeking a patron instead of relying on the public, Chapman was singularly unskilful in compliment. In 1605 with his friend Ben Jonson he was imprisoned for his share in *Eastward Ho!*—a play which reflected on the Scots. In 1608 he was in trouble again for his comments on French politics in *The Conspiracy and Tragedy of Charles, Duke of Byron.* His attempt in *Andromeda Liberata* (1614) to defend the scandalous marriage of Somerset was so maladroit as to bring down his patron's wrath. A lover of arms, yet a visionary and contemplative, who wrote "A Coronet of Love Sonnets for his mistress Philosophy," Chapman seems to have been deeply interested in politics and religion but in so detached a fashion that he defended the massacre of St. Bartholomew on general principles. He was addicted to paradox; his plays contain lengthy praise of cuckolds and of "the dangerous tobacco."

Living a life of poverty (he was obliged in 1599 to renounce for ready money the claims to his mother's inheritance of Shephall), Chapman yet seems to have achieved some public success, particularly by his comedies, in which Plautine conventions were successfully adapted to current manners. He anticipated Ben Jonson's comedy of humours, and enjoyed a stormy and uncertain friendship with him. Jonson's manuscript notes on Chapman's *Homer,* preserved in the Fitzwilliam museum, Cambridge, are far from complimentary; it is clear that Chapman, like most students of his time, relied heavily on Latin commentaries, books of mythology and other aids to learning. His passionate devotion to the arts had more enthusiasm than clarity. His praise of obscurity in poetry, in the preface to *Ovid's Banquet of Sense,* depends upon the doctrine of inspiration derived from Hermes Trismegistus. It was thought that the ancient poets had embodied in their poetry a divine wisdom, concealed under symbolic or mythological form; Francis Bacon assumes such a view in his *Wisdom of the Ancients,* where he interprets ancient myths. Elsewhere, Chapman says that Homer appeared to him in a vision upon Hitchin hill, and commanded the translation of his works. In translation, Chapman treated Homer as a writer to be moralized, adding moral glosses within the text to "explain" it.

Initial rapture was succeeded by a struggle for words which left Chapman's poetry, as he himself recognized, in a volcanic and uncertain state, flashes of great power and splendour alternating with turgid and pedantic eccentricities. The complexity of his thought recalls that of John Donne, but he has not Donne's analytic clarity. In his greatest work, the tragedies, the Marlovian stature of the heroes unfits them for ordinary life and its necessary compromises; such unadaptable grandeur also characterizes Chapman as a poet. In the 9th edition of the *Encyclopædia Britannica,* Swinburne said: "In most of his tragedies, the lofty and labouring spirit of Chapman may be said rather to shine fitfully through parts than steadily to pervade the whole; they show nobly altogether as they stand, but even better by help of excerpts and selections." On the other hand, in his edition of Chapman's *Homer,* Allardyce Nicoll has observed that the sustained sweep of the work rather than its detail constitutes its true greatness.

To his contemporaries, Chapman stood uncompromisingly for the worth and divine dignity of poetry. John Webster, John Fletcher, Nathaniel Field paid tribute to him; and in the venerable bearded head of the portrait of 1616, not unfittingly surrounded by clouds, may be seen something of the heroic simplicity of the great Elizabethan, and his fitness to render Homer in English.

Among his last published works, *Pro Vere, autumni lachrymae* (1622), a plea for the succour of the valiant Sir Horatio Vere "beseiged, and distrest in Mannheim," recalls the glory of earlier days, when he had sung the exploits of Raleigh and had perhaps campaigned in the Low Countries. Achilles as the model of soldierly virtue had seemed to him but a pale reflection of Essex, and his tragic heroes had all been warriors. The soldiers' and the scholars' virtues were complementary for Chapman; both were opposed to the aims of the worldling, whether a sensualist or a seeker after political power. If in his works there sometimes sounds a note of contempt for the common pleasures of life, an acerbity and ill-judged moral reproof toward worldly success, which was a temptation that had not notably come his way. this derived from his Neoplatonic view of divine poetry as "excitation to virtue and deflection from her contrary." This view Chapman shared with Sir Philip Sidney and Ben Jonson. On the other hand, in his *Invective Against Mr. Ben Jonson*, which survives in a manuscript in the Bodleian library, Oxford, Chapman accused his friend of precisely that arrogance to which he himself is prone; and whether or not in writing *Love's Labour's Lost*, Shakespeare set himself in opposition to Chapman by extolling the active life against the contemplative, the pleasures of the senses against those of the study, this difference appears in the general tendency of their works. Chapman had no gift for precise and exact delineation of character; each of his plays is dominated by a hero, whose tirades and descriptive rhetoric are ill-adapted to the living theatre. He despised the common stages, and never subdued his spirit to their demands; his gnomic and high-wrought style was addressed to the few, and his poetry appeals now, as in his own day, to those who can decipher what is authentic, powerful but crabbed.

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CHAPMAN, JOHN (JOHNNY APPLESEED) (1774–1845), U.S. frontier nurseryman and folk character, was born in Leominster, Mass., Sept. 26, 1774. Little is known of him until he appeared in western Pennsylvania shortly before 1800. According to tradition, he had planted by 1801 a chain of seedling apple nurseries in advance of the settlements from the Allegheny to central Ohio. He spent about 25 years in north central Ohio. There the "Johnny Appleseed" stories largely originated, springing not only from his business, but from his eccentricities of manners and dress, Swedenborgian religious views, extreme kindness to wild animals, great generosity and unusual exploits of courage and endurance. By 1828 his nurserying reached northwestern Ohio and Indiana. From 1834 Chapman operated around Fort Wayne, Ind.. where he died in March 1845.

The folk tales portray him on a spiritual mission preparing the wilderness for the westward movement. He has become the patron saint of American orcharding, floriculture and conservation. Late extension of the early oral tradition has been largely literary—stimulated notably by Henry Howe's *Historical Collections of Ohio* (1847, 1889), an article by W. D. Haley in *Harper's* (Nov. 1871) and later imaginative treatments such as those by Eleanor Atkinson, Vachel Lindsay, Newell Dwight Hillis and Walt Disney.

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CHAPMAN, JOHN (christened HENRY PALMER) (1865–1933), English Roman Catholic biblical and patristic scholar and spiritual writer. Chapman was born at Ashfield, Suffolk, on April 25, 1865. After private tuition he went to Christ Church, Oxford, obtained a first class in *Litterae humaniores* and became a deacon in the Church of England. He joined the Roman Catholic Church in 1890, was clothed as a Benedictine novice at Maredsous abbey, Belgium, and was ordained priest in 1895. After several years at Erdington abbey, Birmingham, he was appointed temporary superior of Caldey abbey (1913–14). He served as an army chaplain in World War I, and was subsequently prior (1922–29) and abbot (1929–33) of Downside abbey. He died in London on Nov. 7, 1933.

Chapman's earliest work to attract attention was his *Bishop Gore and the Roman Catholic Claims* (1905), but more important contributions to scholarship are *John the Presbyter and the Fourth Gospel* (1911) and *Notes on the Early History of the Vulgate Gospels* (1908). His *Studies on the Early Papacy* (1928) gathers together only a few of his many articles on early church history; similarly, his New Testament scholarship is inadequately represented by the posthumous *Matthew, Mark and Luke* (1937), in which he seeks to establish this order for the composition of the Synoptic Gospels. He wrote much on the spiritual life and on the theory and practice of contemplative prayer. A collection of his *Spiritual Letters* (published, with a memoir by G. R. Hudleston, in 1935) shows a deep and sympathetic feeling for his various correspondents. (J. D. A.)

CHAPONE, HESTER (née MULSO) (1727–1801), English writer, and one of the group of literary "bluestockings" who gathered around Mrs. Elizabeth Montagu, was born at Twywell, Northamptonshire, Oct. 27, 1727. The precocious but plain daughter of a beautiful mother who was jealous of her accomplishments, she began to write at an early age, and after her mother's death, studied assiduously as well as managing the household. In 1749 she met the learned Mrs. Elizabeth Carter, with whom she carried on a lifelong correspondence. Admiration for Samuel Richardson's *Clarissa* led to her becoming one of the little court of learned ladies who met to hear readings from *Sir Charles Grandison;* she is the central figure in a sketch of the group by Susannah Highmore. Her letters to Richardson show affectionate deference and the unaffected sprightliness he praised in her conversation. Through him she met the attorney, John Chapone, to whom she was married, with her father's reluctant consent, in 1760; her husband died within a year. For the rest of her life she combined literary with domestic activities; a much-loved daughter, aunt and friend, she is described by Fanny Burney as "the most superiorly unaffected creature." She gained a wider reputation for good sense and right feeling by her *Letters on the Improvement of the Mind* (1773), originally written to a niece, which brought many requests from distinguished persons to undertake their daughters' education. Her essays and poems were collected in *Miscellanies* (1775). She died, Dec. 25, 1801, at Hadley, Middlesex.

Her works, containing her correspondence with Richardson and Elizabeth Carter, and a life drawn up by her own family, were published in four volumes (1807).

CHAPPELL, WILLIAM (1809–1888), was a pioneer in English musical research. Born in London, Nov. 20, 1809, he was the eldest son of Samuel Chappell (d. 1834), founder of a music business that William and his two brothers continued. William's interest, however, was in old music, and he helped to establish the Musical Antiquarian society (1840), which issued valuable works by forgotten English composers. His *Collection of National English Airs* (1838–40), revised as *Popular Music of the Olden Time* (1855–59), was an anthology of and lively guide to traditional songs. Chappell died in London, Aug. 20, 1888. (P. M. YO.)

CHAPRA, a town and headquarters of Saran district, Bihar, India, is situated 30 mi. W. of Patna between the Gogra river and the embankment of the North Eastern railway. Pop. (1961) 75,580. The older western portion contains the principal bazaars. The newer eastern part grew up round the civil courts built in the 19th century. The town has two degree-granting colleges affiliated to Bihar university, and parks and playgrounds in the central and eastern parts. Chapra is an important road and railway junction. The streets of the town, however, are mostly narrow and ill-kept.

Chapra, which was a village when the Mogul chief Baber visited it in 1529, grew in importance in the 17th century when the Dutch and British established saltpetre refineries there. (E. Ah.)

CHAPTER HOUSE, the chamber or building in which the chapter or heads of monastic bodies assemble to transact business. Chapter houses occur in various forms—sometimes oblong, as in England at Canterbury or Exeter; sometimes octagonal, as at Salisbury or Westminster; occasionally circular, as at Worcester. Most are polygonal externally and vaulted internally; some, as at Salisbury, Wells, Lincoln, Worcester, etc., depend on a single slight vaulting shaft for all the vaulting support. English chapter houses are often provided with a vestibule; *e.g.*, Lincoln, Salisbury. On the continent of Europe chapter houses occur more rarely than in England and are almost always rectangular. (*See* Monastery; Cathedral.)

In postmedieval times, occasions for building chapter houses in the proper sense were rare; but because the form was so characteristic of medieval architecture, and offered such opportunities for demonstrating medieval building techniques, 19th-century Gothic revivalists made considerable use of it in secular adaptations—typical examples being the chapter house adjoining the Oxford museum, or the library of the house of commons, Ottawa.

In the U.S. the term is sometimes used to refer to campus meeting or residence halls of the members of fraternities or sororities. *See* Fraternity and Sorority. (An. G.)

CHAPU, HENRI MICHEL ANTOINE (1833–1891), French sculptor and portrait medalist, whose works were softened expressions of the neoclassic tradition, was born in Le Mée (Seine et Marne) on Sept. 29, 1833. He studied at the École des Beaux-Arts under James Pradier and Francisque Duret and, having gained the Prix de Rome in 1855, spent five years in Rome. His first success was attained by a figure of "Mercury" (1861); and his fame was established by his statue of "Jeanne d'Arc" (1870) representing her as a simple peasant. In 1872 Chapu undertook the monument to the painter Henri Regnault in the courtyard of the École des Beaux-Arts. In 1877 he completed the tomb of the comtesse Marie d'Agoult at Père Lachaise and in 1887 the monument to Archbishop Felix Dupanloup. Among his portraits were those of Léon Bonnat (Église St. Martin, 1864), Alexandre Dumas *fils* (Comédie Française, 1876) and J. E. Schneider (Le Creusot, 1878). The monument to the Galignani brothers (Corbeil, 1888), representing them in modern costume, excited much comment. The monument to Gustave Flaubert, with an allegorical figure of "Truth," was his last important work. His statuary representing allegorical and mythological figures was sincere in feeling and poetical in conception. Chapu died in Paris on April 21, 1891. The museums of Rouen and Bayonne contain a number of his drawings. (A. K. McC.)

CHAPULTEPEC, a rocky hill on the western edge of Mexico City, has long played a prominent role in the history of that city. On it, Spanish viceroys began the construction of a viceregal palace in the late 18th century, and in the 1860s the emperor Maximilian further beautified the palace and grounds. The area became a large and beautiful park. Chapultepec later became the summer palace of the presidents of Mexico and the home of the National Military academy. In 1937 the palace became a national museum with exhibits of historical interest. In 1945, a conference of American states signed there a convention for the maintenance of peace in the western hemisphere through collective security. (*See* Pan-American Conferences.)

To the Mexican people, Chapultepec has special significance as the scene of the last organized defense of their capital in the war between the United States and Mexico (*see* Mexican War). In 1847 the invading army of the United States, under Gen. Winfield Scott, occupied positions just south and west of the city after winning a series of battles to the south on Aug. 19–20. Scott's decision to attack the city from the southwest required that his forces capture Chapultepec, but he hoped the defenders of Chapultepec could be compelled to retire by a bombardment. A day of artillery fire (Sept. 12) did not produce the desired results, and an assault on Chapultepec was ordered for the following day. After several hours of artillery bombardment the assault began at about 8 o'clock in the morning. The attackers moved through groves and across level ground, captured the first line of defense, and began the ascent of the rocky hill. At this point, it was discovered that the ladders for the scaling of the palace walls had been left behind, and there was an embarrassing delay. The defenders, who seem to have been reconciled to the loss of the hill, failed to take advantage of this situation. When the ladders finally arrived, the assault continued and the palace was captured.

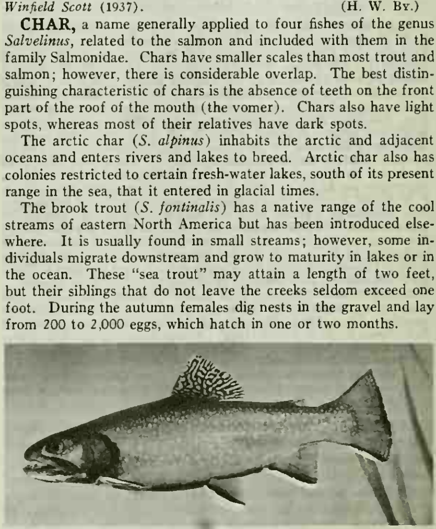
Though Scott had given no orders for further action that day, some of the U.S. forces, under impetuous commanders, moved against the city proper, which they entered after some minor opposition. During the night Mexican forces were withdrawn from the city and on the 14th, Scott entered the capital.

See R. S. Henry, *Story of the Mexican War* (1950); C. W. Elliott, *Winfield Scott* (1937). (H. W. By.)

CHAR, a name generally applied to four fishes of the genus *Salvelinus*, related to the salmon and included with them in the family Salmonidae. Chars have smaller scales than most trout and salmon; however, there is considerable overlap. The best distinguishing characteristic of chars is the absence of teeth on the front part of the roof of the mouth (the vomer). Chars also have light spots, whereas most of their relatives have dark spots.

The arctic char (*S. alpinus*) inhabits the arctic and adjacent oceans and enters rivers and lakes to breed. Arctic char also has colonies restricted to certain fresh-water lakes, south of its present range in the sea, that it entered in glacial times.

The brook trout (*S. fontinalis*) has a native range of the cool streams of eastern North America but has been introduced elsewhere. It is usually found in small streams; however, some individuals migrate downstream and grow to maturity in lakes or in the ocean. These "sea trout" may attain a length of two feet, but their siblings that do not leave the creeks seldom exceed one foot. During the autumn females dig nests in the gravel and lay from 200 to 2,000 eggs, which hatch in one or two months.



TREAT DAVIDSON FROM NATIONAL AUDUBON SOCIETY

CHAR OR BROOK TROUT (SALVELINUS FONTINALIS)

The Dolly Varden trout (*S. malma*), which lives in northeastern Asia and northwestern North America, is less desirable than the other chars because it preys on salmon eggs and young.

The lake trout (*S. namaycush*), an inhabitant of lakes of northern North America, breeds in quiet water. The largest of the chars, the lake trout lacks the red spots typical of the other species; it may weigh as much as 100 lb. All four chars provide good sport and good eating.

See also Fish: *Survey of the Bony Fishes.* (C. Hu.)

CHARABANC: *see* Carriage: *Types in Use, 17th–19th Centuries.*

CHARACTER. In describing the psychological characteristics of any particular person it is customary to distinguish between two main aspects of mental life, which earlier writers commonly termed "intellectual" and "emotional." Emotional characteristics are those that are assumed to supply the energy or driving force for the person's actual behaviour; intellectual characteristics guide or direct his activities toward their conscious or unconscious goals. It would perhaps be more accurate to describe them as the "motivational" and the "directional" components. Later writers have introduced a cross classification, and seek to distinguish those characteristics that are inherited or inborn from those that are acquired (*i.e.*, developed out of the inborn tendencies as a result of personal experience). The word "temperament" generally is used to designate those general motivational characteristics that are inborn, and the word "character" to designate those that are acquired. The sum total of these various traits—the directional and the motivational, the inborn and the acquired—integrated into one unique and distinctive whole, is termed "personality." Some psychologists prefer to distinguish three main aspects—the cognitive, the affective and the conative; the word "temperament" is then commonly restricted to the affective aspect (*i.e.*, the qualities of feeling only), and the word "character" used to cover the whole of the conative or moral aspect.

On the motivational side the chief innate bases of personality consist of the innate conative tendencies (usually called instincts) and the emotions or feelings that are associated with them—sex, anger, fear, joy, sorrow, self-assertion, self-abasement and the like. These are inherited by different persons with different degrees of strength; and this has given rise to the popular classification of temperaments into the sanguine, the melancholy, the phlegmatic and the choleric, the differences being really a matter of degree. Such emotional variations are largely the effect of biochemical differences, particularly those that result from variations in the functioning of the endocrine glands.

These traditional distinctions are to a large extent confirmed, and in minor respects modified or rectified, by the results of later statistical investigations. Assessments are obtained for the character traits of a representative sample of persons; either the traits or the persons can then be correlated, and the coefficients so obtained factorized by methods that are much the same as those used for factorizing intellectual abilities (*see* Psychological Tests and Measurements: *Tests of Personality and Temperament: Factor Analysis*). The empirical study of the genetic components of character, however, is still in its early stages, and the theory of instinctive tendencies in man is largely a speculative inference from animal behaviour.

As a result of individual experience the primary instinctive and emotional propensities tend to become progressively organized about certain dominant ideas or thoughts, forming complex motivational systems that correspond roughly with what are popularly termed a person's "interests"—the various people or things that he likes or dislikes, admires or fears. The earliest interests usually are centred on the persons in the child's immediate environment; at a slightly later age interests may be developed for toys, games, close companions, and later still for teachers, school, hobbies and the like. As the child grows up, he develops interests for more abstract concepts—the school subjects that attract (or repel) him, the code of rules he seeks to obey, the ideal personages or characters whom he takes as models of conduct, and above all for himself. This last—the self-regarding sentiment or ego ideal as it is variously called—plays a dominant role in determining his social and moral behaviour (*see* Ego).

Many of these emotional systems, particularly in persons of unstable disposition, may be more or less unconscious, built up largely as a result of mechanical and even irrational associations and liable to conflict with other emotional systems or with the higher and more conscious levels of the child's personality: they are then termed "complexes." Those that are more completely conscious and more rationally formed are commonly termed "sentiments" (*see* Sentiment). In a fully developed and well-balanced personality all these various tendencies are integrated into a hierarchy of motives and ideals, the whole forming a stable and harmonious character. *See* also Personality; Temperament.

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CHARADE, a kind of riddle, probably invented in France during the 18th century, in which a word of two or more syllables is divined by guessing and combining into one word (the answer) the different syllables, each of which is described as an independent word, by the giver of the charade. Charades may be either in prose or in verse. The following is an example of a poetic charade:

My first is a Tartar,
My second a letter;
My all is a country,
No Christmas dish better.

The solution is Turkey (Turk-e).

The most popular form of this amusement is the acted charade, in which the meaning of the different syllables is acted out, the audience being left to guess each syllable and thus, combining the meaning of all the syllables, the whole word. A brilliant description of the acted charade is given in Thackeray's *Vanity Fair*. In the United States the charade in somewhat different form was resurgent in the 1930s and 1940s and again after World War II. It was called "The Game." Whatever group assembled was divided into two teams. Each team designated one member of the opposing team to personify a quotation, a person living or dead, a phrase or an idea in such manner that his teammates might guess the subject. The designated actor was not permitted to use his voice in any way or to indicate any inanimate object in the room for the guidance of his teammates. The object of the actor was to assist his teammates in guessing the subject in the shortest possible time. A timekeeper determined the team which had arrived at the proper answer in the shorter time and thus had won the contest.

CHARADRIIDAE, a family of birds including plovers, turnstones and surfbirds. Members are found in most parts of the world. *See* Killdeer; Lapwing; Plover; Turnstone.

CHARADRIIFORMES, an order of birds, most members of which live on the water or near it, such as shore birds or "waders," gulls and auks. The young are active and down clad at hatching. *See* Auk; Avocet; Bird; Curlew; Gull; Killdeer; Phalarope; Plover; Sandpiper; Sheathbill; Snipe; Tern; Woodcock.

CHARCOAL. Charcoal is the residue obtained when a carbonaceous material of animal or vegetable origin is partially burned or heated in the absence of air. It is essentially an impure form of carbon (*q.v.*).

The process is often called destructive distillation when, as in this case, the material is decomposed into volatile and nonvolatile fractions. Coke (*q.v.*) is manufactured by the application of a similar process to bituminous coal and may be regarded as a special form of charcoal.

Various charcoals are given names which identify them with the materials from which they are derived: wood charcoal, blood charcoal, etc. Bone charcoal contains only about 12% carbon and consists principally of calcium phosphate and carbonate.

Wood Charcoal.—This material was produced for many centuries by stacking wood into heaps which were partially covered with earth to limit the access of air; the heaps were fired and the charcoal recovered but all by-products were wasted.

This process has been almost completely replaced by those using by-product ovens. In the older of these, cordwood is loaded into large steel buggies which run on standard rails. They are rolled into ovens heated by the combustion of coal, natural gas or the gas and tar formed during the carbonization. In the newer Stafford process dry wood in the form of relatively small pieces preheated to 300° F. is charged continuously into large cylindrical retorts. Once started, the process maintains itself by the heat liberated in the decomposition reactions.

The vapours from either of these processes are cooled to condense tar and pyroligneous liquor which form separate layers. The aqueous layer is redistilled to remove soluble tar. In the older recovery processes acetic acid was obtained by neutralizing the pyroligneous acid with lime, evaporating to dryness and liberating the acetic acid from its calcium salt by means of sulfuric acid. By 1945 this process was used in only a few small plants, the others having adopted more economical operations depending upon rectification and selective solvent extraction.

The products obtained from the distillation of hardwood are as follows in per cent by weight: charcoal 25.2, methanol 1.9, acetic acid 2.9, tar and oil 5.0, gas 18.3, water, etc., 46.7. The gas from the process consists mainly of carbon dioxide 53%, carbon monoxide 27% and methane 15%.

After the production of acetone by fermentation (1915) and later from propylene, its manufacture by destructive distillation of calcium acetate was abandoned. The commercial synthesis of methanol from carbon monoxide and hydrogen and the advent of cheap acetic acid made from acetylene or ethyl alcohol caused the prices of the principal by-products of the charcoal industry to decrease considerably. As a result, in 1940 only 9% of the methanol was made by wood distillation and the large additional demand for methanol from which to produce the formaldehyde required for plastics and explosives needed in World War II was met by still greater expansion of the synthetic methanol industry.

Wood distillation may be expected to continue on a stable basis but from mid-20th century it supplied a diminishing fraction of the total market for all of its principal by-products with the exception of wood tar. The demand for charcoal is thus the factor which determines the magnitude of the wood distillation industry. In fact, interest has revived in charcoal processes in which the by-products are burned because of their low value. The chief use for charcoal is as a blast-furnace fuel although coke is much more commonly employed. Charcoal is also used as a cooking fuel; its clean flame and great ability to radiate heat recommend it particularly for broiling and it has long been the favourite fuel of outdoor cooks at picnics and barbecues. Charcoal is further employed for miscellaneous metallurgical purposes such as case hardening (*see* SURFACE HARDENING), in the manufacture of black powder and as a starting material for chemical synthesis. Carbon disulfide, important in the production of carbon tetrachloride (fire-extinguisher fluid and dry-cleaning agent) and of rayon and rubber accelerators, is made by the action of sulfur on charcoal. Sodium cyanide, important in the metallurgy of gold and silver, as a poison and in plastics manufacture, is made by passing ammonia over a sodium-charcoal mixture.

Activated Charcoal.—The ability of charcoal to deodorize air and decolorize solutions has long been known. These effects occur through the phenomenon of adsorption (*q.v.*) by which charcoal, in common with other solids of large internal area, attracts and holds on the surface of its pores various materials which while there sometimes undergo chemical change. Since charcoal adsorbs oxygen from the air, organic materials simultaneously adsorbed may be oxidized while held on the charcoal surface. Polymerization and hydrolysis frequently occur. Before 1900, R. von Ostrejko made the important discovery that the adsorptive power of charcoal may be strongly enhanced by partial oxidation at a bright red temperature in a current of steam or carbon dioxide. A similar effect is obtained by the action of oxygen (air) at much lower temperatures (300°–450° C.) but this reaction is exothermic and thus harder to control. The subjection of charcoal to the action of a limited air supply in the temperature range 800°–1,000° C. results in excellent activation; the chemical attack on the charcoal in this case is primarily by carbon dioxide formed in the reaction between carbon monoxide and inwardly diffusing oxygen. The product of such processes is called activated charcoal or active carbon.

Another method of obtaining activated charcoal is to carbonize organic material by heating it in the presence of certain solutions such as aqueous zinc chloride or phosphoric acid which exert a dissolving action upon the organic matter and a catalytic effect upon its pyrolysis. A higher yield of charcoal is obtained than in ordinary destructive distillation and the original cell structure, which is reproduced in ordinary charcoal with the utmost fidelity, may disappear completely, the resulting product having a black, glassy fracture. After the impregnated charcoal has cooled, it is extracted with water and acid to remove foreign materials and then dried.

During World War I, N. K. Chaney discovered that lignite, bituminous or anthracite coal may serve as an economical source of excellent activated charcoal if it is carefully carbonized and subjected to steam activation. Chlorinated coal behaves particularly well but requires a binder such as wood tar followed by recarbonization to form pellets which are mechanically strong.

Active carbon is manufactured for three principal purposes: (1) gas masks; (2) decolorization; and (3) water purification. The advent of chemical warfare in World War I sharply emphasized the value of active carbon in a respirator or gas mask. Removal of toxic vapours must be remarkably complete since a concentration of a few parts per million of such gases as phosgene may be fatal. Of all materials tried, only activated charcoal was satisfactory and by the end of the war the soldiers of all belligerent countries were wearing respirators containing it. The Allies employed partial oxidation processes and nut shells and hardwood were the principal sources of the charcoals employed. Germany used a zinc chloride process operated on pine wood.

After World War I active carbons were employed for the removal of gasoline vapours from natural gas and for solvent recovery in connection with such processes as the manufacture of artificial leather, pyroxylin window shades and metal lacquering where large quantities of relatively expensive solvents are evaporated. By 1930 the charcoal gasoline recovery process was almost entirely obsolete but installations employing active carbon were later used increasingly for solvent recovery where their slightly greater initial and operating costs were compensated for by their high efficiency, particularly where the material recovered was expensive or occurred at low concentration.

Bone charcoal towers were first used for decolorizing sugar solutions in 1815. Vegetable decolorizing carbons threatened to displace them after their commercial introduction around 1910 because only one-thirtieth the quantity of material was required and there was a consequent saving in time, fuel, wash water, building space and investment in equipment. Plants employing active carbon can operate efficiently on a much smaller scale than those using bone char and hence are often built adjacent to the raw sugar mills to produce "plantation white" sugar. Sugar refineries with bone char towers already installed, however, have little incentive to change over to vegetable decolorizing carbons.

Where highly acidic solutions are decolorized, bone black is unsuitable because of its high ash content. Here decolorizing carbons replaced older forms of charcoal. A still later application of active carbon was in the elimination of the objectionable odour of city water which contains chlorophenols formed by the action of chlorine (introduced to kill bacteria) upon traces of phenols present in the water. Relatively small quantities of active carbon, introduced as a powder and removed by filtration or present as a bed of granular material through which the water trickles, will render the water palatable. The same may be said for colours and odours produced by algae growing in reservoirs.

See also references under "Charcoal" in the Index volume.

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CHARCOAL DRAWING: *see* CRAYON DRAWING.

CHARCOT, JEAN BAPTISTE ETIENNE AUGUSTE (1867–1936), French polar explorer educated as a physician, was born at Neuilly-sur-Seine on July 15, 1867, the son of the French doctor Jean M. Charcot (*q.v.*). He studied at the École Alsacienne, worked at the Hôpitaux de Paris from 1890 to 1894, when he was also connected with the Institut Pasteur, and was chief of the clinic of the faculty of medicine at Paris from 1896 to 1898.

Charcot led two major antarctic expeditions, in the "Français" (1903–05) and the "Pourquoi Pas?" (1908–10). During the first he wintered at Booth Island, charted parts of the Palmer archipelago, Graham Coast and Loubet Coast and made a reconnaissance southward to Adelaide Island. The second expedition greatly extended this work. Charcot wintered at Petermann Island in 1909 and charted the coast southward to Alexander I Island, discovering Fallières Coast and Charcot Island. He later published two comprehensive series of reports on the scientific results of these expeditions.

During World War I Charcot served under the British admiralty with the rank of auxiliary lieutenant in the French navy. He had visited Jan Mayen in 1902 and every summer between 1920 and 1936 he took the "Pourquoi Pas?" on a research cruise, often to east Greenland, but also to Iceland, the Faeroes and the eastern North Atlantic. On Sept. 15, 1936, the "Pourquoi Pas?" was wrecked off Iceland and 39 men, including Charcot, were drowned.

In addition to medical works Charcot published *Le "Français" au pôle sud* (1906), *Le "Pourquoi Pas?" dans l'Antarctique* (1911; Eng. trans., 1912), *Autour du pôle sud*, 2 vol. (1912), *Christophe Colomb vu par un marin* (1928) and *La Mer du Groenland* (1929). (B. B. Rs.)

CHARCOT, JEAN MARTIN (1825–1893), French physician, one of the greatest figures in French medicine, a neurologist and teacher of enormous influence, was born in Paris on Nov. 29, 1825. In 1853 he took his M.D. at Paris, and three years later was appointed physician of the Central Hospital bureau. In 1860 he became professor of pathological anatomy in the medical faculty of Paris, and in 1862 began his connection with the Salpêtrière, where he created the great neurological clinic. He studied hysteria in relation to hypnotism and early stimulated Sigmund Freud's interest in investigating hysteria from a psychological point of view. In muscular atrophy Charcot differentiated between the ordinary wasting and the rarer amyotrophic lateral sclerosis (1874) and described with Pierre Marie the progressive neural or peroneal type (1886). He differentiated the essential lesions of locomotor ataxia and described both the gastric crisis and the joint affections (Charcot's disease). He distinguished multiple sclerosis from paralysis agitans. In diseases of the brain, the most notable contributions were his articles on cerebral localization, the studies of aphasia and the discovery of the miliary aneurysms and their importance in cerebral hemorrhage. Charcot greatly promoted the study of medicine in art (*see* his *Nouvelle Iconographie de la Salpêtrière*, 1888).

He died on Aug. 16, 1893.

Charcot's best-known works are *Leçons sur les maladies du système nerveux*, five volumes (1872–93) and *Leçons du mardi à la Salpêtrière*, two volumes (1889–90).

See F. H. Garrison, *Introduction to the History of Medicine*, 4th ed. rev. (1929).

CHARD, a market town and municipal borough in Somersetshire, Eng., 16 mi. S.S.E. of Taunton by road. Pop. (1961) 5,778. It lies on a hillside close to the Devon and Dorset borders and the runnels by the sides of the main street are said to flow, one south to the English channel, the other north to the Bristol channel. Industries include agricultural machinery, surgical supplies, lace, shirts and collars and dairy produce. The town takes its name from Cerdic (*q.v.*) who founded the kingdom of Wessex, and appears as Cedre in the Domesday Book. The bishop of Bath held Chard in 1086 and in 1234 his successor granted the first charter which was confirmed in 1253 (when a Monday market and a fair on July 25 were granted), 1280 and 1285. The corporation seal dates from 1570. The town was incorporated by grant of Charles I in 1642 and Charles II gave a charter in 1683 (when two more fair days were added). The cruciform parish church of St. Mary the Virgin is Perpendicular of the 15th century. The grammar school was founded in 1671 when William Symes gave his house for the purpose.

Another Tudor house is the court house of the manor which contains the room where Judge Jeffreys condemned to death 12 natives of Chard for taking part in the Monmouth rebellion.

CHARD (Swiss Chard), a name given to the edible leaf beet (*Beta vulgaris* var. *cicla*), a variety of the beet (*q.v.*) in which the leaves and leafstalks, instead of the roots, have become greatly developed. The plant is a biennial with somewhat branched and thickened but not fleshy roots and large leaves borne on stalks sometimes 2 ft. long and 1 in. to 3 in. wide. It is grown for the tender leaves and leafstalks; the former are boiled and served like spinach, the latter, like asparagus. Swiss chard is popular as a home-garden potherb because of its ease of culture, productiveness and tolerance to moderately hot weather. It furnishes an abundance of greens after the weather becomes too warm for growing spinach and other early greens.

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CHARD (BETA VULGARIS CICLA)

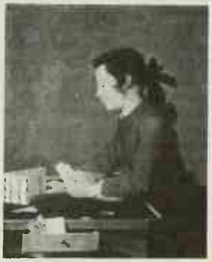
CHARDIN, JEAN (later Sir John) (1643–1713), French traveler to the middle east and India, was born in Paris on Nov. 16, 1643, the son of a wealthy jeweler, and was given an excellent education. To gratify his ambition for travel he set out with a Lyons merchant for Persia and India in 1665. In Persia he profited by the patronage of Shah Abbas II and after a most successful journey returned to France in 1670, and there published his *Récit du Couronnement du roi de Perse Soliman III*.

In Aug. 1671 he set out again for Persia, this time passing through Smyrna, Constantinople, the Crimea and the Caucasus. He reached Ispahan in June 1673, spent four years in Persia, revisited India and returned to France by the Cape of Good Hope in 1677. Persecution of Protestants drove him in 1681 to settle in London where he became jeweler to the court and was knighted by Charles II. In 1683 he represented the East India company in Holland.

Chardin died in London on Dec. 25, 1713.

Bibliography.—The complete account of Chardin's travels appeared at Amsterdam in 1711, under the title of *Journal du voyage du chevalier Chardin*. The Persian portion is in vol. ii of Harris' *Collection* (1705), and extracts are reprinted by Pinkerton in vol. ix. The best complete reprint is by M. L. Langlès (1811). (K. M.)

CHARDIN, JEAN BAPTISTE SIMÉON (1699–1779), French painter, noted for his warm representations of domestic life, was born in Paris, Nov. 2, 1699, the son of a master carpenter. The boy never had a regular education. He learned painting from a modest artist, Pierre Jacques Cazes, and started by painting details in other artists' works and signposts for tradesmen. Chardin became known through the exhibition of the "Jeunesse" in 1728; he showed at least ten other paintings, among them a still life, "The Skate" ("La Raie"), now at the Louvre (*see* Still-Life Painting). The same year he was elected to the Académie Royale de Peinture et de Sculpture. Chardin began to add figures to his still-life paintings, showing scenes from the lives of the modest people among whom he spent his whole life. Among the pictures he sent to the salons were lively portraits of children. Chardin was elected treasurer of the academy, a job he kept for 19 years, aided by his second wife. Among his commissions was that of painting allegorical scenes and decorations above the doors at the castles of Bellevue and Choisy. During his last years, when he was over 70, Chardin still produced pastel portraits even superior to his earlier portraits in oils. His old age was saddened by reverses. Contemporary critics sometimes judged him severely for the revolutionary quality of his technique, when he showed himself to be a forerunner of divisionism. His whole life was spent in his own house in Paris and in his rooms at the Louvre, surrounded by his artist and writer friends. He died on Dec. 6, 1779.



BY COURTESY OF THE NATIONAL GALLERY OF ART, WASHINGTON, D.C., MELLON COLLECTION, 1937

"THE HOUSE OF CARDS" BY CHARDIN. IN THE NATIONAL GALLERY OF ART, WASHINGTON, D.C.

Bibliography.—G. Wildenstein, *Chardin* (1933); *Chardin . . . With an Introduction and Notes by Walter De La Mare* (1948); B. Denvir, *Chardin* (1950). (M. N. B.)

CHARDZHOU, a town of the Turkmen Soviet Socialist Republic in the U.S.S.R., lies 290 mi. E.N.E. of Ashkhabad on the Amu-Darya (Oxus) river, which is navigable throughout the region. Pop. (1959) 66,112. Chardzhou was the administrative headquarters of an *oblast* (area 36,100 sq.mi.) of the same name from 1939 until its abolition in 1962.

The Trans-Caspian railway crosses the river at Chardzhou. There is a branch line along the Amu-Darya from Chardzhou to Kungrad, near the southern shore of the Aral sea, which connects with the Khorezm oasis.

Chardzhou is a cotton and silk centre. An important river-rail transportation hub, it also has shipyards, metalworks, fruit-canning plants and chemical industries. It was founded as a fort in the 1880s and at various times was called Chardzhui or Novy Chardzhui and Leninsk-Turkmenski.

The climate is continental with hot, dry summers and relatively cold winters. The regional vegetation is of the desert variety and agriculture (cotton and silk) is confined to the banks of the river. The completion of the Kara-Kum canal would enable large parts of the desert region to be irrigated. In the early 1960s an industrial region was created in the far southeast of Chardzhou *oblast* (the Gaurdak-Kugitang area) which has deposits of superphosphates, common salt, sulfur, copper and coal.

(G. E. Wr.)

CHARENTE, an inland *département* of western France, separated from the Bay of Biscay by Charente-Maritime, and elsewhere surrounded by the *départements* of Deux-Sèvres, Vienne, Haute-Vienne and Dordogne. Pop. (1962) 327,658. Area 2,306 sq.mi.

Most of the *département* was the old province of Angoumois, consisting of limestone plains below the western margin of the granite highlands of Limousin. In the northeast, in the district of Confolens bordering the highlands, are tracts of poor granitic sands, *terres froides*, but most of the *département* is fertile arable land on calcareous loams (*terres chaudes*). Cereals (wheat and corn) and fodder crops are extensively grown, but Charente is especially famous for its vineyards. These provide the wine for distilling brandy, so specially associated with the name of Cognac (*q.v.*), which lies in the west of the *département* in the valley of the Charente. The river is navigable for small barges as far as Angoulême, which has paper works and food canning industries. There is little industry elsewhere, and mineral resources are unimportant, although there are limestone quarries for building stone, gypsum workings, and clay is dug for scattered brick and tile works.

Charente is divided into the three *arrondissements* of Angoulême (the capital), Confolens and Cognac. It forms the diocese of Angoulême and is associated with the *académie* (educational division) of Poitiers; its court of appeal is at Bordeaux. Charente is rich in Romanesque churches.

For the history of the area, *see* Angoulême; Angoumois.

(Ar. E. S.)

CHARENTE, a river of western France, flows westward from the margin of the Massif Central in the Haute-Vienne *département* to the Bay of Biscay. The Charente and its tributary the Tardoire descend from the pastoral uplands of Limousin to the lowlands of Angoumois, and the combined river flows west as a slow, meandering stream that receives few surface tributaries from the flanking calcareous platforms. The Boutonne river, its chief tributary, derives from the plain of Poitou to the north. Below its confluence, the Charente flows sluggishly past Rochefort through extensive alluvial flats into its silted estuary behind the island of Oléron. Below Angoulême, the Charente flows through what was formerly important vine-growing country; the valley market town of Cognac gives its name to the brandy for which the district is still famous. Many vineyards, however, were not reestablished after the phylloxera plague of the 1870s and the rural economy has been reoriented by specialization upon dairying, organized through numerous co-operative dairies. The river is navigable for small craft as far as Angoulême. The limestone of the valleys is in places quarried for building stone and lime.

(Ar. E. S.)

CHARENTE-MARITIME, a *département* of western France, comprising the ancient provinces of Saintonge and Aunis and a small portion of Poitou. Until 1941 the name was Charente-Inférieure. Area 2,792 sq.mi. (7,231 sq.km.). Pop. (1962) 470,897. Its capital is at La Rochelle. Charente-Maritime extends along the coast of the Bay of Biscay from the Gironde estuary to the Sèvre river on the borders of Vendée and is bounded inland by Deux-Sèvres and Charente. The major physical features are aligned from southeast to northwest, the chalk platform of Saintonge being separated from the Jurassic limestone platform of Aunis by the valley of the Charente river. These salients of the low-lying coast are prolonged offshore by the islands of Oléron and Ré; the re-entrants between are extensively silted and fringed with alluvial marshlands that have been progressively reclaimed. Silting has severely affected port activity, and, in spite of the modern development of an outport at La Pallice, La Rochelle has largely lost its once-important oversea trade, though it remains a major fishing port. Rochefort, up the estuary of the Charente, is a naval station, and Royan, on the north shore of the Gironde, is a much-frequented resort.

Oyster culture is carried on extensively in some coastal areas, especially in the Marennes, but agriculture is the predominant economic activity of the *département*. The dry chalk and limestone platforms, with few surface streams, are open *campagnes*, traditionally devoted to cereals, with vineyards especially along the valley sides. The intervening tracts of reclaimed marshes stand out in contrast as flat, amphibious areas, intersected by a network of drainage channels that are also much used for local transport. Some of the marshlands provide rich market gardens, and elsewhere there are lush meadows. Fodder crops are everywhere important. Vineyards are less important than they were before the phylloxera crisis at the end of the 19th century, and the smallholding economy has been rehabilitated by the development of co-operative dairying; the market towns have become important dairying centres. The chief product is butter, and skim milk helps to support an important pig-raising activity.

La Rochelle, Rochefort, Saintes (*qq.v.*), St. Jean-d'Angély and Jonzac give their names to the five *arrondissements*, and the *département* forms the diocese of La Rochelle. Its court of appeal is at Poitiers, and for educational organization it is attached to the *académie* (educational division) there.

For the history of the region, *see* Aunis; Poitou.

(Ar. E. S.)

CHARES, a Greek sculptor and pupil of Lysippus (*q.v.*). Living in the city of Lindus on the island of Rhodes, he fashioned for the Rhodians a colossal bronze statue of the sun god, the cost of which was defrayed by selling engines of war left by Demetrius Poliorcetes after a siege in 303 B.C. The Colossus, often included among the seven wonders of the world, was 70 cubits (105 ft.) in height. The notion that it bestrode the harbour is absurd. It was destroyed by an earthquake after 56 years.

CHARES (4th century B.C.), Athenian general and mercenary commander. In 357 Chares was sent by the Athenians to regain the Thracian Chersonese from the Thracian king Cersobleptes. In the same year he was appointed to the command in the war of the Athenians with their allies known as the Social War (*see* Greece: *History*) together with the general Chabrias; after Chabrias' death in the attack on Chios, Chares was associated with the generals Iphicrates and Timotheus. Chares, having blamed the subsequent defeat on his colleagues, was left sole commander. Receiving no supplies from the Athenians, however, he joined Artabazus, satrap of Phrygia, during the satraps' revolt against the Persian king Artaxerxes III. When Artaxerxes complained, threatening to aid the rebellious allies, the Athenians made peace with them (355) and recalled Chares.

In 349 Chares was sent to assist Olynthus (*q.v.*) against Philip II of Macedonia, but he returned having achieved nothing. Sent again in 348 he found Olynthus in Philip's possession. In 340 he commanded a force sent to aid Byzantium against Philip; unpopular because of previous plundering, however, he achieved little. Chares was defeated by Philip in 338 at Amphissa in Locris, and was one of the generals at the battle of Chaeronea (*q.v.*). After his conquest of Thebes (335), Alexander the Great is said to have demanded the surrender of Chares among others. In 334, however, Chares was living at Sigeum in the Troad. In 332 he entered the service of Darius III of Persia, and commanded a Persian force in Mytilene, but he capitulated at the approach of a Macedonian fleet on condition of being allowed to retire unmolested. Chares is last heard of at Taenarum (Cape Matapan), and is thought to have died at Sigeum.

See Diodorus Siculus, *Bibliotheca Historica,* books xv, 75, 95, xvi, 7, 21, 22, 85–88.

CHARGÉ D'AFFAIRES (French, "in charge of affairs"), a diplomatic officer authorized to act for his country in the absence of an ambassador or minister plenipotentiary. *See* AMBASSADOR; DIPLOMACY.

CHARI: *see* SHARI.

CHARIBERT (d. 567), king of the Franks, was the eldest son of Clotaire I and Queen Ingund. At his father's death in 561 he received the best part of the kingdom, namely Paris and the whole western region southward to the Pyrenees. The poet Venantius Fortunatus extols his interest in classical literature but Saint Gregory of Tours represents him as despotic and dissolute. He repudiated his wife Ingoberga (the mother of his daughter Berhta, who married King Aethelberht of Kent) and maintained a series of low-born concubines. Still young, he died in Paris in Nov. or Dec. 567, whereupon his brothers divided his patrimony. (JE. H.)

CHARIDEMUS (d. 333 B.C.) of Oreus in Euboea, Greek mercenary leader who fought sometimes on the side of the Athenians, at other times on that of their enemies. He fought under the Athenian general Iphicrates at Amphipolis (*q.v.*) about 367 B.C. but later joined Cotys, king of Thrace, against Athens. Soon afterward he was captured by the Athenians and re-entered their service. Discharged by the general Timotheus in 362, he offered during the satraps' revolt to join Memnon and Mentor, brothers-in-law of the satrap Artabazus in Asia Minor, but instead captured on his own account the cities of Scepsis, Cebren and Ilium in the Troad. After the release of Artabazus from captivity, he again joined Cotys, on whose murder (359) he became guardian to his young son Cersobleptes. In 357, when the Athenian general Chares (*q.v.*) arrived with considerable forces, the Thracian Chersonese (*q.v.*) was restored to Athens. This success was attributed to Charidemus, who received honours, including Athenian citizenship and a golden crown. In 351 he commanded the Athenian forces in the Chersonese against Philip II of Macedonia, and in 349 he superseded Chares as commander in the Olynthian War (*see* GREECE: *The Macedonian Period*). Achieving little success, he was in turn replaced by Chares. Alexander the Great of Macedonia demanded his surrender after the destruction of Thebes (335), but he escaped with banishment. He fled to Darius III of Persia, who, it is said, after receiving him well, executed him for criticizing the preparations before the battle of Issus (333).

See Demosthenes, *Against Aristocrates;* H. W. Parke, *Greek Mercenary Soldiers* (1933).

CHARIKAR, a town in Afghanistan, lies 35 mi. N. of Kabul at an altitude of 5,300 ft. Pop. (1962 est.) 54,372. Charikar, which is situated on the main road between Kabul and Mazar-i-Sharif, where it enters the Ghorband valley of the Hindu Kush, is well known for its pottery and fine grapes. (J. P. C. N. H.)

CHARING CROSS, the locality about the west end of the Strand and the north end of Whitehall, London, Eng., in the city of Westminster. There Edward I erected the last of the series of 13 crosses in memory of his queen Eleanor (d. 1290) which marked the stages of the funeral procession to Westminster abbey. The derivation from Edward's "dear queen" (*chère reine*) is apocryphal. The cross was destroyed in 1647, and in 1675 an equestrian statue of Charles I by Hubert Le Sueur was erected at the top of Whitehall, where several regicides were executed, at the place where the cross stood. The modern cross (1863) stands within the forecourt of Charing Cross railway station. Formerly an important terminus for the continent, the station is now the focus for London suburban services and mostly concerned with trains serving southern England. The name (Cyrring in 1000) may refer to the neighbouring sharp bend in the river Thames.

CHARIOT. The two-wheeled chariot is first attested in Mesopotamia in the early 3rd millennium B.C. Monuments from Ur, Khafaje and elsewhere depict heavy vehicles with two or four solid wheels in use in battle parades, their bodywork framed with wood and covered with skins.

By the middle of the 3rd millennium the draft pole of the chariots begins to differ from the straight pole of earlier four-wheeled vehicles and, with the aim of easier traction and greater speed, arches over the backs of the four onagers which draw it. By these modifications was born a war arm of great importance in the history of the ancient world.

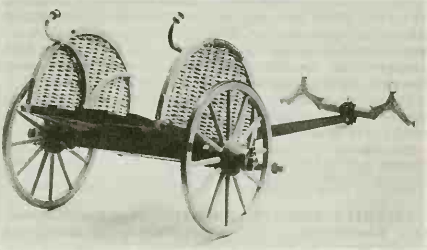
The earliest Mesopotamian chariots were mounted by both spearman and charioteer, although it is doubtful if fighting took place from the vehicle itself. Sometimes a single person was mounted, for it was probably primarily for speed of personal transport in battle that the chariot originated.

In western Asia the military importance of the chariot was greatly developed in the 2nd millennium by peoples with Aryan connections. It was probably in northern India that military demands led to the introduction of the light spoked wheel and the streamlined semicircular chassis with hind axle. Chariots of this type were introduced to Mesopotamia and Syria by Kassites and Mitanni and into 12th-dynasty Egypt by the Hyksos northerners. By 1435 B.C. Egyptians were making chariots out of light woods imported from northern Syria, and by the end of the century chariots with four-spoked wheels and light design were in use throughout the Levant and had been introduced to Minoan Crete and the southern European mainland.

Bronze chariot plaques and horse trappings from early dynastic Shang graves indicate that chariotry was introduced to the Chinese steppes by the 14th century B.C., but no reconstruction is possible of the earliest types. Chariots of *c.* 300 B.C. found in a burial at Liu-li-ko (Honan) have dished wheels, but otherwise are similar in construction to Celtic chariots in western Europe.

Numerous vase paintings of archaic Greek chariots as used in Homeric times indicate their similarity to earlier Mycenaean representations, with a body framework of bent rods and a bar joining the end of the upturned draft pole with the front of the chariot breast. Breastwork was made of wicker or leather straps, although chariots described by Homer as made of metal plates must have been more like the heavier metal-fitted chariots used by Hittite and Assyrian archers for warfare and hunting. Greek chariots in the 8th century B.C. used the four-spoked wheel attached to a fixed hind axle, although six-spoked wheels and medial axles were long in use in parts of western Asia. They were drawn usually by four horses, of which only the central pair was yoked, and were used not only for battle but also for racing. Chariot racing became popular in Greece and was a main part of the games at Olympia and Delphi.

There is no doubt that the chariot was in use in central and northern Europe before the 10th century B.C. Celtic peoples introduced its use to the British Isles about the 5th century B.C. The bodywork of Celtic chariots was somewhat heavier than that of Greece, and metal, sometimes inlaid with fine enamels, was



BY PERMISSION OF THE NATIONAL MUSEUM OF WALES

RECONSTRUCTION OF A CELTIC CHARIOT FROM LLYN CERRIG BACH, ANGLESEY, WALES (*c.* 1ST CENTURY B.C.)

extensively used for axle, draft pole and occasionally for solid metal wheels. On the fringe of the Celtic world, where the chariot remained in use until the 4th century A.D., small ponies, yoked four abreast, were used for draft.

In the Roman circus games chariot racing took foremost place, and chariotry and its consequent racing clubs began to play an important social role. Racing vehicles in use were the *biga* (two horses), *triga* (three) and *quadriga* (four), although as many as ten horses were harnessed on spectacular occasions and chariots drawn by dogs and even ostriches are instanced. The *biga* was the simplest chariot form yet devised: an elongated draft pole sitting on the axle and provided with seat and footrests for the leather-clad charioteer. The circus had to be rounded several times in the course of one race, a process involving many accidents and collisions. *See* CARRIAGE; CART AND WAGON; WHEEL; *see* also references under "Chariot" in the Index volume.

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CHARITON OF APHROOISIAS in Caria (fl. not later than 2nd century A.D.), Greek novelist, wrote a romance *Chaereas and Callirhoë* which is generally accepted as the earliest extant Greek novel. The author's identity, which has been questioned, is established by inscriptional evidence at Aphrodisias. The main action of the novel, the story of which is complex but simply told, takes place in Syracuse, at the Persian court and with the Egyptian fleet. Callirhoë is the daughter of the historical Syracusan general Hermocrates (d. 407 B.C.).

See Warren E. Blake, edition of text (1938) and Eng. trans., *Chariton's Chaereas and Callirhoë* (1939); E. Robde, *Der griechische Roman* (1900).

CHARITY, one of the triad of Christian virtues, together with faith (*q.v.*) and hope. Of all the synonyms for love, charity is probably the most sublime and at the same time the most banal. Popular speech, exemplified by such expressions as "I am not looking for charity" and "Charity begins at home," emphasizes the condescension with which charity is often shown. But in the literature of Christian theology and ethics the term charity, as a translation of the Greek word *agapē* in the New Testament, denotes especially the answering love of man for God, called forth by the giving love of God for man as this was set forth in the life, teachings and death of Jesus Christ. St. Augustine summarizes much of Christian thought about charity when he says: "Charity is a virtue which, when our affections are perfectly ordered, unites us to God, for by it we love Him." Quoting this definition and others from the Christian tradition, the medieval theologians, especially Thomas Aquinas, placed charity into the context of the other virtues and specified its role as "the foundation or root" of them all.

Although the controversies of the Reformation dealt more with the definition of faith than with the definition of either hope or charity, the Reformers identified the uniqueness of God's *agapē* for man as unmerited love, and therefore they required that charity, as man's love for man, be based not upon the desirability of its object but upon the transformation of its subject through the power of divine *agapē*. Modern discussions of charity have debated its relation to other terms and concepts for love, notably to *erōs*, this latter being understood as not merely sexual love in an explicit sense but as desire or yearning.

The classic statement on charity, however, remains the 13th chapter of I Corinthians; subsequent expositions may well be viewed as little more than marginal glosses upon this.

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CHARITY, INSTITUTE OF (INSTITUTUM A CHARITATE; I.C.; ROSMINIANS), a Roman Catholic religious congregation founded in 1828 by Antonio Rosmini-Serbati and approved Sept. 20, 1839. The primary object of the congregation is the sanctification of the souls of its members by the love of God. They engage in educational and charitable work. The motherhouse is at Rome; other houses are found in England, Ireland and the United States. Nuns of this congregation, called Sisters of Providence, with houses in Italy and England, engage chiefly in teaching; their habit is black, with a white veil. *See* WOMEN'S RELIGIOUS ORDERS.

CHARITY COMMISSIONERS FOR ENGLAND AND WALES were established by the Charitable Trusts act, 1853, to sit as a board. That act arose out of the initiative of Henry (afterward Lord) Brougham which led to the appointment between 1818 and 1835 of four statutory commissions whose reports to parliament—the printed Reports of the Former Commissioners for Inquiring Concerning Charities in England and Wales—collected existing information about charities. The fourth commission suggested legislative reforms. A select committee of the house of commons was appointed in 1835 to examine the reports, but legislation was not passed till 1853.

The object of the Charitable Trusts acts, 1853 to 1939, was to secure the better administration of endowed charities. The acts accordingly provided for control of dealings with capital endowments, required the rendering by trustees of annual accounts, gave the charity commissioners wide powers of inquiry and provided means of vesting property, appointing and removing trustees and remodeling trusts without resort to expensive legal proceedings. The charity commissioners were not themselves empowered, however, to administer or manage charitable trusts. Under the acts the secretary of the board of commissioners was the Official Trustee of Charity Lands, who held charity lands vested in him by an order of the court or of the charity commissioners. Certain officers of the board approved by the treasury constituted a body corporate, the Official Trustees of Charitable Funds, with power to hold securities and monies belonging to charities. Neither corporation might administer or manage any charity. The functions of the charity commissioners under the acts in respect of educational charities and certain classes of quasi-educational charities were transferred to the jurisdiction of the minister of education.

Following the report of a committee under the chairmanship of Lord Nathan on the Law and Practice Relating to Charitable Trusts, issued in 1952, and a White Paper on Government Policy on Charitable Trusts, issued in 1955, the Charities act, 1960, was passed to bring up to date the law on charitable trusts and the powers and functions of the charity commissioners. This act reconstituted the charity commissioners under simplified provisions for promoting the effective use of charitable resources. It also required the commissioners to set up a comprehensive register of charities, and to designate one of their officers official custodian for charities with power to accept the transfer to him of personal property and the status generally of a custodian trustee, in succession to both of the above corporations. (S. P. G.)

CHARITY OF ST. VINCENT DE PAUL, SISTERS OF (DAUGHTERS OF CHARITY; D.C.), a Roman Catholic religious congregation founded in 1633 by St. Vincent and St. Louise de Marillac (*q.v.*). Numbering about 43,000 in the early 1960s, the Sisters of Charity comprise the largest congregation of women. Their provinces all over the world are subject to the motherhouse in Paris, over-all supervision being in charge of the superior general of the Lazarists (Congregation of the Mission of St. Vincent de Paul). In Sept. 1964 the sisters' famous white linen winged cap was replaced by a veillike slate blue kerchief falling to the shoulders and lined with white, and the slate blue gown was made simpler, less full, and shorter. *See* WOMEN'S RELIGIOUS ORDERS.

CHARLATAN, a person who pretends to possess knowledge or ability, as in medicine. The word originally meant one who chatters to a crowd to sell his wares (Ital. *ciarlatano*, from *ciarlare*, "to chatter"). For medical charlatans *see* QUACKERY.

CHARLEMAGNE (CHARLES THE GREAT) (742 or 743–814), king of the Franks from 768 to 814 and Western (Holy Roman) emperor from 800 to 814, was born on April 2, 742 or 743, the elder son of Pepin the Short and Berta (Bertrada). His baptismal name, Charles, was already a common one in his family (*see* CAROLINGIANS). He was anointed as king with his brother Carloman by Pope Stephen III (II) at St. Denis in 754. The brothers took possession in 768 of the two kingdoms destined for them by their father shortly before his death. Charles's portion was a vast arc of territory stretching from southwestern France northward and then eastward into the Netherlands and Germany and half encircling Carloman's kingdom, which comprised central, eastern and southeastern France, southwestern Germany and the Alpine regions.

The political interests and aims of the brothers in no way disposed them to work together. Carloman gave Charles no help in 769 against a revolt in Aquitaine led by a certain Hunald (not the same person as the Hunald son of the duke Eudes). Charles, however, defeated the rebels and pursued them right into Gascony, forcing the duke of the Gascons, Lupus, to hand Hunald over to him and to swear allegiance. Charles and Carloman seem to have moved toward a reconciliation in 770, perhaps at their mother's instance. Charles's marriage with Desiderata, daughter of the Lombard king Desiderius, was probably a result of this *rapprochement.* Charles for a very short time adhered to the Lombard alliance (which Carloman steadily favoured) but then repudiated his wife and broke with Desiderius.

Lombards and Papal States.—On Carloman's death (Dec. 771), Charles annexed his brother's kingdom, but Carloman's widow and children took refuge at the Lombard court, which thenceforward became a centre of intrigue against Charles. This hostile power on his southeastern frontier was to draw Charles into many campaigns in Italy. These incursions effected the first major change in the balance of power in the peninsula to take place since the Roman empire had been divided into two.

The popes had long been searching for an ally of sufficient military strength adequately to check the alarming power of the Lombards; the Byzantine emperors, at war with the Muslims and facing serious dissensions within their own dominions, could give no effective assistance. The help of the Franks had already been solicited, and Pepin the Short, by a show of force, had constrained the Lombards to recognize the pope's authority over certain territories which they were either attacking or had already overrun (*see* PAPACY). Since then, however, pressure on the papal states had begun again, as some members of the Carolingian family and some Frankish magnates showed themselves willing to let the Lombards have a free hand. Immediately after his election as pope in 772, Adrian I revived the policy of alliance with the Franks. Desiderius was threatening not only the papal states but Rome itself; moreover he intended to force Adrian to anoint Carloman's sons. As this gave offense to the Frankish king no less than to the pope, Charles conducted two campaigns (773 and 774) against the Lombards, taking two armies into Italy, one through the Great St. Bernard, the other through the Mont Cenis pass. Desiderius was besieged in Pavia and after nine months was obliged to surrender. Charles deposed him and himself assumed the title "king of the Lombards." He showed prudence and restraint in administering his new kingdom; by appointing his young son Pepin as his deputy there, he left to it an appearance of autonomy, although Franks held the key posts. The Lombard duchies, particularly Benevento, remained virtually independent. Charles, however, confirmed (April 774) the so-called Donation of Pepin and also promised the pope the duchies and some remaining possessions of the Byzantines in northern Italy.

Bavarian and Avar Campaigns.—Charles was already planning other campaigns, both north and south of the Alps. To the north, Tassilo, duke of Bavaria, a member of the Agilolfing family, required constant and forcible reminders of the allegiance due from his house to the Carolingians, and he finally lost his crown and his duchy in 788. At this point Charles decided to attack the Avars (*q.v.*) who were occupying the plain of the middle Danube and whose constant harrying of the surrounding Slavic tribes made the latter uncertain neighbours for the Franks. He destroyed the Avar cavalry in a series of campaigns between 791 and 802–803, advancing into their territory as far as northern Croatia and establishing a defensive march in Carinthia, on the upper reaches of the rivers Drava and Sava. The archbishop of Salzburg was commissioned to evangelize all these outlying regions, to which Slavic or Germanic settlers returned.

Saxon Campaigns.—Charles also extended his kingdom toward the north and the northeast. A long struggle went on against the Saxons. These Germanic tribes, pagan and restless, had never respected any agreements made with the Franks by individual chieftains; their incessant raids and cattle thieving kept the whole Rhine valley in disorder. They also made impossible any effective consolidation of the missionary work that had been going on in that area since the mid-8th century. In reprisal for a Saxon raid on Hesse, Charles began a war of intimidation in 772. He destroyed one of their pagan shrines, of which the central feature, called the Irminsul, was an enormous tree trunk. Then, before withdrawing his army, he set up a military outpost in Saxon territory. At every opportunity, however, for instance while he was conquering Italy in 773 and when he was again south of the Alps in 776, the Saxons destroyed the strongholds that he was gradually establishing among them. They massacred the few converts to Christianity and any who favoured the Franks. After each rebellion Charles returned and reinforced his line of outposts, for he still thought it feasible to evangelize the Saxons without completely annexing their territory. Then, while Charles was in Spain in 778, a Saxon chief, Widukind, roused all the tribes once more, massacred all the Christian priests and laity and laid waste the right bank of the Rhine. This final outrage made complete conquest necessary. It proved a long, arduous and bloody enterprise. Charles, however, was determined to succeed and collected a great army; in 785 Widukind was obliged to yield and Saxony was subjected to a reign of terror designed to enforce conversion to Christianity on pain of death. Another rebellion in 793 showed how superficial the appearances of subjection had been; laws even more savage were imposed, and whole groups were deported. At last in 797 Charles came to an agreement with the Saxon chiefs and brought the conquered territories under the common law of his kingdom. Thus, common misdemeanours, or breaches of ecclesiastical discipline, became punishable by payment of a *bannum*, or fine, instead of carrying the death penalty. Yet further years of strife and of mass deportations were necessary before the most easterly tribes, those settled on the lower Elbe and close to Denmark, were satisfactorily tamed.

The Frisians, over whom the Franks had already to some extent established their dominion, were altogether subdued by about 790.

Northern Frontiers.—These conquests brought the Frankish armies into contact with new races, particularly with the Slavs beyond the Elbe; some tribes from among them were faithful allies of Charles. In Denmark the Vikings were already very restive and the number and force of their sea-borne raids fully justified the naval defenses established by Charles on the northwestern coasts of his kingdom early in the 9th century.

In the northwest, Charles never succeeded in exacting permanent recognition of his authority from the Bretons; he remained content to keep a sharp eye on their movements. To protect Neustria against them, he established a fortified march ruled by a count to whom he delegated exceptional authority.

Spanish Frontier.—Aquitaine and its southern adjuncts had long posed a serious problem to Frankish kings. Charles recognized the local tradition of autonomy, making his son Louis king of Aquitaine in 781. The revolts ceased, although a large number of *vassi* (military servants of the crown) had to be established there to maintain order. Farther to the southwest, however, the Basques, who controlled one of the routes into Muslim Spain, were constantly making trouble on the frontier of Gascony (Vasconia) or beyond the Pyrenees. Charles, assessing the danger to which the Franks were exposed, accepted the invitation of Muslim rebels to intervene in Spain, intending to establish a Frankish outpost beyond the mountains. His expedition, however, in 778, was halted outside Saragossa, and he was obliged to retreat. At a place identified in later legend with the pass of Roncesvalles the Basques attacked the rear guard of his army and many of his leading warriors were killed.

Thereafter the Basques and even the Gascons were only kept in a semblance of restraint by regular punitive expeditions. After a Muslim raid in 793, which reached as far as Narbonne, Charles decided again to intervene south of the Pyrenees. A series of campaigns from 796 to 811 won him a foothold in Catalonia, where he established his Spanish march. This provided asylum and land for all the Christian refugees from Muslim territory.

Church and Imperial Coronation.—Charles divided all his conquered lands into bishoprics, either restoring old sees or creating new ones for this purpose. He thus effected among the various populations a rapid if superficial conversion to Christianity. The northern Saxons and the Danes were to be evangelized from Bremen, the remaining Saxons, the Thuringians and the Slavs from Minden, Münster, Paderborn and Osnabrück, the eastern peoples from Salzburg, and the peoples of the Spanish march from Gerona.

As ruler of so vast a group of territories—one, moreover, on which he was seeking to impose unity by the profession of a common faith—Charles was indisputably the arbiter of the west. Furthermore, at the end of the 8th century, the church itself in western Europe looked for leadership to the Frankish king rather than to the pope. Continuing his father's policy of ecclesiastical reform, Charles had reintroduced the Gregorian chant and enforced throughout his dominions the use of the Roman liturgy and obedience to canon law. To the church council assembled by his order at Frankfurt in 794 came representatives from the entire Christian west, some even from Britain. At this council the Adoptionist heresy, begun in Spain by Elipandus, archbishop of Toledo, and professed by one of Charles's subjects, Felix, bishop of Urgel, was formally condemned. It also fell to Charles rather than to the pope to combat the theological innovations of the Byzantines; in his *Libri Carolini* (790–791) he argued strenuously against the Iconoclasts.

The presence in Italy of a Frankish ruler who had little regard for the subtle evasions of Eastern diplomacy seriously threatened Byzantine interests; and these interests were further prejudiced by Charles's special connection with the papacy. The pope was indeed dependent upon Charles; neither the Donation of Pepin nor Charles's promises of 774 would be implemented unless the Frankish king showed the will and had the capacity to conquer Ravenna, Istria, Venice, Spoleto and Benevento for the pope. Charles seemed in no hurry to undertake this task, and his two visits to Rome in 780 and 785 gave Adrian I no satisfaction. In fact, however, Charles was then alternately campaigning against, and negotiating with, the Byzantines, and his activities showed clearly that the Frankish *patricius* had supplanted the pope as arbiter of Italian politics. After Adrian's death (795), four years' confusion in Rome put the papacy even more in Charles's power. In 799 the new pope, Leo III, was accused by his enemies of grave misconduct and was attacked during a procession. Charles then required the pope to clear himself of the charges against him by a solemn oath sworn in a court over which the Frankish king presided. This took place in Dec. 800. Two days later, on Christmas day, 800, Leo placed a crown on Charles's head, and the people acclaimed the king as emperor. Historians disagree seriously no less about the details of the ceremony than about the behaviour, motives and subsequent feelings of the two leading participants. All that seems certain is that the idea was not altogether new; and it is indisputable that Charles's success and prestige in every field of his activity justified the revival of the imperial dignity in his favour.

It is conceivable that Charles's negotiations with the Byzantines had touched on this possibility. His relations with Constantinople had certainly been improving gradually since his annexation of Istria in 788 and they deteriorated again after his coronation. After the accession in 802 to the Byzantine throne of the vigorous emperor Nicephorus I, war broke out. The point at issue was control of Venetia and the Dalmatian coast. When the Franks had conquered Venetia (810), the Byzantines decided to come to terms and peace was agreed in 812. Charles restored Venetia in return for recognition of his imperial title. The pope's expectations thus came to nothing.

Administration of the Empire.—Charles's acquisition of the imperial title marked the transition in his reign from the period of great conquests to that of administrative reorganization and recapitulation. Up to that time, military operations had often forged and maintained a direct contact between the sovereign and his free-born subjects, but now these ties were inevitably loosened and local authorities had to be set up to transmit the emperor's decrees. This task was performed by counts and bishops. They were apprised of the emperor's wishes either by written directives sent to the annual assemblies or by verbal instructions given by the *missi dominici*, the royal officials who were constantly on circuit throughout the empire. The information that they gathered, together with the inventories of lands and movables compiled at Charles's order, provided the government with the essential documentation on the empire. To sustain the vigour and incorruptibility of such a system, however, required an expenditure of energy of which Charles became less and less capable after 810. An alternative method of ensuring that the imperial will was obeyed was to increase the number of links that bound freemen to their king in a relationship of immediate personal dependence; apart from changes in the formalities of homage, this was achieved by grants of land to provide a livelihood for the king's faithful servants. The basic personal ties created in this way were destined to transform society during the 9th century.

Carolingian Renaissance.—The clergy also had an important part to play in the imperial administration, and Charles's continuation of Pepin's work of ecclesiastical reform bore fruit in a generation of churchmen whose morals and whose education were of a higher standard than before. The possibility then arose of providing, for the brighter young clerics and perhaps also for a few laymen, a more advanced religious and academic training. It was perhaps to meet this modest need that a school grew up within the precincts of the emperor's palace at Aachen. In order to develop and staff other centres of culture and learning Charles imported considerable foreign talent. During the 8th century England had been the scene of much intellectual activity: Alcuin (*q.v.*) of York was commissioned to transplant to the continent the studies and disciplines of the Anglo-Saxon schools. Alcuin's many writings and letters made a solid contribution to contemporary learning; but their importance was probably outweighed by his vast educational work. From the school of calligraphy which Alcuin developed at Tours the use of a new script spread rapidly throughout the empire: this was the Carolingian miniscule, more legible and less wasteful of space than the scripts hitherto employed.

Christian refugees from Spain also contributed to this intellectual revival. Disputations with the Muslims had forced them to develop a dialectic skill in which they now instructed Charles's subjects. From Italy came grammarians and chroniclers, men such as Paulus Diaconus (*q.v.*); the formalist traditions in which they had been bred supplied the framework to discipline the effervescent brilliance of the Anglo-Saxons. Charles took a deep interest in all these intellectual pursuits. He also took care to make Aachen a worthy capital for his empire and encouraged projects for building new churches. Einhard, his biographer, who describes all Charles's enthusiasms, held, at any rate during the latter part of the reign, virtually the position of a minister of fine arts.

The "Carolingian Renaissance" which these diverse activities combined to produce was well established even in Charles's time; but its period of greatest brilliance came only after his death.

End of the Reign.—The emperor was an imposing figure, towering and powerful; he engaged with enthusiasm in all forms of sport, enjoyed good living and was not a man to deny himself his pleasures. His court was very far from being austere or puritanical: indeed, the scandals occasioned by his daughters' conduct are but the best-known among those which occurred there. In his latter years age and the toll taken by his past exertions, as well as by certain indulgences at which Einhard hints, began to weaken him. In 806 he decided to provide for the future of his empire and planned a division of territory between his sons, but after the death of his eldest son Charles of Franconia (811) partition was no longer necessary. Louis of Aquitaine (*see* LOUIS I the Pious) became the only possible heir, since Charles's bastard Drogo was a priest, while Bernard, son of Charles's second son Pepin of Italy (d. 810), was too young to exercise authority. Charles summoned Louis from Aquitaine in 813 and had him acclaimed emperor at Aachen, where there was no danger of pontifical interference.

The last few years of the reign were undistinguished. Many factions and coteries grew up and the court was rife with the sinister machinations of intriguers, such as Wala, cousin of the emperor and afterward abbot of Corbie. The conquests were over, the urge for reform played out; even the reins of government fell slack; scandal and intrigue alone held sway at court. Charles caught pneumonia and died at Aachen on Jan. 28, 814. His corpse was borne in a sarcophagus to the church that he had had built. It remained there undisturbed until its formal translation in 1165 on the occasion of Charles's canonization at the request of the emperor Frederick I Barbarossa by the antipope Paschal III. The decree of an antipope did not of course bind the church; nevertheless, the popular cult of Charlemagne was fairly widely observed in Germany and France during the middle ages; so that he is now regarded as having been informally beatified. His feast is kept at Aachen on Jan. 28.

Legend fastened on Charles as soon as he was dead. It helped to create an image that neither he nor his successors could match. His reign overshadowed the future, and most of the problems that his successors had to face were implicit in the legacy that he left them.

See also references under "Charlemagne" in the Index volume.

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CHARLEMAGNE LEGENDS. The stature and achievements of Charlemagne during his lifetime were such that almost before his death popular imagination had made of him a legendary figure. Stone, glass and parchment all contributed to the aggrandizement of his memory and it would be strange indeed if the spoken word did not play its role. The veneration of which he was the object in the churches of his capital city, Aachen, spread rapidly through the eastern half of his empire; already the *Gesta Karoli Magni* (*c.* 883), composed by Notker at St. Gall, appears to owe as much to popular anecdotes woven round the figure of the emperor as to his biographer Einhard, while by the end of the 12th century the *Vita sancti Karoli*, composed to substantiate the disputed canonization of 1165 and exploiting the corpus of treatises of which Charlemagne was already the subject, is conceived on purely hagiographic lines, even attributing miracles to him before and after his death. There is evidence that these ecclesiastical traditions had early spread into France. From these sources one sees the emergence of the figure of Charlemagne as the head of the re-created empire of the West, the champion of Christendom, the invincible warrior, the great political leader and dispenser of justice and even the martyr and saint.

In western Europe the earliest *chansons de geste* portray Charlemagne surrounded by his 12 peers (the number no doubt suggested by the apostles), a patriarchal figure with his flowing white beard, victoriously leading the Franks against the enemies threatening his frontiers, although his own deeds often pale in comparison with those of his barons. There runs through some of these poems a thread of historical verisimilitude: the *Chanson de Roland* (*see* ROLAND, CHANSON DE) is clearly based on Charlemagne's expedition into Spain in 778; the *Chanson des Saxons*, a poem composed by Jehan Bodel of Arras about 1200, but probably rewritten from a much earlier *Guiteclin*, narrates his struggles against the Saxons, albeit the poet is as much concerned with the amours of his principal characters as with the military prowesses of the emperor; the poems relating to Ogier the Dane (*q.v.*) are set against the background of Charlemagne's campaigns against Didier of Lombardy; and later *Fierabras* and the *Destruction de Rome* also relate of his deeds in Italy. Other epic poems were purely fictitious; thus the *Chanson d'Aspremont* (probably second half of the 12th century) leads Charlemagne in the company of a youthful Roland and in alliance with Girard de Fraite to the liberation of Rome from the Saracens and the conquest of Calabria, a theme which existed as early as the 10th century (for the Saxon poet Arnulf, elaborating on a statement of Einhard suggesting that the emperor had conquered the whole of Italy, refers to it, and his conquest of Calabria is specifically mentioned by Benoît du Mont-Soracte in his chronicle *c.* 968) and which may have owed its exploitation here in part to the campaigns of the Normans in Sicily from 1060 onward. Another theme exploited by the *chansons de geste* is that of the supposed pilgrimage of Charlemagne to Jerusalem, also of much earlier ecclesiastical origin and again referred to for the first time by Benoît du Mont-Soracte. This theme owes as much to Charlemagne's historical role against Islam in Spain and Italy as to references in the Carolingian annals to diplomatic relations between the emperor and the patriarch of Jerusalem and the caliph of Baghdad which were exaggerated and embellished to the point that 10th- and 11th-century annals portray the emperor in the Holy City. (A text composed at St. Denis about 1080–95, doubtless to give an aura of authenticity to the holy relics conserved there, shows him in the guise of a crusader liberating Jerusalem.) The 12th-century *Pèlerinage de Charlemagne*, described as a baroque epic, relates with a wealth of parodic material unexpected in so early a text various adventures, more appropriate to a lighter genre, of Charlemagne and his peers —Roland, Olivier, Guillaume d'Orange, Naimes of Bavaria, Ogier, Turpin and others. The object is to allow the emperor to demonstrate to his wife that he is without equal, and the whole is placed in the context of Charlemagne's pilgrimage to Constantinople and Jerusalem.

The cycle of poems of which the emperor is himself the principal hero is, for the most part, of more recent composition. *Berte aus grans piés*, surviving in a late 13th-century version by the Brabantine poet Adenet le Roi (*q.v.*), tells the tale of the betrayal of his father Pepin by intriguers who placed a false bride in his nuptial couch instead of the Hungarian princess Berta, so that Berta spends long years in poverty and suffering, wandering in the forests; through the intervention of her mother the impostress is denounced and the true queen, who is to be the mother of Charlemagne, is eventually discovered. In *Mainet*, a no less fictitious narrative shows Charlemagne being brought up at a Saracen court to which he had been escorted to enable him to escape from the traitors who had poisoned his parents and were plotting his own death, the traitors Rainfroi and Heldri being the sons of those who had betrayed Pepin. A related poem, *Basin*, of which, however, no French version survives, told how Charlemagne, this time a grown man, foils the plot of Rainfroi and Heldri to kill him on the occasion of his coronation. These fictions, which have no vestige of historical veracity, at least exemplify how purely folklore themes, *e.g.*, the substituted bride, came to attach themselves to the figure of the emperor, already rich with legend; in the same way, the presence of Rainfroi and Heldri suggests that to some extent the events concerning Charles Martel, the emperor's grandfather, had come to be associated with Charlemagne, for these are clearly the Ragenfrid and Chilperic who plotted against Charles Martel.

No less apocryphal poems deal with the wars of Charlemagne against his rebellious vassals; *Les Quatre Fils Aymon*, set mainly in Wallonia, is like *Huon de Bordeaux* wholly fictitious, although perhaps, again, echoing faintly events of the reign of Charles Martel (*see* RENAUD DE MONTAUBAN; HUON DE BORDEAUX). Although the emperor does not figure in *Girart de Roussillon*, the poets having placed the long and complex narrative in the reign of Charles Martel (once mysteriously referred to as Charles the Bald), the historical *Girard de Viane* was a contemporary of Charlemagne. Other themes relating to the emperor are those developed in the 13th-century poems of which later derivatives exist in *Macaire* and *La Reine Sebile*, which recount the intrigues of Macaire against Charlemagne's wife Blanchefleur and the ensuing war between the emperor and his son Louis (*see* MACAIRE).

To this category also belong *La Chevalerie Ogier* and *Les Enfances Ogier*, concerned with Ogier the Dane.

It would serve no purpose to enumerate all the *chansons de geste* that feature Charlemagne; later poems elaborate on the themes of earlier ones. Thus in the probably late 12th-century *Otinel*, the eponymic hero, a converted Muslim, accompanies Charlemagne and Roland in an expedition into northern Italy; the *Anseïs de Carthage* (*c.* 1200), which perhaps reproduces an earlier poem, supposes that Marsile had escaped from the vengeance of Charlemagne after the battle of Roncesvalles and—in a narrative that combines themes of romance with those of the epic—a young Breton knight, armed with the emperor's own sword, wages war against Marsile but is victorious only with the aid of Charlemagne, now so aged and feeble that he has to be transported on a litter. *Gui de Bourgogne* (13th century) is also set in Spain, but this time during the 27 years that Charlemagne is supposed to have spent there before Roncesvalles, and now it is the youthful Gui who succours the emperor. A century later, the Franco-Italian *Entrée en Espagne* and *Prise de Pampelune* constitute a prologue to the *Roland*. These later poems, clearly inspired by their predecessors, testify to the continued vitality and popularity of the themes they exploit round the person of Charlemagne.

The purely clerical traditions frequently welcomed accretions from more popular sources; for example, the *Pseudo-Turpin*, a recension of the story of Roland, uncompromisingly exploits the *Roland* and was itself to serve as a model for Girard d'Amiens' dreary *Roman de Charlemagne* (*c.* 1300) and was also used *c.* 1232 by Aubri des Trois-Fontaines, who combined Einhard, the *Pseudo-Turpin*, William of Malmesbury and a variety of data from the *chansons de geste*. Through the medium of the Old French epic poems much of the Carolingian legend was propagated throughout Europe. In Italy the link of the Franco-Italian versions of the legend was early established and Andrea da Barberino wrote his *Reali di Francia c.* 1400. In Spain, apart from the *Roncesvalles*, the *Fuga del rey Marsín* and the *Nota Emilianense*, Rodrigo of Toledo referred to incidents of *Mainet* in his *Chronica Hispaniae* (*c.* 1284), as did the *Primera Crónica General;* these, with the 14th-century *Gran Conquista de Ultramar*, which gives a different account of *Mainet*, prepared the way of Lope de Vega's *Los Palacios de Galiana*. As early as the 12th century German ecclesiastical treatises incorporated material from the *chansons de geste;* the Bavarian Konrad wrote his *Ruolantes Liet* (*c.* 1170?), but even earlier (*c.* 1150) another Bavarian poet had composed a *Kaiserchronik* in which approximately 800 lines were devoted to Charlemagne and include a reference to his wife Berthe. There is also in the *Kaiserchronik* another theme, which had apparently originated in France: that of the emperor's unconfessed sin, first mentioned in the 10th-century *Vita sancti Aegidii* and later identified as his incestuous union with his sister, of which, according to some forms of the legend, Roland was the fruit. The *Vita sancti Karoli* clearly exploits the *Pseudo-Turpin* and early in the 13th century the poet known as the Stricker adapted the *Ruolantes Liet* and introduced into his *Karl* the theme of the substituted bride and that of Charlemagne's early years spent at a Saracen court. For the scholar, however, the Old Norse *Karlamagnussaga*, composed about 1230–50 on the initiative of Haakon IV of Norway, surpasses in importance these later derivatives, for the *Saga* appears to have used as its source versions of the Old French poems earlier than those that have survived. The Normans brought the poems to England and with the decay of Norman-French many were adapted in the 14th and 15th centuries into a series of metrical romances in English.

In France itself the Carolingian legends remained popular until recent times; many of them were rendered into prose in the course of the 14th and 15th centuries, under such titles as *La Conqueste que fit le grand roi Charlemaigne es Espaignes*—the source of Caxton's *Lyf of Charles the Grete* (1485). Many adaptations continued to be published in the "Bibliothèque des romans" and the "Bibliothèque bleue" in which form they still found readers until 19th- and 20th-century scholarship made the originals available.

But the great emperor has more humble claims to the perpetuity of the legends surrounding him, such as the tale of his conception in a cart, to be explained by nothing more sophisticated than a pun on the name of Char-le-magne ("the cart of the *Magne*, the great one"), which also seems to have some bearing on the "Charles's Wain" in the night sky (*i.e.*, the Plough or Dipper; for another view, *see* URSA MAJOR).

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For the *Pseudo-Turpin*, *see* the edition by C. Meredith Jones, *Historia Karoli Magni et Rotholandi* (1936). (D. McMI.)

CHARLEMONT, JAMES CAULFEILD, 1ST EARL OF (1728–1799), Irish statesman, is chiefly notable for his political connection with Henry Flood and Henry Grattan in the patriot movement during the reign of George III (*see* IRELAND: *History*). He was born in Dublin on Aug. 18, 1728, the son of the 3rd viscount Charlemont whom he succeeded in 1734. For various early services in Ireland he was made an earl in 1763, but he disregarded court favours and cordially joined Grattan in 1780 in the assertion of Irish independence, being chosen commander in chief of the volunteer force. He was president of the volunteer convention in Dublin in Nov. 1783 and was a strong opponent of proposals for the union. Charlemont was keenly interested in literature and the arts. He was the first president of the Royal Irish Academy, and on the grounds of his house at Marino on the shores of Dublin bay he erected the celebrated Casino from the designs of Sir William Chambers. He died on Aug. 4, 1799.

See M. J. Craig, *The Volunteer Earl* (1948). (R. B. McD.)

CHARLEROI, a town in the province of Hainaut, Belg., lies on the north bank of the Sambre, about 30 mi. S. of Brussels. Pop. (1955): commune only, 26,078; including suburbs, 458,213. Charleroi was founded in 1666 by the marquess de Castel Rodrigo, the Spanish governor-general of the Low Countries, who named it after his sovereign Charles II of Spain. In the following year Charleroi was occupied by the French, who fortified it with six bastions, and subsequently it came under the domination of Spain, France, Austria and Holland and was besieged many times. The fortifications were finally dismantled between 1868 and 1871.

In the 18th century Charleroi's industries included coal mines, iron foundries, glass works, tobacco factories and woolen mills, and the products were exported via Brussels. During the 19th century there was great expansion when the Sambre was canalized and quays, factories, railways, roads and houses were built outside the town. It thus became the centre of a vast Industrial region called *le pays noir* ("the black country").

The church of St. Christopher, begun in 1667, was entirely rebuilt during 1956–57, and the church of St. Anthony of Padua (1837) is an example of the neoclassic style. The town hall, inaugurated in 1936, is the most striking of the modern buildings; from its belfry the annual September procession of the Walloon festival proceeds. In the Palais des Expositions (1954) industrial exhibitions are held, and the Palais des Beaux-Arts, opened in Oct. 1957, contains a conference hall, lecture hall, exhibition room, dance hall, etc. Charleroi has an *université du travail* (business college) and a medical and surgical institute. The town is easily accessible by road, rail, water and air. It is connected by an electric railway with Brussels and Antwerp and by canal with

Brussels and the Scheldt. The airport is at Gosselies, about 4 mi. N. of the town.

CHARLES I THE GREAT: *see* CHARLEMAGNE.

CHARLES II THE BALD (823–877), king of France (*i.e.*, Francia Occidentalis, the West Frankish kingdom) from 843 to 877 and Western (Holy Roman) emperor from 875 to 877, was the son of the emperor Louis I the Pious by his second wife Judith. His birth in 823 disrupted the arrangements made in 817 for the succession. His half-brothers resented the prospect of Charles's receiving a share of their father's territory, and civil war ensued. Finally, however, he got the support of his half-brother Louis the German (842) and, under the treaty of Verdun (843) received all the lands west of a line roughly following the Scheldt, the Meuse, the Saône, the eastern mountains of the Massif Central and the lower reaches of the Rhône.

Until 864 Charles's position remained precarious. The counts had grown overmighty during the civil wars; but the young king meant to be obeyed and took advantage of a rebellion to behead two of the more notoriously insubordinate among them. The Bretons moreover had thrown off allegiance to the Carolingians and pressed eastward and Charles needed all his ingenuity to prevent their alliance with the Norman Vikings who attacked his long defenseless coast line almost every year after 844. The Viking menace helped Charles to solve one other problem, however: by defending the people of Aquitaine against a Viking raid, he detached them from their allegiance to Pepin II, son and successor of the Pepin (d. 838) who had been made king of Aquitaine by his father Louis the Pious. Yet Charles himself was obliged to recognize Aquitanian separatism when he made his own son Charles king there in 855. From 856, however, Charles had to face an even more serious crisis. A fresh revolt of the magnates, impatient of subjection, coincided with a Norman attack of unprecedented strength, by which the raiders gained possession of the lower Seine valley. Occupied in dislodging them, Charles was betrayed by many of his counts and attacked by Louis the German, who invaded his territory intending to depose and supplant him (858). Only the loyalty of the clergy and of a few counts saved Charles, and his authority was in some measure restored; but revolts, in which his son was now involved, continued in Aquitaine, and the Bretons remained dangerous. Furthermore, in order effectively to repel the Normans, Charles had to concede undue powers to local military leaders whose co-operation he needed.

Nevertheless after 864 Charles's power was fully established, and the great capitularies which he then issued imposed order and uniformity throughout his kingdom. His close collaboration with the church served to enhance his prestige and authority; the clergy, on their side, profited from his firm rule to revive some of the splendours of the Carolingian renaissance. During the years 850–880 many manuscripts were copied and illuminated, there was more building, schools were reconstituted and controversy bore witness to a renewed study of theology. The fame of Charles, acute and able sovereign of this civilized kingdom, spread throughout the west.

His capacity to profit from almost any situation brought Charles some questionable but rich prizes. When his nephew Lothair II of Lotharingia (Greater Lorraine) died in 869, Charles annexed that kingdom, but was eventually obliged to divide it with Louis the German (treaty of Mersen, 870). When his nephew the emperor Louis II died in 875, Charles not only took the kingdom of Provence but hastened to Rome and, on Christmas day 875, was crowned emperor by Pope John VIII, who preferred him to the rival claimants to the imperial dignity. Next, in Feb. 876, he was crowned king of Italy at Pavia. At the death of Louis the German (Aug. 876) Charles attempted to annex his kingdom, aspiring to recreate the empire of Charlemagne. In this, however, he failed.

To pursue his ultimate ambitions, Charles had had to make new concessions to the magnates. On his death, at Brides-les-Bains, on Oct. 6, 877, on his way back to France from Italy, he left to his son Louis II le Bègue a kingdom in which the royal authority was still insecure.

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(J. DE.)

CHARLES III THE FAT (839–888), Frankish king and emperor, was the youngest son of Louis the German and great-grandson of Charlemagne. He was the king of Swabia from 876, and in 879, on the resignation of his sick brother Carloman (d. 880), he took over the kingdom of Italy. He was crowned emperor by Pope John VIII in 881. By succeeding to Saxony on the death of his brother Louis the Younger (882) Charles became king of all the East Franks. Then, on the deaths of the West Frankish kings Louis III (882) and Carloman (884), Charles reunited under his rule the whole empire of Charlemagne with the exception of Burgundy, where the usurper Boso had set up a kingdom for himself. Because of illness (apparently epilepsy), Charles was listless in his duties and disappointed the hopes that he would effectively oppose the enemies of the kingdom and of Christendom. In spite of repeated expeditions to Italy, he failed to help the pope against the Saracens and the dukes of Spoleto. He led armies against the Vikings in the Netherlands (881) and when they were besieging Paris (886), but on both occasions bought off the invaders. His incompetence provoked a rising of the East Frankish magnates, and their leader Arnulf (*q.v.*), Charles's nephew, took over the government (Frankfurt, Nov. 887). Charles did not resist and died the following year at Neidingen on the Danube near Constance. His fall marked the final disintegration of the empire of Charlemagne. There is an edition of Charles's administrative documents by P. Kehr in the series *Monumenta Germaniae historica, Diplomata Regum Germaniae . . . Karolinorum*, vol. ii (1937).

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(T. SCH.)

CHARLES IV (1316–1378), Holy Roman emperor and king of Bohemia, the eldest son of John of Luxembourg, king of Bohemia, and Elizabeth, sister of the Premyslid Wenceslas III, was born at Prague on May 14, 1316, and first received the name of Wenceslas. In 1323 he went to the court of his uncle Charles IV of France, where he was given the name of Charles and where, in 1324, he married Blanche, sister of Philip VI. In 1330 he visited Luxembourg, and in 1331 he went to Italy, as his father's regent there. Returning to Prague in 1333, he was created margrave of Moravia by his father. Three years later he undertook the government of Tirol on behalf of his brother John Henry and became involved with the Wittelsbach family in a struggle for its possession. Charles's former teacher, Pope Clement VI, and those German princes who were opposed to the emperor Louis IV secured the election of Charles as German king at Rense on July 11, 1346. His alliance with the papacy earned him the nickname of "the priests' king" (*Pfaffenkönig*). In Aug. 1346 he fought at Crécy, where his father was killed. Now king of Bohemia, Charles returned to Germany and, after being crowned German king at Bonn on Nov. 26, 1346, prepared to attack Louis. In Oct. 1347, however, Louis died. Günther of Schwarzburg, nominated as Louis's successor by the Wittelsbachs, was defeated by Charles in Jan. 1349.

In 1350 Charles was visited at Prague by Cola di Rienzo (*q.v.*), then "tribune" of Rome, who urged him to go to Italy, where the poet Petrarch and the citizens of Florence also implored his presence. Charles, however, held Rienzo prisoner for a year and then handed him over to Clement at Avignon. Four years later, Charles crossed the Alps, but without an army. He received the Lombard crown at Milan on Jan. 6, 1355, and was crowned emperor at Rome by Cardinal Peter of Ostia on April 5, entering and leaving the city the same day. In 1356 Charles promulgated the Golden Bull (*q.v.*), whose primary object was to regulate imperial elections.

Charles was unremitting in his efforts to secure other territories and to strengthen the Bohemian monarchy. To this end he purchased part of the Upper Palatinate in 1355, and in 1367 annexed Lower Lusatia to the Bohemian crown. He made succession treaties with the Wittelsbach and Habsburg families, the first fruits of which were the inheritance of Brandenburg by Charles's son Wenceslas in 1373. The acquisition by his third marriage to Anna of Swidnica (d. 1362) of the duchies of Swidnica and Jawor (1368) completed the annexation of Silesia to the Bohemian crown. The powerful territorial complex of the Luxembourg house, however, was weakened by Charles himself. In 1377 he partitioned his territories: his first son, Wenceslas, received Bohemia, Silesia and Luxembourg; his second son, Sigismund, received Brandenburg; the youngest, John Henry, was enfeoffed with the duchy of Görlitz; and Moravia was divided between Charles's nephews Jobst and Prokop.

In 1365 Charles visited Pope Urban V at Avignon and undertook to escort him to Rome. Then, on June 4, he was crowned king of Burgundy. During his later years the emperor took little part in German affairs but was able, by skilful diplomacy between pope and electors, to secure the election of his son Wenceslas as king of the Romans in 1376. He also negotiated a peace between the Swabian league and the house of Württemberg in 1378.

Charles had based his power on his rich Bohemian kingdom, which prospered under him. Prague was his imperial capital; there he established the Charles university in 1348, built the Charles bridge and the new district (*nove mesto*). He imported French and German architects to complete the cathedral church of St. Vitus and to build castles modeled on French châteaux, for instance, that at Karlstejn. As margrave of Moravia, Charles had gained ecclesiastical autonomy for Bohemia with the creation of Prague as an archbishopric (1344), and in the Golden Bull he asserted and confirmed the autonomy of Bohemia as a kingdom. He was fluent in Latin, French, German, Czech and Italian and was a patron of letters; he entertained Petrarch in Prague and by his invitation of Konrad of Waldhauser to Prague may be said to have initiated the Bohemian movement for church reform. Charles died at Prague on Nov. 29, 1378.

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CHARLES V (1500–1558), Holy Roman emperor from 1519 to 1556, also king of Spain as Charles I from 1516, the last emperor to pursue the medieval ideal of universal empire and the last to be crowned by the pope, was born at Ghent on Feb. 24, 1500, the son of Philip the Fair of Habsburg (d. 1506) and Joan of Castile.

Youth and Character.—After the early death of his father in 1506 Charles was brought up at Mechelen at the court of his aunt Margaret, the regent in the Habsburg Netherlands. Life at her court was much as it had been with Charles the Bold, duke of Burgundy (d. 1477), under whom the culture of the former Burgundian court had shown a last burst of brilliance.

Charles V's outlook shows traits typical of the Burgundian chivalric ideal which he maintained throughout his life. French was the language of the Burgundian court and became for Charles the most natural form of expression, while his knowledge of German always remained scanty. Having grown up in surroundings where difference of nationality had no meaning, he was eminently suited, unlike his predecessors, to become the ruler of a world-wide empire. Two men particularly influenced the young Charles: his tutor the theologian Adrian of Utrecht, an outstanding representative of the *devotio moderna* (a religious movement widespread in the northern Low Countries); and his guardian, the strongly francophile Burgundian noble Guillaume de Croy, sieur de Chièvres.

The religious intensity of the *devotio moderna* made a deep impression on the young prince, who developed a simple but unshakable religious faith that stood him in good stead in the numerous crises of his reign. Charles firmly believed that his own and the empire's fate depended not on himself but on God. He always held it to be one of his most vital tasks to defend Christendom against its enemies and to preserve church unity from the divisive danger of Luther's preaching. This serious religious attitude did not imply any desire to avoid secular problems. It expressed itself, too, in the relatively blameless conduct of his personal life. Unlike many of his royal contemporaries, he largely refrained from extramarital relations. His liaison with Johanna van der Gheenst, the mother of Margaret of Austria (1522), occurred five years before Charles's marriage to the infanta Isabella of Portugal in 1526, and his fleeting affair with the Regensburg patrician's daughter Barbara Blomberg, the mother of Don John of Austria, happened seven years after Isabella's death in 1539.

Charles seems never to have been truly young. Many of his contemporaries have left observations on him, commenting for example on his measured deportment and his strong awareness of the respect due to him—though admittedly this characteristic may have largely resulted from the stiff and pompous ceremonial of the former Burgundian court. Indeed, the splendours of this ceremonial so pleased Charles that he later introduced it into the Spanish court. Although he early displayed strong self-confidence, he nevertheless allowed his advisers to influence him extensively even after he had taken up the government of his various territories. He did not develop a completely independent policy until the death of the chancellor, Mercurino Gattinara, when Charles was 30. Charles never overestimated his fair though not outstanding intellectual faculties; a most remarkable trait was his great circumspection; sometimes, indeed, he took a very long time to make important decisions. This may have resulted not only from extreme conscientiousness but also from a certain intellectual rigidity.

Political History of the Reign.—For Charles V, politics and religious politics formed an indivisible unity. Not only was he faced, as emperor, by the reforming movement in Germany, but, as king in Spain he inherited the traditional struggle of the Spanish kings with Islam.

Only at the very beginning of his career was Charles free from such problems, when in 1515 he came of age as duke of Burgundy. On Jan. 23, 1516, Ferdinand of Aragon, Charles's maternal grandfather, died. As a result, the problem of the succession in Spain became acute, since by the terms of Ferdinand's will Charles was to govern in Aragon and Castile only in the name of his mother, the mentally deranged Joan of Castile. Furthermore, the will provided that Cardinal Jiménes de Cisneros, archbishop of Toledo and one of Ferdinand and Isabella's most influential advisers, should direct the administration in Castile. The Spanish opponents of Ferdinand who had fled to Brussels succeeded in having the will set aside, however, and on March 14, 1516, Charles was proclaimed king in Brussels as Charles I of Aragon and Castile.

The young ruler, still strongly under the influence of his guardian, the francophile Chièvres, was eager for an early settlement of the Franco-Spanish dispute in Italy and, in the treaty of Noyon (Aug. 13, 1516), accepted terms that were, in fact, unfavourable to Spain. Not until Sept. 8, 1517, did Charles set out for Spain, landing on the coast of Asturias on Sept. 19; because of delays he missed a personal meeting with the regent, Jiménes, who died on Nov. 8, 1517. Charles did not manage affairs happily at the beginning of his rule in Spain. He brought in his train a number of Netherlandish nobles on whom he bestowed offices and clerical benefices, thus offending the Spaniards, who were further provoked by the frequently arrogant deportment of the foreigners. Besides, Charles's slight knowledge of Castilian Spanish made a bad impression when he appeared before the Castilian *Cortes* in Santiago in 1520. Having been elected German king in succession to his grandfather Maximilian I on June 28, 1519, he left Spain for Germany immediately after receiving a grant from the Castilian *Cortes* convened at Corunna. The Spanish nobility, hidalgos and towns had no sympathy with Charles's imperial aims, and this, together with the perpetual friction between the Spanish and Flemish nobility, stirred up a ferment which broke out into dangerous revolt soon after the king had left Spain. The risings of the Comuneros and the Germanía were suppressed only with the greatest difficulty by Adrian of Utrecht (now bishop of Tortosa), whom Charles had left as regent.

Thus, when Charles arrived in Germany for his coronation, which took place at Aachen on Oct. 23, 1520, he was already troubled with serious problems; and he was to find an equally complex situation awaiting him. The reforming movement begun by Luther had now reached such proportions that Aleandro, the papal nuncio, believed that the papal cause was almost lost. The emperor, however, showed himself determined to crush the reformers and believed that the edict published on May 26, 1521, at the *Reichstag* of Worms, would achieve this. The edict laid the ban of the empire on Luther and his followers and forbade the printing and spreading of Lutheran literature; but to no avail. Charles now delegated the further settlement of the Lutheran problem to his brother Ferdinand, whom he constituted as his representative in the empire, giving him, in 1522, the Habsburg lands within the empire as a hereditary possession. While Charles did maintain a keen interest in religious development in Germany after the edict of Worms, the empire's relations with France and the papacy engrossed his attention until the diet of Augsburg in 1530.

In Italy, the duchy of Milan was the centre of contention between France and Spain. After the battle of Marignano in 1515 the family of Sforza had had to surrender Milan to the French, whose position in the duchy was recognized by the treaty of Noyon (1516). The treaty had, however, provided no real solution to the problem, and Duke Francesco Sforza, seeking to regain his family's territories, gained the support of Pope Leo X and even of Charles V, who now felt it his duty to restore the duchy to its imperial allegiance. His conviction was strengthened by Mercurino Gattinara (chancellor since Oct. 16, 1518), a Piedmontese by birth, whose influence was decisive in reorienting Charles's foreign policy from the francophile direction it had taken under the influence of Chièvres. On May 28, 1521, Charles and Pope Leo signed a treaty whose aim was the restoration of Sforza. The treaty also ended the suspicions that had arisen between pope and emperor when Leo tried to prevent Charles's election in 1519. At the end of 1521 Henry VIII of England joined this alliance, but he hesitated for three years before actively entering the war against France. The war began at a time when it was imperative for the European powers to present a united front against the Turkish threat. The attacks of Sultan Suleiman were becoming critically serious, Belgrade fell in Aug. 1521 and Rhodes in 1522. In Jan. 1522 Adrian of Utrecht became pope as Adrian VI. In vain he exerted all his powers to persuade Charles V and Francis I of France to conclude an early peace; the war continued until at the battle of Pavia on Feb. 24, 1525, the French king was taken prisoner.

In the peace negotiations that followed, Charles himself ruined the chances of a genuine settlement, as he believed that he could now force Francis to restore the duchy of Burgundy. At the peace of Madrid (Jan. 14, 1526) Francis pledged himself to make the restoration, and the emperor, in the chivalrous spirit of the old Burgundian court, trusted the French king's word of honour. He was quickly disillusioned, for Francis, as soon as he was free, did his utmost to sabotage the terms of the treaty. Nor did he have difficulty in finding willing allies. The new pope, Clement VII, was strongly anti-Habsburg and, on May 22, 1526, together with Francis I, founded the League of Cognac. Clement VII's active anti-imperial policy immediately increased Charles V's difficulties in Germany, where the work of his brother Ferdinand to restrain the reforming movement was greatly hindered: up to this time even harmonious co-operation between the pope and emperor had failed to arrest its expansion.

Just as, at the battle of Pavia, Francis I had unexpectedly fallen into the emperor's hands, so now the pope came into Charles's power. The imperial army in Italy, in arrears of its pay, marched on Rome of its own accord, sacked the city in May 1527 and took the pope virtually prisoner. This heavily compromised Charles's position, since this affront to the pope ran dead against his ideal of a joint universal monarchy of pope and emperor. When, however, Charles released Clement without attempting to secure a guarantee that ecclesiastical reform would be undertaken or a general council convened, the situation in Germany became yet more favourable to the reformers and the war in Italy continued. Only by temporarily abandoning his plans for a council did Charles achieve a reconciliation with the pope, and this was followed, on Aug. 5, 1529, by peace with the French king. Charles surrendered his claims on Burgundy and Francis renounced his claims on Milan and Naples, but neither party was satisfied with this compromise agreement. The treaty between Charles and Clement, had, however, smoothed the way toward the emperor's coronation by the pope at Bologna on Feb. 24, 1530. Charles, for whom the papal coronation was of great importance, had, until this time, styled himself "Roman emperor elect."

From Bologna the emperor went to Augsburg, where a diet had been convened to debate the religious question. Charles was by no means intransigent on this issue and hoped that it could be resolved peacefully. However, both the *Confessio Augustana* (*see* AUGSBURG CONFESSION) and the *Apologia* produced in its defense were unacceptable to him. When negotiations failed, however, Charles did not at once resort to war to enforce conformity on the Protestant estates. The siege of Vienna by the Turks (1529) had shown that the threat to Europe from the east was too great for Charles to allow the German situation to deteriorate into war. He was obliged to give provisional recognition to the Augsburg Confession and indeed right up to 1544 he was driven to compromise on the religious issue in order to buy the support of the Protestant princes and cities, which from 1531 were organized, for military and political purposes, in the Schmalkaldic league.

In 1532, faced again with a Turkish threat to the hereditary Habsburg lands, Charles granted a religious truce to the adherents of the Augsburg Confession. In exchange for further religious concessions, he received armed support (*Türkenhilfe*) powerful enough to resist the invaders though not sufficient to make any forceful counterattack. Soon after his return to Spain in 1533, however, Charles prepared a counteroffensive against the Turks in the Mediterranean.

In 1529 the conquest of Algiers by the corsair Barbarossa (*q.v.*) had made the struggle against the infidel of vital importance for the coastal populations of Spain and the western Mediterranean. When in Aug. 1534 Barbarossa, now Turkish admiral, captured Tunis, thus considerably extending the basis of his power, the emperor decided to reconquer the port. The successful expedition of 1535 gave Charles his first personal experience of warfare. Tunis was taken, but Charles missed the full measure of victory since Barbarossa evaded capture.

From Africa, Charles traveled via Sicily and Naples to Rome to realize his urgent wish for a general council to reform and reunite the church. To this the new pope, Paul III, was far more favourably disposed than Clement VII. The second essential condition for a council, however, was a reconciliation between the two greatest Catholic rulers, Charles and the French king; but this had already become impossible by the time that Paul promulgated the council. While the emperor was in Rome, Francis attacked the duchy of Savoy to reconquer Milan, though he had renounced it in 1529. On April 17, 1536, a few days after the French troops had entered Turin, Charles proposed, in the presence of the pope, the college of cardinals and the ambassadors of France and Venice, that he and the king of France should settle their dispute in personal combat. The winner should receive the duchies of Burgundy and Milan as his indisputable possessions and should be given command of a crusade against the Turks.

This manifestation of Burgundian chivalry did not have the results that Charles desired. He therefore decided to launch a campaign against France to prevent what seemed to him a dangerous drift in power. He first attacked Provence, hoping thereby to compel the French to withdraw in Italy; but the enterprise failed. Had Charles confined himself to clearing the French from Savoy, his action might have been justified as an attempt to restore the peace of 1529; but when he attacked French territory even before Francis had moved against Milan, he himself invited the charge of aggression. Thus political blunder was heightened by strategic failure. It was only after Charles, together with Ferdinand, had signed an alliance against the Turks with the pope and Venice, that Francis, who had long tended toward a *rapprochement* with the Turks, showed any willingness to negotiate. At Nice, in May 1538, Charles V, Francis I and Pope Paul met to discuss terms of peace. The agreement, however, left all the major issues between the Valois and Habsburgs unresolved and merely established a ten-year truce. Immediately after the congress Charles attended further discussions with Francis in Aigues-Mortes. He left this friendly encounter thinking himself now free at last to settle, once and for all, the German religious question and to launch a forceful drive against the Turks; but soon he saw he had misjudged again.

Charles had claims on the inheritance to the duchy of Gelderland and was determined to make them good, as the acquisition of this valuable duchy would round off the Habsburg territories in the Netherlands. In 1538, however, the estates of Gelderland elected William V, duke of the neighbouring Cleves, as the successor to Duke Charles; and when, in 1540, the duke of Cleves married a French princess the situation in Gelderland threatened new international complications. Francis I now seemed likely actively to oppose Habsburg territorial expansion on the lower Rhine. In 1541 the Turks made new advances, conquering the greater part of Hungary. In face of this danger, Charles, despite the failure of discussions between Catholics and Protestants in 1540–41, again extended the provisional toleration of the Augsburg Confession. Charles attacked in the Mediterranean. In 1541 he led an expedition against Algiers, but had to abandon the campaign when autumnal storms wrecked his supply fleet.

After this disaster Charles returned to Spain. By this time tension between the emperor and the French king had grown to the point of imminent war. In 1540 Charles had enfeoffed his son Philip with the duchy of Milan and thus disappointed Francis' expectations that a French collateral line would be established there. Francis had allied himself with the duke of Cleves and with Christian III of Denmark and was preparing campaigns against Navarre and the Netherlands. In the summer of 1542 war finally broke out. The regent of the Netherlands, the emperor's sister Maria, now found herself wedged between Denmark and Cleves. Because of her diplomacy Henry VIII of England concluded an alliance with Charles at the beginning of 1543, but only in the spring did Charles himself decide to leave Spain for Gelderland. In the directive he left to his son Philip, the provisional regent in Spain, Charles wrote that he regarded the Gelderland operation of all his ventures to date as the most dangerous to his life, reputation and resources.

In 1544 the duke of Cleves was expelled from Gelderland, but the international situation was not much improved. The king of France was now in open alliance with the Turks, and in 1542 the combined French and Turkish fleets had taken the town, though not the fortress, of Nice. Charles himself had earlier attempted to negotiate with Muslim Persia. For him the infidels proper were the Turks, now allied with the "most Christian king." Nevertheless the Franco-Turkish alliance, which was not generally approved even in France, made the princes of the empire more willing to assist Charles against the French. After the Danes had detached themselves from the French alliance (treaty of Speyer, 1544), Charles led a strong army into France from the east, intending to march on Paris. Though the campaign did not reach its goal, the French king was ready to come to terms. By the treaties of Crépy-en-Laonnois (Sept. 1544) Francis surrendered the first French settlements in Canada. Besides, he had to promise to send delegates to the oft-postponed general council and to give the emperor armed support should the Protestant estates of the empire refuse to attend; finally Francis was to equip a powerful army for the intended major offensive against the Turks.

At last Charles seemed to be set for his two grand designs, the restoring of church unity and the repulse of the Turkish menace—the more so since he was willing to make concessions to France. By the terms of Crépy he confirmed the renunciation of his claims on Burgundy and further agreed that Charles, duc d'Orléans (the youngest son of Francis I), was to marry either his niece the archduchess Anna with Milan as her dowry, or his daughter Maria, in which case the couple should become joint rulers of the Netherlands after Charles's death. Charles worked toward the fulfillment of these important decisions up to the end of 1544. He was criticized by two major parties at the Spanish court: the one regarded Milan as the foremost hindrance to peace, and wanted to see it surrendered; the other, true to traditional Aragonese policy, saw in Italy the master key to Europe and wished to surrender the supposedly valueless Netherlands. Economically and strategically Italy and the Netherlands were roughly equal in importance within Charles's universal empire; he decided to surrender Milan. In 1545, however, the duc d'Orléans died. His death nullified Charles's decision on Milan and revived the prospect of further conflict between Habsburg and Valois.

Before any new crisis developed, however, Charles took measures against the German Protestants who had refused to attend the council opened at Trent on Dec. 13, 1545. In 1541 Charles had already won over the Protestant princes Philip of Hesse and Joachim II of Brandenburg. Besides, the stanch Catholicism of William IV of Bavaria helped to heal the traditional antagonism between the Habsburgs and Wittelsbachs. An alliance between the emperor and the pope completed the diplomatic negotiations for the coming conflict with the Schmalkaldic league. Charles began hostilities early in July 1546. Although early in 1547 the pope withdrew his troops, Charles routed the league's army at Mühlberg on April 24, the Protestant elector of Saxony, John Frederick, being taken prisoner. The battle was the occasion for Titian's famous equestrian portrait in which, at his own request, the emperor was portrayed in the armour that he had worn at Mühlberg.

But victory soon was tarnished: in March the council decided to adjourn to Bologna in the papal states, where the emperor had no influence. There it was at first prorogued and then, in Sept. 1549, suspended by Pope Paul III, having completed only part of its work. At the very moment when Charles's ecclesiastical policy seemed within sight of success the necessary understanding between pope and emperor suffered another break. In June 1548, at the diet of Augsburg, the emperor dictated a provisional religious ordinance for the empire, the so-called Augsburg Interim. Charles did not, even now, abandon his hopes of church unity, but most of the Protestant princes assented to the Interim only with inner reservations; at some points, such as Magdeburg, armed resistance to the emperor continued.

It was, however, not merely the emperor's religious policy that caused anxiety: Protestant and Catholic princes alike were perturbed by Charles's plans for an imperial reform that aimed at enhancing the monarch's power in Germany. "German freedom"—the relative independence of princes of whatever religion—seemed to be in danger of falling under "Spanish servitude." Linked with these fears was a strong opposition to Charles's attempts to have his son Philip elected his successor in the empire. This attempt to maintain imperial unity shows that even as late as 1550 Charles had not identified himself with the particular interests of his Spanish subjects but retained his idea of universal empire and conducted a policy transcending local concerns.

During 1551 the German opposition grew into an alliance with Henry II of France. In this way the conflict which had for so long dominated the politics of western Christendom reappeared in all its former ferocity. The emperor had received full warning of the storm that was brewing against him since 1551; but, as so often in similar situations, he did not seriously believe that his opponents would dare to march against him. In March 1552 he finally appreciated the true dimensions of the danger, but it was too late to prepare adequate defenses. He was driven from Innsbruck and only found some sort of refuge at Villach in Carinthia. Meanwhile French troops captured the town and fortress of Metz and pushed on to the Rhine.

These disasters did not indeed destroy Charles's faith in his grand political conception, but his sense of honour was utterly humiliated. Physically he was broken, being racked by gout. From now on his thoughts turned increasingly toward abdication.

In autumn 1552, after he had been compelled to yield further weighty concessions to the Protestant princes at the treaty of Passau, he left Austria intent on the reconquest of Metz. This campaign too fell short of his aims and early in 1553 he abandoned the hopeless siege. He now handed over all responsibility for German affairs to his brother Ferdinand and devoted the rest of his energies to negotiating the second marriage of his son Philip to Mary of England. In this he followed his long-established practice of marrying his numerous relations where there seemed to be most hope of furthering his grand political design. The conclusion of the marriage in 1554 gave great happiness to Charles, after a string of serious failures. Even when Philip remained king of England in name only it nevertheless appeared to Charles to offer a guarantee that the incipient revival of English Catholicism would proceed more rapidly and thoroughly than if Mary had been restricted to her English connections. Mary's marriage, however, remained childless. She died on Nov. 17, 1558, but Charles did not live to see England's return to Protestantism under Elizabeth I.

From 1554 at the latest, Charles's decision to resign the government of his various lands was firm; nevertheless, since Henry II of France had successfully resumed his predecessor's Italian policy, Charles could not responsibly envisage immediate abdication. Even though the position of the imperial army in Italy had improved, the political situation swung badly against Charles when, in summer 1555, Giampietro Carafa, a bitter enemy of Spain, became pope as Paul IV. However, the emperor no longer felt able further to postpone his resignation. At Brussels on Oct. 25, 1555, he handed his power in the Netherlands over to his son Philip, an occasion marked by all the pomp of the former Burgundian court. There followed, on Jan. 16, 1556, Charles's abdication in favour of Philip in Spain, the Italian lands and the colonies; and on Sept. 12, he renounced the imperial title in favour of his brother Ferdinand.

Early in 1557 Charles took up residence near the Hieronymite monastery of San Yuste in Spain. In no way a recluse, he followed the development of events with lively interest and often acted as adviser to Philip II on important decisions. He died on Sept. 21, 1558, shortly before completing his 59th year.

Problem of Finance.—Knowledge of the material conditions under which Charles worked is of comparatively recent acquisition, and much work on Charles's finance, for want of sifted sources, remains at best provisional and hypothetical. Former information was only fragmentary, dealing for example with the financing of his election as emperor in 1519. Mainly because of the great merchant banker Jakob Fugger, Charles was able to bribe the electors more heavily than his rival, the king of France; this turned the scale in his favour but saddled him with a debt of about 800,000 florins.

Charles V, like all early 16th-century rulers, relied on credit to wage his wars. Because of the contemporary methods of war, military disputes were liable to extend over many years, and the regular sources of revenue could not meet the costs. Charles was in fact favourably placed for raising credit since two of the most important money markets of the time, Antwerp and Augsburg, were within his domains. Genoa, of similar importance as a financial centre, was not an ally of the Habsburgs until the late 1520s. The commercial centres were not of course at the sole disposition of the emperor, but he could always count on receiving preferential treatment there.

The vast majority of Charles's debts were in the form of short-term bonds; *i.e.*, letters of exchange which sometimes expired at the end of the quarter and seldom fell due later than a year after the date of issue. At times of severe financial need the emperor therefore had to conduct ceaseless negotiations to gain the funds to cancel his current letters of exchange. When for any reason this hand-to-mouth system broke down and the mercenary army could not be paid, there was an immediate danger that it would disperse, even when strategy might dictate that it must be ready for action. The short-term credits which provided Charles with most of his funds were issued at interest rates usurious by modern standards. The annual rate was never less than 12%, and with skill Charles's creditors could expect a return of 45% a year on their capital. In 1516 the emperor's fluctuating debts at Antwerp alone amounted to about 200,000 livres and in 1556 they had risen to 7,000,000 livres (at 40 Flemish groschen the livre). Less than 5% of his debts at Antwerp were consolidated at the end of his reign, that is on a long-term or permanent basis at relatively low interest (mostly 6.25%); and since all loans had to be guaranteed, Charles was continually mortgaging future taxation, or had to use the gold and silver armadas from America to satisfy his creditors. In fact the precious metals from America did not begin to play an important part in the imperial finances until the early 1550s, when the rich silver mines of Potosí were first systematically exploited. But even this new source of revenue was not sufficient to stabilize the precarious finances of Charles's later years, though he was still able to raise credit right up to his abdication. He experienced only the beginning of that period of total financial exhaustion which compelled his son Philip II to conclude in 1559 the treaty of Cateau-Cambrésis with an equally exhausted France.

World of Politics: Idea and Reality.—When, in 1519, Charles was elected emperor, more than 250 years had passed since the reign of Frederick II, the last great emperor. In this period the political structure of Europe had been radically changed, particularly by the rise of France. Already in the late middle ages French apologists had asserted that the king was equal to and independent of the emperor, at times even claiming that the kingship had a more ancient origin. In 1519 the French king Francis I stood as a rival candidate in the imperial election. The idea that the empire was the highest of secular authorities in Christendom and must maintain the peace, uphold law and protect the church had survived as a living ideal even when, with Maximilian I, it was in sharp conflict with the realities.

The source of Charles's concept of empire has been subject to much debate. The German scholars Karl Brandi and Peter Rassow agree that Charles's aim was to revive the medieval empire, while the Spaniard R. Menéndez Pidal regards Charles's political outlook as directly in the Spanish tradition of the "Catholic kings" Ferdinand and Isabella. Yet the Spanish historian J. Vicens Vives argues convincingly that Charles's political theories derived from various sources, above all from Erasmian humanism with its ideal of the *universitas christiana.* Vicens Vives' theory allows that Charles's ideas were influenced though not fully reoriented by the political traditions of Castile. When Hernán Cortés, the conqueror of Mexico, offered Charles an imperial title which the conquistador regarded as equal to the German, his offer was refused.

The substance of Charles's imperial theory has also been disputed. The question at issue is whether he regarded the empire simply as the highest-ranking secular authority in western Christendom, or whether he wished to build up a *monarchia mundi* in which he himself should stand as the undisputed lord above all other rulers. Many of his contemporaries believed that he did wish to set up such a universal monarchy. The grand chancellor Mercurino Gattinara, Charles's most influential adviser between 1519 and 1530, tried to convince the emperor that he must not merely maintain his empire but also extend it. However, it is doubtful whether the emperor accepted these views. Then and later he repeatedly declared that he had no intention of conquest nor, above all, any desire to provoke war within Christendom. Nevertheless, of his reign of almost 40 years, about half was spent in war; besides Charles vigorously pursued his claims on the duchy of Burgundy. It may seem difficult to reconcile these two facts either with Charles's protestations of peaceful intentions or with his disclaimers of conquest.

On a less superficial view of the period, however, these contradictions are resolved, if not fully, in such a way as to leave the sincerity of the emperor beyond dispute. He regarded the duchy of Burgundy as a constituent part of the Burgundian inheritance that had come to him from his grandfather Maximilian I, and looked on the French royal house, which had held the territory since 1482, as intruders. The duchy of Milan, the other main point of contention between him and France, he claimed as a part of the empire. Charles regarded war on these issues as just, in accordance with the medieval conception of the *bellum justum.* Again the first war against the German Protestants was in his eyes the ultimate instrument for restoring the unity of the church after his attempts at a peaceful solution to the problem had failed. In his second war in Germany (1552) he was, beyond all doubt, the victim of aggression. When the Protestant princes tried to rob him of the fruits of his victory of 1546–47 he had no choice but force, since he was committed to the restoration of the unity of the Catholic Church and faith with all the means at his disposal.

In retrospect one might think that Charles's universal policy and his attempt to realize his imperial idea were from the outset doomed to founder on the obstacles of European politics. Yet his power was more broadly based than that of any medieval emperor, embracing as it did gigantic and always growing territories in the new world. The sum of his resources, however, proved inadequate to discharge that massive undertaking that Charles regarded as his mission. The problems produced by his universal policy grew much beyond his financial means, and financial weakness was a main cause of that gap between aim and achievement reflected in his many compromise solutions.

Charles's political career in Europe was a series of compromises and failures, leaving his main goals unrealized. However, whereas the medieval ideal of empire had been centred on Europe, Charles applied it, beyond the confines of Europe, in the new lands discovered by the great explorers. Though he could not contain the Reformation in Europe, his rule gave scope to Catholic missions in the new world. As Spanish culture gained ground outside Europe, so the overseas parts of Charles's empire took on some significance in European affairs. Charles's reign marks one of the most important phases of European expansion, which led to the complex interdependencies observable in modern world politics.

See also references under "Charles V" in the Index volume.

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CHARLES VI (1685–1740), Holy Roman emperor from 1711, was born in Vienna on Oct. 1, 1685, the second son of the emperor Leopold I and his third wife Eleonora of Neuburg. When, on the death of Charles II in 1700, the Spanish branch of the house of Habsburg became extinct, Leopold proposed his son Charles as candidate for the Spanish succession. England, the United Provinces and finally Portugal recognized the candidature and in Vienna, in Sept. 1703, Charles was proclaimed king of Spain as Charles III in opposition to Philip V, grandson of Louis XIV of France (*see* SPANISH SUCCESSION, WAR OF THE). Traveling through Germany, the United Provinces and England, Charles arrived at Lisbon in March 1704 and thence crossed into Spain. He remained in Spain until 1711, mostly in Catalonia, where the Habsburg party was strong. At Barcelona, in 1708, he was married to Elizabeth Christina of Brunswick-Wolfenbüttel (1691–1750), a Lutheran princess who accepted Roman Catholicism. He entered Madrid in 1706 and 1710, but on both occasions he had to retire to Catalonia. On the death of his elder brother Joseph I on April 17, 1711, Charles inherited the possessions of the Austrian Habsburgs. He left Spain with great reluctance in Sept. 1711 and was elected emperor on Oct. 12, 1711, and crowned at Frankfurt on Dec. 22, 1711. His wife remained at Barcelona as regent, to uphold his claims, under the protection of the able general Guido von Starhemberg, but the refusal of the European powers to tolerate the reconstruction of the empire of Charles V led to the treaty of Utrecht (April 11, 1713) between Charles's former allies and France, by which the allies recognized Philip V as king of Spain. Charles continued at war with France but had to submit to necessity and at the peace of Rastatt (March 1714) renounced his claims on the Spanish throne, receiving as compensation the Spanish Netherlands, Milan, Sardinia, Naples and parts of Tuscany. These lands were governed from Vienna by a Spanish council (*Consejo de España*), composed mainly of Charles's Spanish partisans, who were very influential with him. Nevertheless, Charles withheld his recognition of Philip V as king of Spain.

His experience in Spain had made Charles aware of the importance of maritime trade. He raised Trieste to the position of a major seaport, linking it by road to Vienna, and in 1722 he set up the Ostend company (*q.v.*) to develop trade with the East Indies. The company was successful but provoked protests from its English and Dutch rivals, so that in 1731 Charles agreed to its closure. From 1733 to 1735 the empire was engaged in the unsuccessful War of the Polish Succession, which brought the loss of Naples and Sicily. By the disastrous peace of Belgrade concluded with the Turks in 1739, the empire lost nearly everything that had been gained by the treaty of Passarowitz, which had followed the successful war of 1716–18.

Charles's ruling preoccupation, however, was to secure his inheritance against dismemberment. In 1713, being still childless, he had begun to prepare a "pragmatic sanction" intended to regulate the succession. In 1716, a son, Leopold, was born, but he died the same year, and in 1721–22, after the birth of two daughters, Maria Theresa (1717) and Maria Anna (1718), Charles laid before the estates of the empire the famous pragmatic sanction (*q.v.*) settling the entire inheritance in the first instance on his eldest daughter. In 1724 a third daughter, Maria Amalia, was born to him, and Charles's main political aim was to gain European recognition for the dispositions he had made.

Charles died at Vienna on Oct. 20, 1740. Despite his precautions his heiress had to face years of war before her position was established. (*See* AUSTRIAN SUCCESSION, WAR OF THE.)

Charles, like his father and brother, composed music and devoted much of his time to it. He also showed a special interest in architecture. In the Klosterneuburg at Vienna, known as the Austrian Escorial, he gave architectural expression to that "Spanish dream" which he never forgot.

See also references under "Charles VI" in the Index volume.

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CHARLES VII (1697–1745), Holy Roman emperor, known also as Charles Albert, elector of Bavaria, was born on Aug. 6, 1697, the son of the elector Maximilian II Emmanuel. During the War of the Spanish Succession, Bavaria was occupied by the Austrians and, in 1706, Charles Albert and his brother Clement, later archbishop of Cologne, were carried prisoners to Vienna. When his father was restored to his electorate after the war, Charles Albert was released, and in 1717 he led the Bavarian contingent of the imperial army which served under Prince Eugene of Savoy against the Turks. In 1722 he married Maria Amelia, the younger of the two daughters of the emperor Joseph I. Her uncle, the reigning emperor Charles VI, insisted that the Bavarian house should recognize the pragmatic sanction that established his daughter Maria Theresa as heiress of the Habsburg dominions. They did so, but with secret protests and mental reservations of their rights to the Habsburg lands, based on the will of the emperor Ferdinand I.

Charles Albert succeeded his father as elector on Feb. 26, 1726. His policy was to maintain good relations with the emperor while evading his obligation to accept the pragmatic sanction and intriguing to secure French support for his claims by marriage to the imperial throne. These claims were advanced immediately after the death of Charles VI (Oct. 20, 1740), and Charles Albert now entered into the league against Maria Theresa. He was elected emperor in opposition to her husband Francis, grand duke of Tuscany, on Jan. 24, 1742, under the title of Charles VII, and was crowned at Frankfurt am Main on Feb. 12. But even while he was being crowned Bavaria was being overrun by Austrian troops. During the War of the Austrian Succession Charles VII was a mere puppet in the hands of the anti-Austrian coalition, and although he was able to re-enter his capital, Munich, in 1743, he had immediately afterward to take flight again. He was restored by Frederick the Great of Prussia in Oct. 1744, but died at Munich on Jan. 20, 1745.

See P. T. Heigel, *Der österreichische Erbfolgestreit und die Kaiserwahl Karls VII.* (1877); F. Wagner, *Kaiser Karl VII. und die grossen Mächte, 1740–1745* (1938).

CHARLES I (1887–1922), emperor of Austria and, as Charles IV, king of Hungary, was born at Persenbeug castle, Lower Austria, on Aug. 17, 1887, the eldest son of the archduke Otto and grandnephew of the emperor Francis Joseph. In 1911 he married the princess Zita of Bourbon-Parma. With the assassination of the archduke Francis Ferdinand on June 28, 1914, Charles became heir presumptive to the throne, since Francis Ferdinand's children were excluded from the succession by virtue of his morganatic marriage. In World War I Charles held military commands in Italy, Galicia and Rumania. On Nov. 21, 1916, he succeeded Francis Joseph as emperor of Austria. Charles's political judgment was sound, but he was slow to act. A compromise with the Czechs, planned at the beginning of his reign, was constantly postponed. In Aug. 1918 autonomy was promised to the various nationalities under the dual monarchy, but it was already too late; moreover, the exclusion of Hungary from the settlement made this, too, a half measure. Also, in July 1917, a generous political amnesty had been declared, but this merely accentuated domestic troubles. Nor did the assumption of the military high command by Charles himself increase confidence in the leadership of the army.

Charles had, however, a realistic appreciation of the international situation and worked toward peace. Besides the official peace resolutions passed in Dec. 1916 and March 1917, secret proposals were made to France and Great Britain through Prince Sixtus of Bourbon-Parma, a brother of the empress Zita. These remained fruitless since Charles could not persuade Germany to surrender Alsace-Lorraine and Belgium, nor would he surrender his own territorial claims in Italy. Charles's reputation in Austria suffered badly when, in April 1918, the French prime minister Clemenceau revealed the Sixtus negotiations. After the collapse of the Austro-Hungarian forces, Charles on Nov. 11, 1918, renounced all participation in affairs of state but made no formal abdication. He left Austria in March 1919 and was deposed by the Austrian parliament in April. In spring 1921 he made two attempts from Switzerland to gain a foothold in Hungary; after their failure he was banished from Hungary. He then went to Madeira at the end of Oct. 1921 and died there on April 1, 1922.

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CHARLES I and **II**, kings of France: *see* Charlemagne; Charles II the Bald. The alternative system of enumeration whereby Charles the Bald is reckoned as Charles I of France and the emperor Charles III (*q.v.*) the Fat as Charles II of France is less common. *See* also Carolingians.

CHARLES III the Simple (879–929), king of France, a member of the Carolingian dynasty, was born on Sept. 17, 879, the posthumous son of Louis II le Bègue by his second wife, Adelaide. In 887, on the deposition of the emperor Charles III the Fat, who had taken possession of the West Frankish kingdom in 885, the boy Charles had an obvious claim to the kingdom as the only surviving grandson of Charles II the Bald, but in view of the need for a strong military leader, the magnates gave the throne instead to Eudes (*q.v.*), son of Robert the Strong, who was not a member of the Carolingian family. Eudes began his reign auspiciously, but his later military defeats swung opinion in favour of Charles, who was crowned by Fulk, archbishop of Reims, in Jan. 893. For five years he was constantly on the move, attempting to enlist support. After the death of Eudes in 898 he was recognized as king by all the magnates; but he saw that he would forfeit his throne if he interfered unduly in their affairs. He at last gained a chance to act decisively in 911, when the death of Louis the Child, the last Carolingian ruler in Germany, raised the question of the succession to his territories. Anxious to acquire a powerful principality in the east of his kingdom, he decided to establish himself in Lorraine. To free his troops for this purpose, he gave formal recognition to Viking occupation of Normandy (treaty of St. Clair-sur-Epte, *c.* 911).

Charles's preoccupation with Lorraine and his consequent prolonged absences from Neustria encouraged the magnates there to revolt, and in 922 they elected a new king, Robert I, the brother of Eudes. Charles killed Robert in battle in 923, but was subsequently taken prisoner. His wife Eadgifu and his son Louis (afterward Louis IV) took refuge in England with his father-in-law, king Edward the Elder. Meanwhile the magnates elected another king, namely Robert I's brother Rudolph (Raoul). Charles never succeeded in regaining power and died in prison at Péronne on Oct. 7, 929. He was the first Carolingian ruler of Francia Occidentalis to lose his crown.

See A. Eckel, *Charles le Simple* (1899). (J. De.)

CHARLES IV le Bel or the Fair (1294–1328), king of France from 1322 to 1328, was the third and youngest son of Philip IV. He received La Marche from his father as an appanage in 1311 (it was raised to the rank of peerage in 1316). When his brother Philip V died in the night of Jan. 2–3, 1322, leaving one daughter and a widow with child (another daughter), Charles acted on the precedent established by Philip in 1316 and took the crown without difficulty, leaving to his two nieces only their mother's dowry, the county of Burgundy.

The most important fact of his reign was the renewal of war with England. In 1323 Charles ordered the building of a bastide at St. Sardos, a small village of Agenais. Whereas Agenais was held by the English, St. Sardos itself depended on the abbot of Sarlat, in Périgord, who was a direct tenant of the French king and had concluded a treaty with Charles giving him joint rights over St. Sardos. The seneschal of Guienne and Gascony, however, to assert his English master's rights, stormed St. Sardos and hanged a number of Charles's officers. Edward II of England, whom Charles had summoned to do him homage for Guienne, Gascony and Ponthieu by July 1, 1324, failed to give satisfaction. Charles therefore pronounced the confiscation of these fiefs, and a French army occupied all Guienne and Gascony, except Bordeaux, Bayonne and St. Sever. In March 1325 Edward sent his wife Isabella (Charles's sister) to Paris to negotiate; and, as Edward did not wish to go to France to do homage, she obtained (Sept. 1325) that the fiefs should go to her son Edward, who would do homage. Charles, however, claimed to keep Agenais and La Réole, and Edward II rejected the arrangement. The fiefs were again confiscated, and the overthrow of Edward II prevented any English resistance. On March 31, 1327, Isabella, now regent of England, signed a treaty by which her son had to renounce Agenais and Bazadais in order to recover the remainder of the fiefs.

To pay for the war, Charles had to put civil offices up for auction, to increase duties on trade and to make the salaries of the magistrates dependent on the exaction of heavy fines.

On the pretext of a crusade to free Armenia from the Turks, Charles obtained from the pope a tithe levied on the clergy, which he kept for his own use. As his predecessors had done, he confiscated the property of the Lombard bankers. He summoned a number of assemblies to obtain support for these measures and to try again to reform the coinage, but they were held only locally, in *bailliages* and *sénéchaussées*. In 1326 he was satisfied with a meeting of prelates and barons in Meaux, which accepted the principle of a subsidy for the war.

Charles died at Vincennes on Feb. 1, 1328. He had been married three times, first to Blanche of Burgundy, who in May 1314 was convicted of adultery, then to Mary of Luxembourg (d. 1324) and thirdly to Joan of Évreux. He left one daughter by Mary; and his widow was with child.

See R. Fawtier, *L'Europe occidentale de 1270 à 1328* (1940); J. Viard (ed.), *Journaux du trésor de Charles IV le Bel* (1917). (F. Ct.)

CHARLES V LE SAGE OR THE WISE (1338–1380), king of France from 1364 to 1380, was born at Vincennes on Jan. 21, 1338, the eldest son of the duc de Normandie, later John II of France, and Bona of Luxembourg, daughter of King John of Bohemia. By the cession of Dauphiné to him by Humbert II of Viennois in 1349 Charles became the first heir apparent to the French crown to bear the title of dauphin. On April 8, 1350, he was married to his cousin Jeanne de Bourbon. John II in 1355 gave him the task of convening the estates of Normandy to raise subsidies to defend that province against the English (*see* HUNDRED YEARS' WAR), with whom Charles II the Bad, king of Navarre, was then in alliance; and on Dec. 7 the duchy of Normandy was conferred on Charles, who took formal possession of it at Rouen on Jan. 10, 1356. By the end of June 1356, however, the English were advancing from Guienne, and in September Charles took part in the battle of Poitiers (*q.v.*), in which John II was taken prisoner.

King's Lieutenant and Regent, 1356–64.—Charles left the battlefield in haste (perhaps on his father's orders) and reached Paris ten days later (Sept. 29) with the title of king's lieutenant. Promptly convening the estates-general to raise the money for the king's ransom, he found himself faced with demands that went so far as to require the dismissal of John's councilors and their replacement by 28 nominees of the estates. This was the first time that the sovereign's absolute right to choose his councilors was contested and that the estates claimed to take a direct part in the royal government in this way. Charles tried to escape from the influence of the estates by going to Metz to greet his uncle the Holy Roman emperor Charles IV (Dec. 22, 1356), but when the estates met again in 1357 they repeated their demands and brought such pressure to bear, through the provost of the Paris merchants, Étienne Marcel (*q.v.*), and the bishop of Laon, Robert le Coq, that Charles had to yield. He issued a great ordinance of reform on March 3, 1357, and complied with the king of Navarre's demands in December.

Charles was determined, however, to put a stop to the revolutionary moves of Étienne Marcel, who had made him take the title of regent in order to show that he could do what he liked with the monarchy. Two of Charles's marshals, Jean de Conflans and Robert de Clermont, were murdered before his eyes in his palace in Feb. 1358. By March 27, Charles had already left Paris. Summoning the estates to Compiègne, he won assurances of loyalty from them and on Aug. 2 re-entered Paris in triumph. With him then were three men who were to be his best advisers after he became king: Jean and Guillaume de Dormans, later chancellors; and Pierre d'Orgemont, later president of the Paris *parlement*.

Order was restored in the kingdom's internal affairs, but Charles failed when he tried, in 1359, to resist the proposals for a treaty drafted by Edward III of England and John II in London. On his return to France, John signed the treaty of Brétigny (Oct. 2, 1360), then felt himself bound to go back to London, leaving Charles as regent again. John's death, on April 8, 1364, made Charles king of France.

Character of the Reign.—Of delicate constitution but quick-witted, Charles was to govern France as king in the same way as he had governed as dauphin—by avoiding conflict and by relying on persuasion (he was a good speaker) if not on practices that often came near to trickery. That was why contemporaries—including Christine de Pisan, author of the best sketch of him—called him "the Wise" (*le Sage*). This name, however, alluded also to other qualities of his, gentleness, generosity, chastity and a devoutness in religion that yet left a place for tolerance (for instance when he intervened in favour of the Jews in 1359 and to restrain inquisitorial activities in Languedoc in 1372). Furthermore, Charles had the strongest feeling for the greatness of the monarchy and for the supreme dignity conferred on the sovereign by his consecration as king. He desired, therefore, to live in splendour. Extant inventories show what rich treasures he had at the Hôtel de St. Pol in Paris, at Vincennes and at Melun. He had begun to build the Hôtel de St. Pol, which was to be his favourite seat, in 1361, since the old palace on the Île de la Cité was not only so crowded with government offices as to be unrecognizable as a king's residence but also was defiled for him by the memory of the murders of 1358. Moreover, he commissioned the architect Robert du Temple to turn the stronghold and arsenal of the Louvre into a more cheerful palace with a façade of sculptures and a great spiral stairway rising from its inner courtyard. He also gave Paris a wider circuit of walls, with the Bastille, begun in 1370, to guard its eastern approaches. At Vincennes the donjon and the Sainte Chapelle, which he completed, can still be seen.

Charles liked the society of men of learning and collected books, forming the first royal library of France on three floors of a tower in the Louvre (he had additional books in his other residences). Some of the manuscripts, which his valet Gilles Malet catalogued, are now in the Bibliothèque Nationale. Together with ancient classical literature, ethical treaties, liturgical books and compilations of laws, Charles had scientific works on astronomy, surgery and natural history. Especially noteworthy, however, are the works dedicated to him personally by men of his own chosen circle, scientists and philosophers, since the truly distinguishing feature of his government was his determination to act according to a carefully constructed system of principles to which he would adhere because he had approved them and because his inclination was always to govern from the study. Thus he asked Nicole Oresme to translate Aristotle for him and Raoul de Presles to translate St. Augustine's *De civitate Dei* and prompted the composition (*c.* 1375) of the *Somnium viridarii* ("Dream of the Orchard"). This last work, which was forthwith translated into French as *Le Songe du vergier,* formerly was attributed to Philippe de Mézières. It consists of a dialogue between a clerk and a knight, in which they discuss the great problems of the government of the kingdom and, in addition, the question of the French king's relations with the Holy Roman emperor. The emperor at this moment was still the king's uncle, Charles IV. At the latter's state visit to Paris (Jan. 4, 1378), on the occasion of a pilgrimage to St. Denis, Charles gave him a magnificent reception but took good care to do nothing that might imply recognition of the emperor as superior to the king of France.

Political Achievement.—The emperor's visit is rightly regarded as expressing his admiration of his nephew's achievement in restoring the kingdom to which he had succeeded. Charles had entrusted the conduct of military affairs to Bertrand du Guesclin (*q.v.*), whom he was to make constable of France in 1370. Having defeated Charles of Navarre's forces at Cocherel in May 1364, Du Guesclin had been less fortunate at Auray in the following September (in the War of the Breton Succession), but he succeeded in ridding France of the "great companies" of vagrant mercenaries by leading them away to Spain. Charles subsequently consolidated the defense of the country by his great ordinance of Jan. 1374, which organized the recruiting system, the administration and the command of troops and established a permanent army for France. The admiral Jean de Vienne was instructed to build up a new fleet at Le Clos des Galées, near Rouen.

In his internal policy, Charles was concerned to extend the royal domain and to ensure its integrity: he introduced an oath into the coronation ceremony promising not to alienate any part of it and restricted the grants in appanage made to his brothers. He decided that the king of France should come of age on entering his 14th year. For the nomination of the chancellor of France, he relied on the council's choice. In financial matters, he introduced notable changes, in accordance with Nicole Oresme's theories on the lawfulness of the impost and its necessary permanence coupled with the indispensable stability of the coinage. The estates-general of 1355 and those of 1356–57 had already set up a special administration of their own for the subsidies that they voted under the general description of *aides;* and the estates of 1363 had added a direct *fouage* ("hearth tax"), without establishing how long it was to be levied. Between 1372 and 1379 the new tax-collecting agents, from being *élus des états,* were turned into royal officials, *élus de par le roi,* controlled by nine "general superintendents."

Thus, although the troubles of the times contributed to it, the transformation that the French monarchy underwent in the 24 years from 1356 was in a very large part due to Charles V's direct influence on the men and on the institutions of his time, both during his regency and in the 16 years of his reign.

Last Years.—The last crisis of the reign affected the whole church rather than the French kingdom. Charles, however, played an important part in it. He sent one of his most intimate advisers, the cardinal Jean de la Grange, bishop of Amiens, to Rome and associated himself with him in recognizing the antipope Clement VII (Robert of Geneva, elected on Sept. 20, 1378, in opposition to Urban VI). Charles must thus bear much of the blame for the great schism of the papacy. On the very day of his death, at Beauté-sur-Marne on Sept. 16, 1380, he declared himself still sure that Clement was "the true Shepherd of the Church."

The statue of Charles now in the Louvre in Paris originally stood in from the doorway of the church (no longer existing) of the convent of the Celestines, the foundation stone of which he laid in 1374. This statue and that of Jeanne de Bourbon, Charles's consort, are among the earliest masterpieces of the "realistic" style of sculpture in France. The recumbent figure of Charles among the tombs of the French kings at St. Denis was commissioned by him from the master-sculptor André Beauneveu.

See also references under "Charles V" in the Index volume.

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CHARLES VI le Fou or the Mad (1368–1422), king of France from 1380, was born in Paris on Dec. 3, 1368, the son of Charles V and Jeanne de Bourbon. Foreseeing that at his death an heir who was still a minor would encounter serious difficulties, his father in 1374 issued three ordinances to settle the question of his succession: the king was to come of age on entering his 14th year; till then, a regency was to be exercised by Louis of Anjou (the eldest of Charles V's brothers); and the guardianship of the young king was to be entrusted to the queen, assisted by Philip the Bold, duke of Burgundy, and her brother Louis II, duc de Bourbon. However, Jeanne de Bourbon died two years before Charles V, and when Charles VI succeeded to the throne on his father's death (Sept. 16, 1380) dissension broke out. Having dismissed Charles V's counselors, whom public opinion held responsible for oppressive taxation, the uncles of Charles VI decided that he should be crowned without delay and that they would share among themselves the powers of a sovereign who was still too young to rule effectively. Crowned at Reims on Nov. 4, 1380, Charles made his solemn entry into Paris on Nov. 11. His uncles completed their plans for the administration of the country with the ordinance of Jan. 28, 1381, which created a supreme council of 12 with Louis of Anjou at its head.

Following a year during which taxes had not been collected (after Charles V's decision at the end of his life to abolish the *fouage* or hearth tax), the inevitable resumption of the levying of *aides* led to insurrections in several towns (notably that of the Maillotins in Paris and of the Harelle in Rouen). On his departure for Italy to claim the kingdom of Naples (spring 1382), Louis of Anjou left the conduct of affairs in France to his brother Philip the Bold of Burgundy. Having negotiated a compromise with the Maillotins and taken Charles to Rouen to crush the Harelle, Philip next led Charles to the help of Louis of Male, count of Flanders, Philip the Bold's father-in-law, against the revolt led by Philip van Artevelde. On Nov. 27, 1382, the Flemish rebels were crushed in the battle of Roosebeke. Strengthened by this success, Charles returned to Paris on Jan. 11, 1383, to put an end to renewed agitation there by suppressing the provostship of the merchants and executing the leaders of the bourgeoisie, who had fomented the disorders. Having himself succeeded to the countship of Flanders in Jan. 1384, Philip the Bold then set about consolidating his position there in the face of constant English intervention and involved Charles in his policy. As German alliances were necessary for this, Charles was married, on July 17, 1385, to Isabella (*q.v.*) of Bavaria, daughter of Stephen, duke of Bavaria-Ingolstadt. It was Philip also who, by playing on his taste for knightly exploits, induced Charles to lead an expedition against William, duke of Gelderland, in Aug. 1388, in support of Jeanne of Brabant, the aunt of Philip's wife. Charles, however, made an early peace with William and returned to France. On Oct. 28 he arrived at Reims, where he had summoned his council.

At a meeting held at the archbishop's palace on Nov. 2, 1388, Charles, who was nearly 20 and found the guardianship of his uncles irksome, announced amid general approval that henceforth he alone would conduct the affairs of the kingdom. After trying in vain to persuade him to reverse his decision, his uncles withdrew, leaving the effective administration of the kingdom in the hands of the former officials of Charles V, known derisively as the "Marmousets" because of their humble origin.

The first concern of the king and his counselors was to reorganize the machinery of government and to reform certain institutions, and a start was made with the promulgation of several ordinances during the early months of 1389. In the following winter Charles visited Languedoc to put an end to the financial extortions of the duc de Berry (Jean de France) and, on his way through Avignon, discussed with the antipope Clement VII a plan for an expedition to install Clement in Rome and to facilitate the establishment of French princes in both northern and southern Italy. Informed of these discussions, Richard II of England, who was favourably disposed toward the Roman pope, Boniface IX, proposed the resumption of negotiations between France and England. These occupied the whole of 1391 and caused the postponement of the Italian venture.

At the beginning of April 1392, during talks at Amiens with the dukes of Lancaster and York about the possibility of ending the war with England, Charles fell ill for the first time with a kind of fever which produced convulsions. It is probable that his precarious mental stability had been finally undermined by the constant round of pleasures which his courtiers provided for him. Next, on June 13, in Paris, Pierre de Craon, cousin of John IV (Jean de Montfort), attempted to assassinate the constable of France, Olivier de Clisson. When Craon took refuge in Brittany, Charles insisted on setting out on a punitive expedition in July, though his brother Louis, duc d'Orléans, and his uncles tried to dissuade him. Another attack of fever compelled him to halt at Le Mans, but he resumed his journey on Aug. 4, a hot day. Next day, the sudden appearance in the middle of the forest of a man dressed in white who flung himself at the head of the king's horse brought on a violent fit of madness, and Charles was carried back to Paris in a litter.

With the effective disappearance of royal authority, there now began a long contest between the houses of Burgundy and Orléans. Philip of Burgundy promptly resumed control of the royal administration, leaving the task of keeping the king amused to the duc d'Orléans. On Jan. 28, 1393, during his first period of recovery, Charles nearly lost his life in a foolhardy masquerade (subsequently known as the "Bal des Ardents") in which four of his companions were burned to death. His feeble brain gave way completely, and henceforth he alternated between delirium and lucidity. In all there were 44 attacks of madness lasting from three to nine months, separated by intervals of sanity lasting from three to five months. In his madness Charles would tear his clothes, smash furniture and plates, fail to recognize the queen and imagine himself made of glass, so that he dared not move for fear of breaking. Recovering his reason, he would be full of remorse for his insane acts and obsessed with dread of another attack, but would still make an effort to rule again. Events however, were beyond his control: the Armagnacs (*see* Armagnac) continued the struggle against the Burgundians after John the Fearless, Philip the Bold's successor, had had Orléans murdered (1407); the Burgundians allied themselves with the English; Henry V of England claimed the French crown and won the battle of Agincourt (1415). In Dec. 1418 the dauphin Charles proclaimed himself regent, but by the treaty of Troyes (1420) his mother disinherited him in favour of Henry V.

When Charles VI died, in Paris, on Oct. 21, 1422, he was widely mourned. In his lucid phases he had shown good intentions but his reign of 42 years was a disastrous one for France. The history of this long period of disorder was rather that of the kingdom than of the king, who, under tutelage from 1380 to 1388 and then for 30 years in the hands of doctors and quacks, existed only through those who ruled in his name. The reign was important precisely because of the king's impotence, which was fully exploited by those whose interest it was to weaken the royal power. The helpless witness of so many events, Charles yet remained a precious hostage whom the conflicting parties sought to possess.

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CHARLES VII (1403–1461), king of France from 1422, was born in Paris on Feb. 22, 1403, the fifth son of Charles VI (*q.v.*) and Isabella of Bavaria. Created count of Ponthieu in 1404, he was betrothed in 1413 to Mary of Anjou, daughter of Louis II, king of Naples, and Yolande of Aragon. He spent the next three years in Provence and in Anjou with the family of his future wife, whom he was to marry in 1422. On April 5, 1417, the death of his brother John made Charles dauphin, at a moment when he was in Paris in the hands of the Armagnacs (*see* ARMAGNAC). His father subsequently appointed him lieutenant general of the realm (June 14; confirmed Nov. 6, 1417).

In the night of May 28–29, 1418, when the Burgundians were entering Paris, the dauphin left the city and retired to Bourges. As the constable, Bernard VII of Armagnac, was murdered by the Burgundian faction, the dauphin was now the leader of the Armagnacs. In his capacity as lieutenant general he proceeded to organize offices of government at Poitiers and at Bourges. At the end of the year he assumed the title of regent. He next made an attempt to reach agreement with John the Fearless, duke of Burgundy, but the Burgundian faction was finally antagonized when partisans of Charles, in his very presence, murdered the duke at Montereau (Sept. 10, 1419). This act frustrated hopes of national unity against the English. By the treaty of Troyes (May 21, 1420), Isabella of Bavaria recognized Henry V of England as heir to France instead of the dauphin, who was to be banished from the kingdom. Charles succeeded, nevertheless, in establishing his authority south of the Loire.

Accession.—Henry V died on Aug. 31, 1422, Charles VI on Oct. 21. Henry VI of England was then proclaimed in Paris as king of France. In Nov. 1422, however, the dauphin was crowned at Poitiers and took the title of king of France, as Charles VII. He was a prey to various influences: his Armagnac counselors; his mother-in-law, Yolande of Aragon; Richemont (*i.e.*, the earl of Richmond; *see* ARTHUR III), whom he appointed constable of France in 1425; and Georges de La Trémoïlle, Charles's own favourite, who exercised unlimited power till 1432. These conflicting influences led to private feuds among various Armagnac factions, particularly in Poitou.

End of the Hundred Years' War.—Charles VII sought help from other sources and in the years 1424–28 managed to arrange several periods of truce with Philip the Good, duke of Burgundy. The war with England, however, continued. In 1428, after reaching the banks of the Loire, the English laid siege to Orléans. Then Joan of Arc (*q.v.*) forced them to raise the siege in May 1429 and made her way to Reims, the traditional place of coronation for the French kings, where Charles VII was consecrated on July 17, 1429. After Joan had been taken prisoner (1430) private wars—notably between Richemont and La Trémoïlle—again broke out. Charles remained inactive, but French captains held the English forces in check. In 1434, however, Charles secured an alliance with the Holy Roman emperor Sigismund; and on Sept. 21, 1435, after long discussions, the treaty of Arras was concluded between Charles of France and Philip of Burgundy. Then at last, freed from his former favourites' influence, Charles surrounded himself with men of action—Jean, comte de Dunois (*q.v.;* the bastard of Orléans), Richemont, Pierre de Brézé and Charles of Anjou—and began the liberation of France from English control. In 1437 Charles entered Paris, which became his capital once more, and in 1444 a truce was made between France and England. In 1440, meanwhile, Charles had had to quell the Praguerie, a revolt of the nobles led by his son the dauphin Louis (*see* LOUIS XI). After the death of Yolande of Aragon (1442), various mistresses used their influence with the king; Agnès Sorel (*q.v.*) in particular had undisputed authority until her death in 1450.

To put an end to the activities of the Écorcheurs (bands of mercenary soldiers which were ravaging the whole of France), the king undertook the reorganization of the army, which was made a regular, paid force (ordinances of 1439, 1445 and 1448). The *compagnies d'ordonnance*, recruited from the nobility, formed an élite cavalry; the *francs-archers* ("infantry") were chosen from among the common people. The brothers Jean and Gaspard Bureau (*q.v.*) made the artillery a formidable weapon. Thus, when the English, despite Charles VII's diplomatic activity and Henry VI's marriage to Margaret of Anjou (the niece of Charles's consort), broke the truce in 1449, the battles of Formigny (1450) and of Castillon (1453) recovered Normandy and Guienne for France. In 1456 Charles signed a treaty of alliance with Christian I of Denmark, who promised to provide a fleet and an army for use against the English.

Ecclesiastical Affairs.—Charles added his efforts to those of the emperor Sigismund in an attempt to mediate between Pope Eugenius IV and the Council of Basel. In 1438 the council's decrees were approved by an ecclesiastical assembly at Bourges. The pragmatic sanction of Bourges, drawn up by this assembly, made certain concessions to the pope, but established the liberties of the Gallican Church (notably in the matter of the granting benefices) and abolished the annates. Up to the end of Charles's reign the papacy tried to have the pragmatic sanction abrogated and proposed in vain to the king a plan for a concordat. Calixtus III failed to persuade Charles to join the crusade against the Turks, and relations between Charles and Pius II were strained because of the prohibition on the levying of tithes in France.

Financial and Legal Reorganization.—At the beginning of his reign Charles had asked assemblies of the estates-general to grant him money. Gradually, however *aides* and *tailles* became permanent, the amount to be levied being fixed by the royal council. The estates of Languedoïl made no attempt to conserve what rights they possessed and finally ceased to meet. Those of Languedoc continued meeting, but became less and less important as time went by. To ensure a more exact knowledge of the laws, an ordinance of April 1454 prescribed that compilations of regional customs should be made.

Foreign Relations.—On his eastern frontiers Charles tried to weaken and limit the power of Burgundy. In 1444 he made use of the Écorcheurs in two expeditions: one, led by the dauphin Louis, supported Austria and Zürich in their war with the confederation of Swiss cantons; the other laid siege to Metz, but failed to capture it, though Toul and Verdun recognized French sovereignty. Charles also concluded a series of treaties with German princes and took Luxembourg and Liège under his protection. In Italy René of Anjou was unable to reconquer the kingdom of Naples (1442) and Charles of Orléans failed to win Milan (1447). In 1452, by the treaty of Montil-lès-Tours, Charles VII undertook to support Milan and Florence against the Venetian league if they should need him, but in 1454 the Italian states, frightened by French encroachments, settled their differences. In 1458 John of Anjou occupied Genoa, which had called on Charles VII for support, but the intruder was quickly expelled.

Jacques Coeur (*q.v.*), a merchant who had at his disposal a large fleet, contributed greatly to the commercial expansion of France, both through his contacts with the counties of the east and through his numerous trading posts in Europe (at Bruges, Barcelona, Geneva and other places). After the disgrace of Coeur in 1451 Charles continued to develop French trade with north Africa, as well as with Spain and Scandinavia.

Last Years.—The end of Charles VII's reign was overshadowed to some extent by the treason of the duc d'Alençon (Jean II), who was sentenced to death in 1458 but kept in prison until the king's death. Far more distressing, however, were the intrigues of the dauphin Louis, both within France and with foreign powers. In 1452, against his father's wishes, Louis had married Charlotte, daughter of the duke of Savoy; and after the annexation of Dauphiné by Charles VII (1456) he took refuge in Burgundy, remaining there until his father's death. Charles VII died at Mehun-sur-Yèvre on July 22, 1461.

See also references under "Charles VII" in the Index volume.

See A. Vallet de Viriville, *Histoire de Charles VII*, 3 vol. (1862–65); G. du Fresne de Beaucourt, *Histoire de Charles VII*, 6 vol. (1881–91).

(Y. M. L.)

CHARLES VIII (1470–1498), king of France from 1483, was born at Amboise on June 30, 1470, the only son of Louis XI of France and Charlotte of Savoy. Louis XI on his deathbed in 1483 entrusted his daughter Anne and her husband Pierre de Bourbon, seigneur de Beaujeu, with the care of Charles, and the Beaujeus conducted the government of France until 1492 (*see* ANNE of France; and FRANCE: *History*, for the events of these years). Charles, however, after his marriage to Anne of Brittany (1491), let his favourite, Étienne de Vesc, persuade him to free himself from the Beaujeus. With his mind full of glorious dreams derived from romances of chivalry, he then resolved to claim the rights of the house of Anjou, to which Louis XI had succeeded, on the kingdom of Naples and to use this as a steppingstone to Constantinople and to his own coronation as emperor of the east. He sacrificed everything to this policy, signed the disastrous treaties of Étaples (1492) and Barcelona (1493) with England and Aragon to keep his hands free, and set out in 1494. Pope Alexander VI did what he could in support of his ally, the Aragonese dynasty in Naples, but was forced to treat with Charles when the French occupied Rome. Charles entered Naples on Feb. 22, 1495, and was crowned there on May 12. Already in March, however, Milan, Austria, Venice and the pope had formed the League of Venice against him, and after the indecisive battle of Fornovo (July 1495) he was forced to return to France. He was preparing a fresh expedition when he died after an accident at Amboise on April 8, 1498.

See also references under "Charles VIII" in the Index volume.

See J. S. C. Bridge, *A History of France From the Death of Louis XI*, 2 vol. (1921–24).

CHARLES IX (1550–1574), king of France from 1560 to 1574, was born at St. Germain-en-Laye on June 27, 1550, the second son of Henry II and Catherine de Médicis (*q.v.*). The death of his eldest brother, Francis II, made him king in 1560, under the regency of his mother. He was proclaimed of age on Aug. 17, 1563, after his 13th birthday (according to the custom of the kingdom), but remained almost always under his mother's domination, being incapable of choosing and following a policy of his own. His health was poor, and he was mentally unstable.

To strengthen the prestige of the crown, Catherine took Charles on a tour of France from 1564 to 1566. The kingdom, however, was torn by the hostility between Catholics and Huguenots (*see* FRANCE: *History*). The victories over the Huguenots won by his brother, the duc d' Anjou (afterward Henry III), at Jarnac and at Moncontour in 1569 seem to have made Charles jealous of Anjou's glory, so that in 1571, when Gaspard de Coligny (*q.v.*) came to court, he was persuaded to favour the Huguenot plan for intervention against the Spaniards in the Netherlands: he sanctioned a defensive alliance with England (signed at Blois in March 1572) and Huguenot aid to the Dutch. This all came to nothing when Catherine, alarmed at the new policy and at Coligny's ascendancy, induced Charles to give permission for the massacre of St. Bartholomew's day.

The massacre apparently haunted Charles for the rest of his life. Thenceforward his health deteriorated and he became increasingly melancholy. He died at Vincennes, of tuberculosis, on May 30, 1574. Charles left no children by Elizabeth of Austria, daughter of the emperor Maximilian II, whom he had married in 1570, but he had one son, Charles, comte d'Auvergne and later duc d'Angoulême, by his mistress Marie Touchet.

Charles IX was by no means an imbecile. His education had been entrusted to the humanist Jacques Amyot, who had developed a love of literature in him. He wrote poetry and a work on hunting, *Traité de la chasse royale* (1625; modern ed. 1858), and was a patron of the Pléïade and of J. A. de Baïf's academy.

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CHARLES X (1757–1836), king of France from 1824 to 1830, was born at Versailles on Oct. 9, 1757, the fifth son of the dauphin Louis (son of Louis XV) and Maria Josepha of Saxony. Baptized as Charles Philippe, he was given the title of comte d'Artois. The dauphin's second son had died in 1754 and the eldest died in 1761, leaving only the future Louis XVI and the comte de Provence, later Louis XVIII, as senior brothers to the comte d'Artois. He was married in 1773 to Thérèse of Savoy, whose sister Louise was already married to the comte de Provence. Their sons were Louis Antoine, duc d'Angoulême (*q.v.*), and Charles Ferdinand, duc de Berry (*q.v.*).

The comte d'Artois spent his early youth in scandalous dissipation, incurring heavy debts that had to be paid by the state. His service with the French army at the siege of Gibraltar in 1782 was undertaken rather for distraction than for any serious concern. In 1785, however, he began a lasting liaison with Louise d'Esparbès, comtesse de Polastron (d. 1805), and from that time he became less frivolous and took more interest in politics. In the events leading up to the Revolution he emerged as an opponent of concessions to the third estate.

In the night of July 16–17, 1789, two days after the fall of the Bastille, the comte d'Artois left France for the Austrian Netherlands, whence he soon proceeded to Turin in Piedmont. He thus became the first chief of the royalist emigration, as the comte de Provence did not join it until 1791, when the brothers established themselves in Germany, at Coblenz. After Louis XVI's execution (1793), Provence, as self-styled regent of France, nominated Artois lieutenant general of the kingdom. When Provence became titular king, as Louis XVIII, on his nephew Louis XVII's death (1795), Artois, as the king's brother, took the designation Monsieur. Meanwhile he had visited Austria, Prussia and Russia, lived for a year at Hamm in Westphalia and served with the English army in the Netherlands (1794).

In Aug. 1795 Monsieur went to England. Then he sailed for the Vendée, to lead the royalist rising there. He landed on the island of Yeu, but the insurgents on the mainland failed to seize a landing place for him on the coast, and the enterprise came to nothing. Monsieur then returned to England. After some time in London, he moved to Holyrood palace, Edinburgh, then back to London (1799–1809), then finally to Hartwell, where he remained until the Restoration (1814) enabled him to return to France. For the ten years of Louis XVIII's actual reign Monsieur was the leader of the Ultras, the party of extreme reaction. His younger son, the duc de Berry, was assassinated in 1820.

King of France.—Louis died on Sept. 16, 1824, whereupon his brother became king as Charles X. On May 29, 1825, he was crowned at Reims, with all the gorgeous ceremonial of the old regime. It soon became clear that he would pursue his policy of reaction. The former *émigrés* were awarded 1,000,000,000 fr. as compensation for their confiscated lands; and Gallicans as well as Liberals were alarmed at measures which increased the power of the clergy. Charles and his trusted minister, the comte de Villèle (*q.v.*), soon began to lose what popularity they had had. On April 29, 1827, the national guard in Paris, which he was reviewing, greeted the king with cries of "Down with the ministers!" He disbanded it next day.

The fall of Villèle's ministry at the end of 1827 made the king consent to try a more moderate policy. A government headed by the vicomte de Martignac (*q.v.*) took office in 1828, and the king declared that France's happiness depended on "the sincere union" of the royal authority with the liberties consecrated by the charter of 1814. Martignac tried to placate the Liberals, but Charles proved temperamentally incapable of playing the part of a constitutional king as Louis XVIII had done. "I would rather hew wood," he explained, "than be a king under the conditions of the king of England." The Liberals, moreover, continued to obstruct all measures proposed by a ministry not selected from the parliamentary majority. When they finally joined with the extreme right to defeat Martignac (April 1829), the king lost patience. In Aug. 1829 he called on the extreme clericalist and reactionary Prince Jules de Polignac to form a government.

A formidable agitation sprang up, which only made the king more obstinate. In opening the session of 1830 he declared that he would "find the power" to overcome the obstacles placed in his path by "culpable maneuvers." The reply of the chambers was a protest against "the unjust distrust of the sentiment and reason of France": whereupon they were first prorogued, then, on May 16, dissolved. The result of the new elections was a large increase in the opposition; and Charles, on the advice of his ministers, determined on a virtual suspension of the constitution. On July 25 he signed four ordinances, three of which dissolved the new chamber, modified the electoral law and curtailed the liberty of the press. Issued next day, these provoked revolution.

July Revolution.—Charles had taken no precautions against a violent outbreak. From St. Cloud he went first to Versailles, then to Rambouillet, where he learned to his surprise that the insurrection could not be resisted. On Aug. 1 he appointed the duc d'Orléans, Louis Philippe (*see* ORLÉANS, DUCS D'), lieutenant general of the kingdom; and on Aug. 2 he abdicated in favour of his grandson, the duc de Bordeaux (Henry V; *see* CHAMBORD, HENRI, COMTE DE). On Louis Philippe's acceptance of the crown, he began a dignified retreat to the coast, surrounded by the infantry, cavalry and artillery of the guard. At Maintenon he dismissed most of his troops and went with about 1,200 men to Cherbourg, whence he sailed for England on Aug. 16.

Last Years.—After some time at Holyrood palace again, Charles left for Bohemia, where he established himself in the Hradcany palace in Prague. There he spent the closing years of his life in religious austerities, intended to expiate not his failure as a monarch but the venial excesses of his youth. He died at Gorizia, in Friuli, on Nov. 6, 1836.

Leopold I of the Belgians, in a letter of Nov. 18, 1836, to Princess (afterward Queen) Victoria, wrote: "History will state that Louis XVIII was a most liberal monarch, reigning with great mildness and justice to his end, but that his brother, from his despotic and harsh disposition, upset all the other had done, and lost the throne. Louis XVIII was a clever, hard-hearted man, shackled by no principle, very proud and false. Charles X an honest man, a kind friend, an honourable master, sincere in his opinions, and inclined to do everything that is right."

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CHARLES I (1600–1649), king of Great Britain and Ireland from 1625 to 1649, whose reign saw the outbreak of the English Civil War, was born in Dunfermline palace on Nov. 19, 1600, the second surviving son of James VI of Scotland and of Anne of Denmark. A sickly child, Charles was christened within a few hours of his birth and when his father became king of England (March 1603) he was temporarily left behind in Scotland because of the risks of the journey. Devoted to his elder brother, Henry, and to his sister, Elizabeth, he became lonely when Henry died (1612) and his sister left England to marry Frederick V, elector palatine of the Rhine (1613). Little is known about his childhood, but his governess, Lady Carey (afterward countess of Monmouth), protected him from some of his father's intellectual absurdities. He was created prince of Wales on Nov. 3, 1616.

All his life Charles had a Scots accent and a slight stammer. Small in stature, he was less dignified or soulful than his portraits by Van Dyck suggest. He was always shy and struck observers as being silent and reserved. His excellent temper, courteous manners and lack of vices impressed all those who met him, but he lacked the common touch, traveled about little and never mixed with ordinary people. A patron of the arts (notably of painting and tapestry; he brought both Van Dyck and Rubens to England) and, like all the Stuarts, a lover of horses and hunting, he was much more fastidious than his father and the character of the court became less coarse as soon as he became king. His private life was proper and he was sincerely religious. From his father he acquired a high sense of duty as a king, but his earliest extant letters reveal a distrust of the unruly house of commons with which he proved incapable of coming to terms. Lacking flexibility or imagination, he was unable to understand that those political deceits which he always practised in order to uphold his authority would, if publicly exposed, impugn his honour and damage his credit. So all his life he was acting a part not only toward other people but toward himself.

Before succeeding to the throne, Charles, accompanied by the duke of Buckingham (*see* BUCKINGHAM, GEORGE VILLIERS, 1ST DUKE OF), made an incognito visit (1623) to Spain in order to conclude a marriage treaty with the infanta. Although Charles was attracted by the languorous Spanish princess, the mission failed because he would not become a Roman Catholic, while the Spanish government refused to make specific promises to help restore the elector palatine. Charles then suffered a revulsion against Spain and joined Buckingham in pressing his father for war against that country, while a marriage treaty (1624) was arranged on his behalf with Henrietta Maria, sister of the French king, Louis XIII.

Conflict With Parliament.—Charles I became king on March 27, 1625. He married Henrietta Maria soon afterward. When his first parliament met (June 1625) trouble immediately arose because of the general distrust of Buckingham. The Spanish war was proving a failure and the king offered no explanations in parliament about his foreign policy or its costs. Moreover, the temper of the house of commons was strongly Puritan, whereas the sympathies of the king were with what came to be known as the high church party. Thus antagonism soon arose between the new king and the commons, and parliament refused to vote him the right to levy tonnage and poundage (customs duties) except on conditions, though this right had been granted to previous monarchs for life.

The second parliament of the reign, meeting in Feb. 1626, proved even more critical of the king's government, though some of the former leaders of the commons were kept away because Charles had ingeniously appointed them sheriffs in their counties. The failure of a naval expedition against Cádiz in the previous autumn was blamed on Buckingham and the commons tried to impeach him for treason. To prevent this, Charles dissolved parliament (June 1626). The kingdom now became involved in a war with France as well as with Spain and, in desperate need of funds, the king imposed a forced loan, which his judges declared illegal. He dismissed the chief justice and ordered the arrest without cause shown of over 70 knights and gentlemen who refused to contribute. The court of king's bench ruled in a test case (known, inaccurately, as the Five Knights' case) that the king was within his prerogative in doing so. Nevertheless it created a sense of grievance which was ventilated in the next parliament.

By the time that Charles's third parliament met (March 1628), Buckingham's expedition to La Rochelle had been decisively repelled and the king's government was thoroughly discredited. The house of commons at once passed resolutions condemning arbitrary taxation and arbitrary imprisonment and then set out its complaints in the Petition of Right. The king, despite his efforts to avoid giving specific assent to this petition, was compelled to employ the regular form of assent to a private bill—*Soit droit fait comme est désiré*—though when later published the bill appeared without his original answer attached. After subsidies had been voted, parliament made ready to demand Buckingham's dismissal, but the king prorogued parliament on June 26, 1628. By the time it met again (Jan. 1629) Buckingham had been assassinated. In the fourth parliament, the house of commons objected both to what it called the revival of "popish practices" in the churches and to the levying of tonnage and poundage by the king's officers without its consent. The king ordered the adjournment of parliament on March 2, 1629, but before that the speaker was held down in his chair and three resolutions were passed condemning the king's conduct. Charles I perceived that such behaviour was revolutionary: "This house," he said, "proceeds not upon the abuses of power only, but upon power itself." For the next 11 years he ruled his kingdom without calling a parliament.

"The Eleven Years' Tyranny."—On March 10, 1629, Charles published a lengthy declaration defending his treatment of the late parliament and justifying his religious policy and his levying of tonnage and poundage without parliamentary consent. In order that he might no longer be dependent upon parliamentary grants he now made peace with both France and Spain, for, although the royal debt amounted to over £1,000,000, the proceeds of the customs duties at a time of expanding trade and the exaction of traditional crown dues, such as knighthood fines, fines on landowners for breaches of the forest laws or of the statutes against enclosures and profits from the court of wards, combined to produce a revenue that was just adequate in time of peace. The king also tried to economize in the expenditure of his household. To pay for the Royal Navy, ship money writs were issued, first in 1634 to ports and later to inland towns as well. The demands for ship money aroused obstinate and widespread resistance by 1638, even though a majority of the judges of the court of exchequer found in a test case that the levy was legal (*see* HAMPDEN, JOHN; SHIP MONEY).

These in fact were the happiest years of Charles's life. At first he and Henrietta Maria (*q.v.*) had not been happy and in July 1626 he had peremptorily ordered all of her French entourage to quit Whitehall. However, after the death of Buckingham he fell in love with his wife and came to value her counsel. Their eldest surviving son, the future Charles II, was born on May 29, 1630, and a succession of other children followed. Though the king regarded himself as responsible for his actions to God alone—the so-called doctrine of Divine Right of Kings—he recognized his duty to his subjects as "an indulgent nursing father." If he was often indolent, he exhibited spasmodic bursts of energy. He took over the work of reclaiming the fens in eastern England from the earl of Bedford. With the help of the archbishop of Canterbury, William Laud, he tried to enforce the statutes against enclosures. He gave orders for administrative reforms, although little impression was made upon the elaborate network of private interests in the armed services and at court. On the whole, the kingdom seems to have enjoyed some degree of prosperity until 1639 when Charles became involved in a war against the Scots.

Bishops' Wars and the Long Parliament.—The early Stuarts neglected Scotland. At the beginning of his reign Charles alienated the Scottish nobility by an act of revocation whereby lands claimed by the crown or the church were subject to forfeiture. His decision in 1637 to impose upon his northern kingdom a new liturgy, based on the English Book of Common Prayer and approved by the Scottish bishops, met with concerted resistance. When many Scots signed a national covenant to defend their Presbyterian religion, the king decided to enforce his ecclesiastical policy with the sword. He was outmaneuvered by a well-organized Scottish covenanting army and by the time he reached York in March 1639 the first of the so-called Bishops' Wars was already lost. A truce was signed at Berwick-upon-Tweed on June 18.

On the advice of Archbishop Laud and of the earl of Strafford, his able lord deputy in Ireland, Charles I summoned a parliament which met in April 1640 and offered to waive his right to ship money if the house of commons would vote him 12 subsidies. Under the leadership of John Pym the house insisted first on discussing grievances against the government and showed itself opposed to a renewal of the war against the Scots; so, on May 5, the king dissolved what was known as the Short parliament. The collection of ship money was resumed and so was the war. A Scottish army crossed the border in August and the king's troops panicked before a cannonade at Newburn. Charles, deeply perturbed at this second defeat, convened a council of peers on whose advice he summoned another parliament, the Long parliament, which met at Westminster in Nov. 1640.

In his opening speech Charles told the Long parliament that the Scots were rebels and that its first duty was to provide money to maintain an English army. Instead, the new house of commons condemned ship money, "innovations in religion," the conduct of the prerogative courts, the expensive levying of troops, Strafford's Irish policy and the Scottish wars, and made preparations to impeach Strafford and other ministers for treason. The king adopted a conciliatory attitude—he agreed to the Triennial act which ensured the meeting of parliament once every three years—but expressed his resolve to save Strafford, to whom he promised protection.

The trial of Strafford opened in March 1641. Charles, while outwardly conciliatory to the leaders of the commons and while attempting to build up a moderate party to support him in parliament, also planned to strengthen and sustain an army with which he could in a crisis impose his will. When it became clear that the case against Strafford might fail, a bill of attainder was introduced and pushed through both houses of parliament. The king failed in an attempt to put loyal troops into the Tower of London, and early in May a mob of Londoners intimidated the house of lords. At this point Strafford himself offered to set Charles's conscience at liberty and begged him to sign the bill of attainder. Though afterward he regretted his action, the king was persuaded that it was his public duty to do so, and Strafford was beheaded on May 12, 1641.

On the same day that he signed the act of attainder, Charles agreed to a measure whereby the existing parliament could not be dissolved without its own consent. He also accepted bills abolishing nearly all the prerogative courts, declaring ship money and knighthood fines illegal and in general condemning his methods of government during the previous 11 years. But though making these concessions, he visited Scotland in August to try to enlist support there. He agreed to the full establishment of presbyterianism in his northern kingdom and allowed the Scottish estates to nominate royal officials. His temporary popularity was undermined by a rumoured plot to kidnap the Scottish covenanter leaders, known as "the Incident," and Charles failed at that stage to create a royalist party in Scotland.

Meanwhile parliament reassembled in London after a recess and on Nov. 23, 1641, the commons passed by 159 to 148 votes the Grand Remonstrance to the king, setting out all that had gone wrong since his accession. At the same time news of a rebellion in Ireland had reached Westminster. When the king returned to London on Nov. 25 he gave a noncommittal answer to the Grand Remonstrance, published on Dec. 10 a proclamation upholding the Church of England (a movement to abolish the bishops had started in the lower house) and ordered a guard that had been placed round the house of commons to be withdrawn. Pym and the leaders of the commons, fearing that if an army were raised to repress the Irish rebellion it might be used against them, planned to gain control of the army by forcing the king to agree to a militia bill. When asked to surrender his command of the army, Charles exclaimed "By God, not for an hour." He observed from the division over the Grand Remonstrance that a royalist party was forming; and fearing an impeachment of his queen, he screwed himself up to desperate action. He ordered the arrest of one member of the house of lords and five of the commons for treason and went on Jan. 4 with about 400 men to enforce the order himself. However, the accused members escaped and hid in the City. After this rebuff the king left London on Jan. 10, this time for the north of England. The queen went to Holland in February to raise funds for her husband by pawning the crown jewels.

A lull followed during which both royalists and parliamentarians enlisted troops and collected arms. Not that Charles immediately gave up hopes of peace; with the advice of men like Viscount Falkland, Edward Hyde and Sir John Colepeper, who were members of parliament, he still tried to conciliate and had even offered (Jan. 1) John Pym the post of chancellor of the exchequer. But the queen urged him not to "yield everything." After a vain attempt to secure the arsenal at Hull, in April the king settled in York, where he ordered the courts of justice to assemble and where royalist members of both houses gradually joined him. In June the majority of the members remaining in London sent the king the Nineteen Propositions, which included demands that no ministers should be appointed without parliamentary approval, that the army should be put under parliamentary control and that parliament should decide about the future of the church. Charles realized that these proposals were an ultimatum; yet he returned a careful answer in which he gave recognition to the idea that his was a "mixed government" and not an autocracy. But in July both sides were urgently making ready for war. The king formally raised the royal standard at Nottingham on Aug. 22 and sporadic fighting soon broke out all over the kingdom.

Civil War: the First Phase.—(For a full account of the fighting, *see* CIVIL WAR, ENGLISH. Here only the king's actions and movements are described.) In Sept. 1642 the earl of Essex, in command of the parliamentarian forces, left London for the midlands, while Charles moved his headquarters to Shrewsbury to recruit and train an army on the Welsh marches. A drawn battle was fought at Edgehill near Warwick on Oct. 23. The king addressed his troops in these words: "Your king is both your cause, your quarrel, and your captain. The foe is in sight. The best encouragement I can give you is that, come life or death, your king will bear you company, and ever keep this field, this place, and this day's service in his grateful remembrance." Charles I was a brave man but no general and he was deeply perturbed by the slaughter he saw on the battlefield. He rejected the advice of his nephew, Prince Rupert, and of others to make a dash for London. Instead he preferred to occupy Oxford in a leisurely way and only in mid-November advanced on London. He started to negotiate before forcing the Thames, thus giving time for a resolute defense force to gather at Turnham Green. The king then ordered a retreat. As Rupert had attacked at Brentford during a truce for negotiations, Charles was personally blamed for treachery. He withdrew to Reading and then to Oxford, where he set up his court and military headquarters.

In 1643 the royal cause prospered, particularly in Yorkshire and the southwest. At Oxford Charles dwelt pleasantly enough in Christ Church and met his council at Oriel, while All Souls was used as an arsenal and New College as a mint. The queen, having sold some of her jewels and bought a shipload of arms from Holland, landed in Yorkshire in February and joined her husband in Oxford in mid-July. Both by letters and by personal appeal she roused him to action and warned him against indecision; "delays have always ruined you," she observed. The king seems to have assented to a scheme for a three-pronged attack on London, from the west, from Oxford and from Yorkshire, but neither the westerners nor the Yorkshiremen were anxious to leave their own districts. So in August the king decided to besiege the city of Gloucester, which, since Bristol had fallen to Prince Rupert in July, was the only important parliamentarian stronghold left in the west. Essex, however, relieved Gloucester and, after the first battle of Newbury, fought on Sept. 20, Charles, though claiming the victory, ordered a withdrawal on Oxford.

In the course of 1643 a peace party on the parliamentarian side made some approaches to Charles in Oxford, but these failed and John Pym made a military alliance with the Scottish covenanters. The entry of a Scottish army into England in Jan. 1644 thrust the king's armies upon the defensive and the plan for a converging movement on London was abandoned. Charles was content to hold his inner lines at Oxford and throughout the west and southwest of England, while he dispatched Prince Rupert on cavalry raids elsewhere. The king ordered him to relieve York where a royalist army was besieged by the Scots and by two English parliamentarian armies, but his letter was badly expressed and Rupert imagined he must not merely save York but must beat the parliamentarian forces in the field. With the odds against him he suffered defeat at Marston moor on July 2. Meanwhile Charles, leaving Oxford, defeated a force under Sir William Waller at the battle of Copredy Bridge on June 29 and pursued the earl of Essex, who was moving west into Cornwall. Henrietta Maria had left Charles again in April. She gave birth to their youngest child, Henrietta, in Exeter (June 16) and then sailed to France. The king's campaign in the west was a success. The army under Essex was outmaneuvered and surrendered at Lostwithiel at the very end of August. On his return to his headquarters Charles was confronted by a large parliamentarian force at the second battle of Newbury, but he beat off his enemies and reached Oxford safely. He was not elated, however, and put out a number of peace feelers. These came to nothing, but he was cheered by reports that his opponents were beginning to quarrel among themselves.

The year 1645 proved to be one of decision. Charles may have had some foreboding of what was to come, for in the spring he sent his eldest son into the west with his ablest adviser, Edward Hyde; thence they escaped to France. On June 14 the New Model army, commanded by Sir Thomas Fairfax, defeated the king and Prince Rupert at the battle of Naseby. After the royal cavalry had suffered defeat the king himself tried to rally his infantry, but a Scottish professional soldier put his hand on the king's bridle and turned his horse's head and Charles found himself carried away from the battle. Prince Rupert was obliged to surrender Bristol on Sept. 11, and Charles, whose mind had been poisoned by hints of treachery, revoked his commission. Then the king, who was in south Wales, moved north in the hope of linking with the marquess of Montrose, his victorious commander in Scotland. He reached Chester, which he failed to relieve; then he wandered across to Newark, where he learned of the defeat of Montrose at Philiphaugh (Sept. 13). There also he saw Rupert, whose condemnation was revoked by a council of war. The king returned to Oxford on Nov. 5.

Civil War: the Second Phase.—The first phase of the Civil War was now virtually over. By the spring of 1646 Oxford was surrounded. Charles left the city in disguise with two companions late in April, and arrived at the Scots' camp at Newark on May 5. A few days later he accompanied the Scots to Newcastle. But the covenanters, having come to terms with the victorious English parliament in Jan. 1647, left for home, handing over Charles I to parliamentary commissioners. He was held at Holmby house in Northamptonshire where he lived a placid, healthy existence and, learning of the quarrels between the New Model army and parliament, hoped to come to a treaty with one or the other and regain his previous power. In June Cornet George Joyce with a force of some 500 men seized the king and carried him away to the army headquarters at Newmarket.

After the army marched on London in August, the king was moved to Hampton Court palace, where he was reunited with two of his children, Henry and Elizabeth. He escaped on Nov. 10, but his friends' plans to take him to Jersey and thence to France had been muddled and instead Charles found himself in the Isle of Wight, where the governor, Col. Robert Hammond, was loyal to parliament and kept him under surveillance at Carisbrooke castle. There Charles conducted complicated negotiations with the army leaders, with the English parliament and with the Scots; he did not scruple to promise one thing to one side and the opposite to the other. He came to a secret understanding with the Scots on Dec. 26, 1647. By this "Engagement" the Scots offered to support the king's restoration to power in return for the establishment of the Presbyterian religion in both kingdoms for the time being. Charles then twice refused the terms offered by the English parliament, known as the Four bills, and was put under closer guard, from which he vainly tried again to escape.

In Aug. 1648 the Scottish Engagers were defeated at the battle of Preston and the second phase of the Civil War was over. The army now began to demand that the king should be put on trial for treason as "the grand author of our troubles" and the cause of bloodshed. He was removed to Hurst castle in Hampshire at the end of 1648 and thence taken to Windsor castle for Christmas. On Jan. 20, 1649, he was brought before a specially constituted high court of justice in Westminster hall.

Execution of the King.—Charles I was charged with high treason and "other high crimes against the realm of England." He at once refused to recognize the legality of the court because "a king cannot be tried by any superior jurisdiction on earth." He therefore refused to plead but maintained that he stood for "the liberty of the people of England." The sentence of death was read on Jan. 27; his execution was ordered as a tyrant, traitor, murderer and public enemy. The sentence was carried out on a scaffold erected outside the banqueting hall of Whitehall palace on the morning of Tuesday, Jan. 30, 1649. The king went bravely to his death, still claiming that he was "a martyr of the people." A week later he was buried at Windsor.

See also ENGLISH HISTORY; CIVIL WAR, ENGLISH; and references under "Charles I" in the Index volume.

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CHARLES II (1630–1685), king of Great Britain and Ireland from 1660 to 1685, was born at St. James's palace, London, on May 29, 1630, the eldest surviving son of Charles I and Henrietta Maria. Up to the age of 12 Charles received, at the hands of Brian Duppa, bishop of Chichester, and William Cavendish, earl of Newcastle, a conventional princely education, in which the latter's concern for good horsemanship and other gentlemanly exercises was probably dominant. But during the 18 years after the outbreak of the Civil War (*q.v.*) in 1642, he had to come to terms with defeat, isolation and the persistent humiliations of poverty. Thus the character of the boy is indistinct, but the young man emerges clearly in precocious maturity, sardonic, lazy, a born dissimulator, becoming skilled in the sort of moral evasions which make for ease even in adversity.

The Years of Exile.—The nature of his adversities invites respect for Charles, even though the long years of cheap dissipation in exile have tarnished the romance of his exploits. After being driven to take refuge in the west country by royalist defeats in 1645, Charles moved to Scilly and then to Jersey, finally joining his mother in Paris by July 1646. His father, now in Scottish hands, had granted her full control of his education "in all things except religion," and her supervision seems to have been close, but insufficient to prevent him fathering his first child, James, later duke of Monmouth. Thomas Hobbes, as a mathematician, was among his tutors.

Moving to the Netherlands, Charles made two unsuccessful attempts to save his father. In July 1648 he took part in a naval demonstration in the Thames, hoping to appeal to Londoners, and in Jan. 1649 he signed a blank paper for the insertion of any terms that would preserve his father's life. Although proclaimed king after Charles I's execution, he was more helpless than ever, penniless and at the centre of factious wrangling in an impotent court. Asserting his independence, he made his headquarters first at Jersey, then at Breda, and to the dismay of his council took up negotiations with the Presbyterian Scots. Terms were finally agreed on May 1, 1650, by which he abandoned James Graham, marquess of Montrose, and accepted the Covenant in return for a faint prospect of support in regaining the English throne. He landed in Scotland on June 23. The whole enterprise entailed a sacrifice of honour and conscience which could barely be sanctioned by Charles's claim that he was under pressure and therefore not bound by his word. Indeed, soon after the Scottish defeat at Dunbar (Sept. 1650) he made an attempt to escape from his hosts but was thwarted, and after a series of public humiliations he was crowned king of the Scots at Scone on Jan. 1, 1651. These months were among the bitterest in his life and the march into England was a welcome escape. It ended in defeat at Oliver Cromwell's hands in the battle of Worcester, Sept. 3, 1651. Then began the 40 days' hiding, the concealment in the "royal oak" at Boscobel, the furtive journey through the west country and the eventual escape to France which he reached on Oct. 16. He faithfully remembered to reward those who had assisted his escape.

A period of utter destitution followed, for he and his following were unwelcome in France. Charles quarreled with his mother and could gain little help from other European princes. The only comfort he could offer his advisers, Edward Hyde, Sir Edward Nicholas and James, marquess of Ormonde, was to remain true to the Anglican faith and vigorously counter his mother's attempt to convert his youngest brother Henry to Roman Catholicism. His firmness alienated potential Catholic support and reveals how strongly he adhered to his father's injunction that constancy in his religion would alone regain him his throne. Meanwhile, Cromwell's diplomatic successes closed France and the Netherlands to Charles, and in March 1655 a poorly co-ordinated royalist rising in England was crushed. Charles then turned to Spain, concluding a treaty in April 1656 which enabled him to live in the Spanish Netherlands. With some difficulty he detached his brother James from his command in the French army and gave him some regiments of Anglo-Irish troops in Spanish service, but this nucleus of a royalist army was doomed to inactivity by poverty. No attack on England could be mounted, and Cromwell's death in 1658 did little to improve Charles's prospects. A royalist rising of Aug. 1659 was betrayed and crushed, and in the confusion of parties which followed Richard Cromwell's retirement the conflicting ambitions of army leaders held the best hopes of negotiating a restoration. In the event it was Gen. George Monck, marching his formidable army down from Scotland, who successfully took advantage of the situation to impose his terms upon the council of state in London. Power now passed from the Republicans and Independents to the Presbyterians who saw in monarchy the only answer to imminent anarchy. A parliament was summoned for April 1660 and negotiations were opened with Charles (*see* ENGLISH HISTORY).

The Restoration.—By the declaration of Breda, issued on April 4, 1660, Charles expressed his personal desire for a general amnesty, for liberty of conscience, an equable settlement of land disputes and full payment of arrears to the army, but he assigned the actual terms of such a settlement to parliament. The convention parliament, in which royalist peers and many young Cavaliers had found seats, imposed no terms beyond acceptance of the declaration, and Charles was proclaimed king on May 8, 1660. On May 25 he landed at Dover and on May 29 was ushered into Whitehall by rejoicing crowds. In the Restoration settlement which took shape in the years following, Charles's role was often a passive one, but he intervened at once to temper the severity of the convention in its punishment of his enemies. The Act of Indemnity (Aug. 1660) pardoned all treasons, felonies and other offenses committed since Jan. 1, 1637, with few exceptions, and only 13 regicides and Sir Henry Vane (*q.v.*) were executed.

In its formal aspects the restored monarchy differed much from that inherited by Charles I, since the early enactments of the Long parliament survived. But the most effective limitation on Charles II's independence was the financial settlement. He was given an annual income which would have been inadequate even if its estimated yield of £1,200,000 had not been overoptimistic. Some attempt was made by parliament to deal with the disbanding of the army and the debts of both the crown and the revolutionary government, but the convention left Charles with a serious unsolved financial problem.

Charles was crowned on April 23, 1661, and a month later the negotiations with Portugal for his marriage with Catherine of Braganza were completed. The treaty gave Charles a dowry of over £300,000, together with Bombay and Tangier and substantial trading privileges for English merchants. These material gains outweighed English distaste for a Roman Catholic consort, and French support countered Spanish and Dutch objections. The marriage took place on May 21, 1662, and Charles confessed to his satisfaction.

During the early part of his reign, Charles mainly left the government in the hands of Edward Hyde (*see* CLARENDON, EDWARD HYDE, 1ST EARL OF), whom he made lord chancellor and earl of Clarendon. Clarendon was fairly successful in reconciling all classes under the throne, but apart from the financial problem, two aspects of the Restoration settlement left a legacy of discontent and increased Charles's difficulties. The land settlement left a small class of discontented Cavaliers who felt that their loyalty was not appreciated and, having received no compensation for their losses in the Civil War, added bitterness to the usual struggle for preferment at court and sorely tried Charles's generosity. However, it was the religious settlement which created the greatest unrest. The so-called Clarendon code uncompromisingly restored the Anglican Church, rejecting the toleration which Charles had promised at Breda. In an attempt to keep his word, Charles issued a declaration in Dec. 1662 reasserting his desire to relieve dissenters and attempting to suspend the penal laws, but parliament rejected any toleration when it met in 1663 and continued to harass the Nonconformists.

Thus parliamentary pressure restrained Charles in the exercise of his prerogative to dispense with legal penalties; in 1673 it was to deny that he had any such prerogative at all in religious matters. But in the 1660s the king still enjoyed the uncontradicted control of the executive, the judiciary and of foreign policy. The Militia act of 1661 confirmed his command of the armed forces, the Licensing act muffled the press and in 1664 the repeal of the Triennial act removed the offensive machinery which enforced frequent meetings of parliament.

Government and Foreign Policy.—Charles had entered with care and moderation upon his inheritance but he proceeded to enjoy it overfreely. His pursuit of pleasure was no new characteristic, but in the precarious financial condition of the government it laid dangerous strains upon parliament and his advisers. In 1662 parliament supplemented his regular revenue with a hearth tax. Although his income was still deficient it was so to a smaller extent than is usually claimed, and the lord treasurer, the earl of Southampton, had no doubt that the principal bar to solvency was the king's heedlessness.

Debt hampered the pursuit of a vigorous foreign policy. Dunkirk proved too costly to hold and its sale to France in 1662 underlined England's incapacity to defend its overseas possessions. Nevertheless, Charles endorsed the commercial rivalry with the Dutch which kept English interests alive in the Levant, Africa and the East Indies. By 1664 minor provocations had led to the war which was formally declared early in 1665 (*see* Dutch Wars).

The Anglo-Dutch conflict fostered Charles's first political crisis. By the time the Dutch sailed up the Medway in 1667, burning English shipping, the combined effects of the Great Plague of 1665 and the Great Fire of London in 1666 upon a nation already exasperated by high costs, inefficiency and corruption had created a state in which exhaustion was overborne by a resolve to get redress. Clarendon was the obvious scapegoat and Charles, tired of the censorious old servant, was ready to sacrifice him to the ambitions of younger politicians. Parliament, however, went on to insist on a close inquiry into government expenditure, and Charles was wise to initiate a drive for the better management of his treasury. He was also obliged to organize or buy support in a house of commons which, transformed by maladministration and by-elections, now spoke with an altered, critical tone. Lord Arlington, assisted by Sir Thomas Clifford, created the nucleus of a court party which gave Charles a precarious control of domestic politics. Meanwhile the king sought greater security abroad than was offered by the popular Protestant triple alliance with the United Provinces and Sweden, formed in 1668. Through his sister Henrietta, duchess of Orléans, Charles embraced Louis XIV's terms for French assistance. He was to declare himself a Roman Catholic, restore that faith in England and engage in a joint land-sea war upon the Dutch, in return for military help and an annual subsidy. Of his advisers, Clifford, Arlington, the duke of Buckingham, Lord Ashley and the earl of Lauderdale, whose initials fortuitously made up the word Cabal, only the first two were trusted to sign the secret treaty, which Henrietta brought to Dover in May 1670, though all endorsed a feigned treaty which omitted the conversion clauses.

With money voted by a complaisant parliament to support the Dutch alliance, Charles prepared to further this "grand design." In Jan. 1672 he freed his revenue of liabilities by postponing repayment of money due mainly to London bankers—the "Stop of the Exchequer"—and on March 15 issued a Declaration of Indulgence suspending the penal laws against Protestant and Catholic nonconformity. The third Dutch War began two days later. England's naval contribution was unpopular and indecisive, and when parliament met in 1673 it forced Charles not only to withdraw the Declaration of Indulgence but also to accept the Test act which drove Roman Catholics, including Clifford and Charles's brother James, duke of York, from office. When Charles withdrew from the war in Feb. 1674 it was amid another political storm. Clifford was dead, Ashley, now earl of Shaftesbury, in opposition, and Buckingham, Arlington and Lauderdale under threats of impeachment. The man who could help Charles weather this was Sir Thomas Osborne, soon earl of Danby. As an Anglican country gentleman, hostile to France, his policies were calculated to reassure the commons and his financial acumen as lord treasurer promised to relieve the king. He successfully maintained an obedient court party in parliament and fostered the popular marriage in Nov. 1677 of Mary, daughter of the duke of York, to William of Orange. But Charles had maintained his secret negotiations with France and Danby was forced to be a party to them; consequently he was vulnerable to the rancour of Ralph Montagu, ambassador in Paris, who exposed Danby out of spite.

The "Popish Plot" and the Exclusion Crisis.—The exposure of the French negotiations was but one aspect of the great crisis of Charles's reign, the "popish plot"—an inflated tissue of fiction built round a skeleton of even stranger truths. After Titus Oates in Aug. 1678 revealed an intended Catholic insurrection, confirmed apparently by the letters of Edward Coleman and the murder of Sir Edmund Berry Godfrey (*q.v.*), the country was sufficiently inflamed to believe anything and bogus informers flourished unchecked. Parliament presided over the inquiries, encouraged by Shaftesbury, and Charles himself was obliged to acquiesce in the execution of 35 Catholic victims. But when the queen was accused and Danby threatened with impeachment, Charles dissolved the Cavalier parliament (Jan. 1679). He sent James, an avowed Catholic since 1668, abroad, but the problem of his succession to the throne had now been raised in an acute form. Charles was prepared to propose limitations on a Catholic king but refused to compromise the rightful succession. To emphasize the absence of any other heir he publicly affirmed the illegitimacy of his eldest son, the duke of Monmouth. The new parliament of 1679, however, which was preparing a bill for the exclusion of James, had to be dissolved quickly, and when its successor of Oct. 1680 repeated the attempt it was only by the narrowest of margins that the brilliant moderation of the earl (later marquess) of Halifax secured the defeat of the exclusion bill in the house of lords.

The campaign to bar the Catholic duke from the throne, drawing upon accumulated resentments against a corrupt and scheming court, had by now brought the London mob into politics, and Shaftesbury as a demagogue exercised an influence greater than he had wielded as a statesman. So Charles called his last parliament to meet at Oxford in March 1681, where, strengthened by a financial agreement with France, he felt safe in dismissing it after one week. The conflict between supporters and opponents of exclusion distinguished by the novel names of Whig and Tory, was now viciously fought at the level of local politics, and Charles showed little mercy in reducing borough corporations to obedience by threatening the forfeit of their charters. The discovery of the Rye House plot to assassinate him and his brother in 1683 brought the royalist reaction to its climax, and the execution of Lord William Russell and Algernon Sidney marked the collapse of the exclusionist cause. The country's mood of zealous loyalty was now almost as fervent as that which had greeted him in 1660, but far less deep-rooted, and although the last years of Charles were passed in tranquillity the apparent stability of the Stuart throne was deceptive.

Character.—Charles, whose life testified to a belief that "God will never damn a man for allowing himself a little pleasure," died at Whitehall palace on Feb. 6, 1685, after a hasty profession of the Catholic faith. The mixture of caution and indifference which had delayed this conversion until his deathbed is typical of him. He was fortunate enough to enjoy all the merits of his defects, and the tolerance which he brought to religious matters may have contributed more to the peace of his reign than was lost by his shifty insincerity. With this easy conscience went an easy manner. Charles was affable and familiar to a degree thought excessive in a king, and his wit has been described as more suitable for a private gentleman. But beneath the frivolity and licence was a mordant cynicism allied to an acute judgment of character. He was rarely deceived; his lasciviousness was quite unromantic. Consequently his mistresses exerted no positive influence upon his actions. Barbara Villiers, duchess of Cleveland, confirmed the nation's worst expectations by dominating the early years of his reign, embittering his wife and intriguing against Clarendon, and she occasioned Montagu's disastrous intervention in politics by demanding his dismissal. Above all she was expensive. Her sons by the king were Charles, Henry and George, dukes of Southampton, Grafton and Northumberland. Louise de Kéroualle, duchess of Portsmouth, enjoyed Charles' deep affection perhaps, but her French connection was less decisive than her sponsors hoped. By her Charles had Charles Lennox, duke of Richmond; by Nell Gwyn, Charles Beauclerk, duke of St. Albans; and by Catherine Peg, Charles Fitzcharles, earl of Plymouth. In all there were 14 acknowledged illegitimate offspring. Of these only James, duke of Monmouth, played a major role in English politics.

Charles paid a smaller price for his amours than for his laziness. He had a robust constitution, was tall and active and loved riding and sailing but, although capable of outsitting his advisers at the council board, hated routine and prolonged application. This failing vitiated those drives for economy which might have salvaged his credit or prevented dependence on the French alliance. Instead a state of nearly continuous financial crisis ensured that one of the positive political achievements of his reign was the development of greater parliamentary control over revenue and its expenditure, which was hardly offset by improvements in departmental efficiency at the treasury. The same lack of interest that allowed the admiralty to become a political football reduced the navy to a sad condition by the end of the reign.

More than its fair share of genius has brought distinction to an age that was not remarkable for public patronage of arts other than drama. Nonetheless, Charles actively shared the preoccupations of that sceptical, materialist century which gave birth to the Royal society under his charter, and he did something to foster technological improvements in navigation and ship design. John Evelyn, mourning his death, remembered all these things and many more: his fine physique, his natural kindness, the smell of his spaniels about the court. "The history of his reign," Evelyn wrote, "will certainly be the most wonderful for the variety of matter and accidents above any extant of many former ages," and the same complexity belongs to Charles's character.

Charles, careless of economy, turning abruptly on his heel when warned by an adviser that "He that will not stoop for a pin, will never be worth a pound," is perhaps typical of the king, but Charles chatting familiarly with Nell Gwyn over a garden wall or striding through St. James's park at his wonted large pace are images that fall far short of conveying the whole man.

See also references under "Charles II" in the Index volume.

Bibliography.—A. Bryant, *King Charles II,* rev. ed. (1955); O. Airy, *Charles II* (1904); D. Ogg, *England in the Reign of Charles II,* 2 vol. (1956–57); J. Kenyon, *The Stuarts* (1958). (H. G. Ro.)

CHARLES I (Charles Robert or Carobert of Anjou-Naples) (1288–1342), king of Hungary, was the son of Charles Martel of Naples and Clemencia, daughter of the emperor Rudolf I. He claimed the Hungarian crown, as the great-grandson of Stephen V, with the approval of the pope, and was crowned at Esztergom after the death of the last Árpád, Andrew III, in 1301. However, his claim was disputed and he was forced in the same year to surrender the crown to Wenceslas II of Bohemia, who in 1305 transferred his rights to Otto, duke of Lower Bavaria. Otto was taken prisoner by the Hungarians, and Charles was enthroned at Buda on June 15, 1309, and crowned at Székesfehérvár on Aug. 27, 1310. His foreign policy, aimed at the aggrandizement of his family, benefited Hungary greatly. His alliance with Poland for mutual defense against the Habsburgs and the Czechs, made at Trencsén in 1335 and confirmed the same year at the brilliant congress of Visegrád, where the princes of central Europe met to settle their differences, led to a victorious attack by the Magyars and the Poles together on the emperor Louis IV and his ally Albert of Austria. Charles wished to unite the kingdoms of Hungary and Naples under his eldest son Louis, but was frustrated by Venice and the pope, who feared that Hungary might become the dominant Adriatic power. Charles balanced this setback by a pact (1339) with his ally and brother-in-law Casimir III of Poland, whereby they agreed that Louis of Hungary should succeed to the throne of Poland on the childless Casimir's death. A statesman of the first rank, Charles not only restored his kingdom to the status of a great power but also enriched and civilized it. He was pious, courtly and valiant, popular alike with the nobility, the clergy and the middle classes, whose welfare he did much to promote. His court was famous throughout Europe as a school of chivalry. Three sons, Louis, Andrew and Stephen, survived him. Charles died on July 16, 1342, and was buried beside the high altar at Székesfehérvár, the ancient burial place of the Árpáds.

See D. G. Kosáry, *A History of Hungary,* with bibliography (1941). (Ge. Gr.)

CHARLES I (1227–1285), king of Naples and Sicily, the first of the Angevin dynasty, was the son of Louis VIII of France and Blanche of Castile. Born in March 1227, a few months after his father's death, he grew up under the protection of his mother and of his elder brother, Louis IX. He received the countships of Anjou and Maine as appanages in 1232. He was married to Beatrice, daughter and heiress of Raymond Berengar IV of Provence, in 1246 and, with Louis IX's help, established himself effectively as count of Provence, despite the claims of James I of Aragon and the efforts of certain towns toward autonomy. Accompanying Louis on his Egyptian crusade (1248), Charles was taken prisoner with him (1250). Released, he returned to France and began to add to his domains. He even tried to acquire Hainaut in return for help to Margaret of Flanders. By intervening in the disputes between communes and feudal lords, he became himself lord and protector of certain lands in Piedmont. Friendly relations with Genoa gave him control of the routes into Italy from the west. After revolts in Provence and in Piedmont had been suppressed (1262), his position appeared incontestable.

Pope Innocent IV had already proposed that Charles take the crown of Naples and Sicily from Manfred, the bastard son of the Hohenstaufen emperor Frederick II (*see* Naples, Kingdom of; Sicily: *History*). Pope Urban IV repeated this proposal in 1263, and agreement was finally reached in 1265 between Charles and Urban's successor, the French pope Clement IV, who satisfied Charles's heavy demands for financial help. For military help Charles began negotiations with the Guelphs of northern Italy.

In June 1265, after narrowly escaping capture by Manfred's fleet, Charles arrived in Rome, where he waited to collect a powerful army. On Jan. 6, 1266, he received the crown of Naples and Sicily from the pope. Crossing the Neapolitan border at Ceprano, Charles moved toward Benevento where, on Feb. 26, 1266, after a hard-fought battle, Manfred was defeated and killed. Two years later Conradin (*q.v.*), last legitimate descendant of the Hohenstaufen, came to Italy hoping to win the support of the Italian Ghibellines, to start a revolt in the kingdom and to take it from Charles. Defeated and captured at Tagliacozzo (Aug. 23, 1268), Conradin was taken to Naples and executed.

Following the example of his Norman and Hohenstaufen predecessors, Charles sought to make his kingdom a great Mediterranean power. He accompanied Louis IX on the Tunisian crusade in 1270, where he fought with great valour. His expeditions in the Balkans gained him Albania, with Durazzo and Corfu, and Achaea. In 1277 he assumed the title of king of Jerusalem, after purchasing the right of succession from Mary of Antioch and Hugh III of Cyprus. In Italy, meanwhile, the pope looked to Charles to maintain political stability and gave him a free hand in the papal states, and Charles also took advantage of the troubles in Tuscany and Lombardy to bring several cities there under his suzerainty by intervening on behalf of the Guelphs. His ever increasing power, which he sometimes abused, finally alarmed some of his former supporters.

To finance his vast projects Charles relied on heavy taxation. In southern Italy, a poor land already bled white in Frederick II's wars, this taxation not only neutralized the effect of his legislative attempts to give the country a good administration but also provoked widespread discontent, which misgovernment by his French and Provençal officials rendered more acute—especially in Sicily, which had ceased to be the pivot of the kingdom since Charles had moved the capital from Palermo to Naples. Revolt broke out at Palermo on March 31, 1282, and led to the expulsion of the Angevins from Sicily (*see* VESPERS, SICILIAN). The rebels then appealed to Peter III of Aragon, who, as husband of Manfred's daughter Constance, presented himself as Manfred's heir. To settle the dispute it was naïvely suggested that Charles and Peter should fight a duel at Bordeaux, in the presence of the king of England, but neither of the contestants appeared on the appointed day (each accused the other of cowardice and bad faith). Savage land and sea warfare ensued. While the Sicilians and the Aragonese, having invaded Calabria, were trying to spread the rebellion to the mainland, Peter's fleet, under Giovanni da Procida, destroyed the Angevin fleet in the gulf of Naples (June 5, 1284) and took Charles's son prisoner. Preparing a counteroffensive, Charles died suddenly at Foggia on Jan. 7, 1285, leaving his kingdom in a state of chaos.

See also references under "Charles I" in the Index volume.

See general histories of Naples and Sicily under the Angevins and special works on the War of the Sicilian Vespers. (E. Po.)

CHARLES II THE LAME (*c.* 1254–1309), king of Naples and, by title, of Sicily, was the son and heir of Charles I (*q.v.*). As prince of Salerno, he was married in 1270 to Mary, daughter of Stephen V of Hungary, while his sister was married to Mary's brother, the future Laszlo IV. In 1283, early in the War of the Sicilian Vespers, he presided as king's vicar over the parliament at San Martino in Calabria and had to make serious concessions to the nobility. Captured by the Aragonese in the sea battle of June 5, 1284, he was in their hands when his father died (1285). Negotiations for his release were prolonged by the papacy's resistance to the cession of Sicily to the Aragonese. Released at last under the treaty of Canfranc (in Aragon) of Oct. 4, 1288, Charles was crowned king by Pope Nicholas IV (May 29, 1289), absolved of his renunciation of Sicily (as prejudicial to papal suzerainty and exacted under duress) and encouraged in his resumption of war against the Aragonese, who moreover were maintaining themselves on the mainland in the vain hope of acquiring Naples as well as Sicily. Charles, however, relied more on papal diplomacy than on force to recover Sicily, and indeed Alfonso III of Aragon (d. 1291) and his successor James II (James I of Sicily from 1285) might have been ready to yield Sicily in return for other advantages. James in fact agreed, under the treaty of Naples (1295) with Pope Boniface VIII, Charles's protégé, to cede Sicily back to the church, but the Sicilians themselves repudiated James and took his brother Frederick as their king instead. Intent on independence, they fought bitterly for it even when Charles and James allied themselves against them. Finally, under the treaty of Caltabellotta of Aug. 1302, it was resolved that Frederick should have Sicily, with the title of king of Trinacria, until his death, when it should revert to Charles, whose daughter Eleonora he was to marry.

The Sicilian war cost Charles huge sums. Partly to raise money, partly perhaps out of religious fervour, he sacked the Saracen colony founded by the emperor Frederick II at Lucera, selling the survivors and their goods at public auction. He did his utmost to restore Angevin power in Italy. Furthermore, he successfully exploited his Hungarian connections. When his brother-in-law Laszlo IV died childless (1290), Charles secured papal recognition of his own eldest son Charles Martel as king of Hungary in opposition to the last Árpád claimant, Andrew III. When Charles Martel died (1295), Charles II's Sicilian preoccupations prevented his giving immediate help to his grandson Charles Robert against other pretenders, but in 1308, because of Charles's diplomacy and to papal support, Charles Robert was accepted by the Hungarian diet as king (Charles I of Hungary). Charles II died in Naples on May 5, 1309, leaving his kingdom to his third son, Robert.

See E. Pontieri, *Ricerche sulla crisi della monarchia siciliana del secolo XIII* (1957); also B. Homan, *Gli Angioini di Napoli in Ungheria*, Italian trans. (1938). (E. Po.)

CHARLES III (CHARLES OF DURAZZO) (1345–1386), king of Naples from 1381 to 1385, represented the fourth or Durazzo branch of his great-grandfather Charles II's descendants (junior to the Hungarian, Neapolitan and Taranto branches). When his father, Louis of Durazzo, died in prison (1362), the childless Joan I of Naples took Charles, the last male of the Angevin dynasty living in Naples, under her protection, to mask her plans for leaving the Neapolitan crown elsewhere. Louis I (*q.v.*) of Hungary, however, who had his own designs on Naples, required her first to send Charles to learn soldiering in Hungary (1365), then to give him as wife his cousin Margaret of Durazzo, daughter of his uncle Charles by Joan's sister Mary and so next in succession to the throne (1375). When Joan supported the antipope Clement VII (a protégé of France) and adopted Louis of Anjou (the French king Charles V's brother) as her heir, Hungary supported Pope Urban VI, who declared Charles of Durazzo king of Naples. Defeating Otto of Brunswick (Joan's fourth husband), Charles entered Naples in July 1381. Joan died in prison next year, but Charles had still to contend not only with Louis of Anjou but also with the restless Neapolitan barons. Louis, however, died suddenly at Bari (Sept. 1384). Then Urban, who had come to Naples and wanted to share in the government, quarreled with the forceful Margaret of Durazzo and declared the dynasty to be deposed and excommunicated (Jan. 1385). Besieged in Nocera by Charles, he was rescued by partisans of his. Finally Charles, against Margaret's advice, left Naples for Hungary and was crowned in Buda as rival to Louis of Hungary's daughter Mary. Soon afterward he was assassinated there, on Feb. 27, 1386.

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CHARLES II THE BAD (1332–1387), king of Navarre from 1349, was the son and successor of Joan of France, queen of Navarre, and Philip, count of Evreux (Philip III of Navarre; d. 1343). Married in 1352 to Joan, daughter of John II of France, he demanded Champagne, Brie and Angoulême as fiefs once held by his mother. As John had granted these to the constable of France, Charles of La Cerda, Charles II's supporters assassinated the constable (1354), but since Charles II was meanwhile negotiating with the English (*see* HUNDRED YEARS' WAR) John had to make terms with him, ceding extensive lands in Normandy. When Charles continued plotting with the English, John had him arrested at Rouen (April 1356). Soon afterward the English captured John at Poitiers. Escaping from prison in Nov. 1357, Charles began a series of treacherous dealings with every party in France: with the dauphin (later Charles V), for whom he did at least suppress the Jacquerie; with Étienne Marcel (*q.v.*) in Paris; and with the English again. Having made terms with the dauphin (1359), he recovered his Norman lands at the treaty of Brétigny (1360). He then went back to Navarre. In Spain he first supported Pedro of Castile against Peter IV of Aragon (1362), then allied himself with Peter IV and Henry of Trastámara against Pedro (1363). Then John of France died (1364) and Charles V decided to secure Normandy against the Anglo-Navarrese threat. Bertrand du Guesclin defeated Charles II's forces at Cocherel in May 1364, and Charles, faced with a Franco-Aragonese plan to partition Navarre (1365), had to accept the treaty of Vernon (1366), keeping some Norman lands but renouncing all his major claims in France in return for a vague offer of Montpellier. These setbacks forced him to ally himself again with Pedro of Castile, who offered him Guipúzcoa, Álava and part of Rioja (part of Libourne, 1366), and whose English allies Charles allowed to cross Navarre to defeat Henry of Trastámara at Nájera (1367)—though he had also promised Henry not to do so.

In 1369 Charles appeared at Cherbourg in Normandy. He then reached an agreement with Charles V (March 1370), signed a treaty with Aragon against Henry of Trastámara (April) and began new negotiations with England (June). These last came to nothing, and he had to treat with France again in 1371. In 1372, after papal arbitration, he had to restore Guipúzcoa, Álava and Rioja to Castile.

In 1378 Charles II's son and future successor Charles the Noble had to acknowledge evidence found in France, proving that his father had been planning not only a new alliance with England but also the poisoning of Charles V. This meant the final loss of all Navarre's Norman possessions except Cherbourg. An attempt to seize Logroño from Castile (1378) ended in defeat, and the treaty of Briones (1379) tied Navarre to Castilian policy. Charles died (of leprosy?) on Jan. 1, 1387. His daughter Joan married first John IV of Brittany, then Henry IV of England.

CHARLES III THE NOBLE (1361–1425), king of Navarre from 1387, was born in France, at Mantes, the eldest son of Charles II the Bad, whom he succeeded. Unlike his father, he pursued a consistent policy of peace both with Castile (which in gratitude restored certain districts to Navarre) and with France. By the treaty of Paris (1404) Charles not only renounced the Navarrese claims to Champagne but also ceded Cherbourg (which he had recovered from the English in 1393) and the countship of Evreux to Charles VI of France in exchange for Nemours, which was raised from a countship to a peerage-duchy for him. He did much to promote the economic welfare of his kingdom.

By his marriage (1375) with Leonor of Trastamara, daughter of Henry II of Castile, Charles had nine children, all of whom died early except his daughter and successor Blanche, who was married first, in 1402, to Martin I of Sicily (d. 1409), then, in 1420, to the future John II of Aragon. Her son by this latter marriage, Charles, prince of Viana, was declared the eventual heir to the throne. Charles III died at Olite on Sept. 8, 1425.

CHARLES, king of Portugal: *see* CARLOS I.

CHARLES, kings of Rumania: *see* CAROL I; CAROL II.

CHARLES I, king of Spain: *see* CHARLES V (emperor).

CHARLES II (1661–1700), king of Spain from 1665 to 1700 and the last monarch of the Spanish Habsburg dynasty, was born in Madrid on Nov. 6, 1661, the son of Philip IV by his consanguineous second marriage with Mariana of Austria. Weak and unhealthy from birth (he was not weaned until four years old), the last Spanish Habsburg seemed to symbolize by his physical and moral infirmities the misfortunes of his country. Charles's reign, which began on the death of Philip IV in 1665, opened with a ten-year regency under the queen mother, during which the government was preoccupied with combating the ambitions of Louis XIV in the Low Countries and with intrigues at court involving the queen, her Jesuit confessor Johann Eberhard Nithard, her subsequent favourite Fernando de Valenzuela, and the king's bastard brother Don John (1629–79) of Austria. Charles II came of age in 1675. There were two phases in the period of the king's personal government; the first, concerned with resistance to the French imperialism of Louis XIV, ended with the peace of Rijswijk in 1697; the second, the last three years of the reign, was dominated by the succession problem, for by then it was clear that Charles, who had married in 1679 Maria Luisa of Orléans (d. 1689) and in 1689 Mariana of Neuburg (d. 1740), would father no children.

Between 1675 and 1697 while the French armies paused only to consolidate past victories and to prepare new ones, internal politics in Spain were divided between the frivolity of Valenzuela, the messianism promoted by Don John, and the intrigues at court, in which the queens, their confessors and the foreign ambassadors unceasingly badgered the unfortunate Charles. Any attempt, such as that made by the conde de Oropesa, to introduce a worthwhile government was quickly frustrated. These machinations reached their peak over the succession problem, when the Austrian and French parties (*see* SPAIN: *History*) were prepared to use any means to gain the support of the wretched king. At this stage, however, Charles II rose above the atmosphere at court, and came to acquire true stature by his obstinate defense of the majesty of the crown and his determination to preserve its territorial integrity. In this latter aim he failed, for his death in Madrid on Nov. 1, 1700, led to the War of the Spanish Succession and the dismembering of Spain's European possessions.

See Duque de Maura, *Vida y reinado de Carlos II* (1954), *Supersticiones de los siglos XVI y XVII y hechizos de Carlos II* (1929). (J. RE.)

CHARLES III (1716–1788), king of Spain from 1759 to 1788, was born in Madrid on Jan. 20, 1716, the first child of Philip V's marriage with Isabella of Parma. He ruled as duke of Parma, by right of his mother, from 1732 to 1734, and then became king of Naples, where he served a useful apprenticeship in enlightened despotism. On the death of his half brother Ferdinand VI in 1759 he became king of Spain and resigned the crown of Naples to his third son, Ferdinand.

Charles III was convinced of his mission to reform Spain and make it a first-rate power. He brought considerable qualities to the task. In spite of a fanatical addiction to hunting, his frugality and his application to the business of government impressed foreign observers as well as his own subjects. His religious devotion was accompanied by a blameless personal life and a chaste loyalty to the memory of his wife, Maria Amalia of Saxony, who died in 1760. On the other hand he was so highly conscious of royal authority that he sometimes appeared more like a tyrant than an absolute monarch. His greatest quality, however, was his ability to select effective ministers and continually to improve his government by bringing in men of higher quality like the conde de Aranda and conde de Floridablanca. While conferring with them regularly Charles was also wise enough to give them sufficient scope for action.

The survival of Spain as a colonial power and therefore as a power to be reckoned with in Europe was one of the main objects of Charles's policy. His foreign policy, however, was not successful. Fearing that a British victory would upset the balance of colonial power, he signed the Family compact with France in Aug. 1761. This brought war with Great Britain in Jan. 1762. Charles overrated his own strength and prospects and those of his ally. Sharing in the defeat, he lost Florida and showed up Spanish naval and military weakness. In the American Revolution Charles III was caught between a desire to embarrass his colonial rival, which accounts for his undercover aid to the American revolutionaries from 1776, and fear for his own American possessions, which led him to offer his mediation in 1779. When Great Britain refused his conditions, he declared war, but at the same time he refused to recognize United States independence. Charles was more successful in strengthening his own empire. Commercial reforms, designed to open new routes and new ports for trade between Spain and the colonies, were undertaken from 1765. Territorial readjustments were carried out in the interest of defense, and a modern administrative organization, the intendant system, of French origin and already operating in Spain itself, was introduced. Released from the former commercial restrictions, secured against attack, and with the prospect of better administration, the Spanish empire under Charles III assumed a new look.

In Spain Charles was concerned to make himself more absolute and therefore better able to undertake reform. His ecclesiastical policy was conditioned by his determination to complete the subordination of the church to the crown. He allowed no papal bulls or briefs in Spain without royal permission. He particularly resented the Jesuits, whose international organization and attachment to the papacy he regarded as an affront to his absolutism. Suspecting their loyalty and obedience to the crown in the American colonies, he also chose to believe that they were the instigators of the violent riots in Madrid and elsewhere in 1766. After a commission of investigation, he ordered their expulsion from Spain and the colonies (1767). In 1773, co-operating with the court of France, Charles succeeded in procuring from the papacy the complete suppression of the society. Charles's opposition to ultramontanism also led him to curb the arbitrary powers of the Inquisition, while his desire for reform within the church caused him to appoint inquisitors-general who preferred persuasion to force in ensuring religious conformity.

Charles III improved the agencies of government through which the will of the crown could be imposed. He completed the process whereby individual ministers replaced the royal councils in the direction of affairs. In 1787 with the assistance of Floridablanca he co-ordinated the various ministries by establishing a *junta de estado* whose regular meetings could produce a concerted policy. He tightened crown control of local government by stimulating his intendants and giving the council of Castile supervision of municipal finances. The objective of his government was to create the conditions in which industry and trade could improve. By the end of his reign Spain had abandoned its old commercial restrictions and, while still excluding foreigners, had opened up the entire empire to a commerce in which all its subjects and all its main ports could partake. Protected against foreign competition, the native cotton industry grew rapidly, and the state itself intervened in the production of luxury goods. Charles III's agrarian policy, however, timid in face of landed interests, failed to deal with the greatest obstacles to agricultural progress and to the welfare of the rural masses in Spain—untilled latifundia and strict entail. In fact strength rather than welfare was the aim of Charles III. Within these limits he led his country in a cultural and economic revival, and when he died, in Madrid, on Dec. 14, 1788, he left Spain more prosperous than he had found it.

Bibliography.—M. Danvila y Collado, *El reinado de Carlos III*, 6 vol. (1890–96); F. Rousseau, *Règne de Charles III d'Espagne*, 2 vol. (1907); V. Rodriguez Casado, *Politica interior de Carlos III* (1950). (Jo. L.)

CHARLES IV (1748–1819), king of Spain from 1788 to 1808, was the second son of Charles III of Spain and Maria Amalia of Saxony. He was born at Portici, Italy, on Nov. 11, 1748. His elder brother being unfit to rule, Charles IV succeeded his father in 1788. His political capacities were still untried, but he began by keeping Charles III's policy and ministers. Within four years, however, he had replaced the conde de Floridablanca by the conde de Aranda, and Aranda by Manuel de Godoy (*q.v.*). The political decisions of Charles IV have usually been attributed to the influence of his wife, Maria Luisa of Parma, a strong-willed and meretricious woman, eager to satisfy her passions and to gratify her lover Godoy. While Charles certainly possessed little intelligence or will power and undoubtedly listened to her and to Godoy, it was the French Revolution that disrupted the Spain of Charles IV and determined the course of his rule (*see* Spain: *History*). From 1796 Spain was dragged through France's wars in a satellite role. By 1808 Charles's son Ferdinand was heading an opposition faction which Godoy attempted to expose but which was highly useful to Napoleon. Threatened from within and without Charles decided to embark for America. He got no further than Aranjuez. There an insurrection, organized and led by the Fernandista party, broke out on March 17, 1808. As a result Godoy was relieved of his offices and imprisoned, while Charles abdicated the crown to Ferdinand. He soon retracted and put himself at the mercy of Napoleon. The latter by threats and deception got the new king to leave Madrid and lured him to Bayonne for an interview. There he obtained Ferdinand's abdication of the crown in favour of Charles IV and, immediately after, Charles IV's abdication in his own favour (May 5, 1808). Charles then retired to Rome where he died on Jan. 20, 1819.

Bibliography.—Andrés Muriel, *Historia de Carlos IV*, 6 vol. (1893–94); Gomez de Arteche, *Historia del reinado de Carlos IV* (1892); A. Savine, *L'Abdication de Bayonne* (1908); C. Corona, *Las ideas politicas en el reinado de Carlos IV* (1954). (Jo. L.)

CHARLES VIII (Karl Knutsson) (1408 or 1409–1470), king of Sweden from 1448, was a scion of Sweden's highest nobility. In 1436 he joined the noble faction supporting the peasants' revolt against Eric of Pomerania, king of the Northern union of Denmark, Sweden and Norway. Without scruples, Charles played king, *riksråd* and peasant leaders off against one another. In the end he helped to subdue the revolt. In 1438 he was elected regent of Sweden. Thus established, he led the Swedish resistance to Eric, who was deposed. When Christopher (*q.v.*) of Bavaria, already king of Denmark, was elected king of Sweden in 1440, Charles could not but acquiesce. He was then accorded considerable advantages, which allowed him to establish himself at Viborg castle in Finland. In 1448 Christopher III died, and Charles succeeded in having himself elected king, though some powerful nobles were against him.

In his foreign policy Charles aimed at substituting Swedish hegemony in the north for the joint system of the Northern union. At home, he reclaimed many royal fiefs from the nobles, and penalized the church for its long abuse of its economic privileges. These policies he sought to strengthen by nationalistic propaganda. By 1457, Charles had spent his resources in lost campaigns abroad, while at home church and nobility united against him. He had to flee, and Christian I of Denmark was elected king. Recalled in 1464, Charles fled again in 1465 but was finally reinstated in 1467. Henceforth he was king in name only; the real power lay with the nobles. He died in Stockholm on May 15, 1470.

See I. Andersson, *History of Sweden* (1956). (G. T. We.)

CHARLES IX (1550–1611), king of Sweden, was born Oct. 4, 1550, the youngest son of Gustavus I Vasa (*q.v.*) and his second wife, Margareta Leijonhufvud, and by his father's will became in 1560 duke of Södermanland, Närke and Värmland. In 1568 he was one of the leaders of the rebellion which deposed his half-brother Eric XIV and put his other brother on the throne as John III. His subsequent relations with John were uneasy. Charles was grasping, ambitious and tenacious of his rights as duke, while John was morbidly suspicious of his loyalty. Charles disliked John's religious policy: his own religious position was intermediate between Lutheranism and Calvinism, which he sought to unite in common action against Rome. He successfully excluded John's new liturgy from his duchy and gave asylum to Lutherans fleeing from the persecution in Sweden. When, in Nov. 1592, John was succeeded by his son Sigismund, king of Poland since 1587 and a zealous Roman Catholic, Charles used the church's fear of Rome and the aristocracy's fear of absolutist rule by an absentee monarch to force Sigismund to guarantee Lutheranism in Sweden and to have himself appointed as regent, ruling in conjunction with the aristocratic council.

Charles, however, distrusted the nobility; he was ambitious, and perhaps already contemplated usurping the throne. By 1596 he had quarreled irrevocably with the council, and in 1597 summoned a diet to Arboga in defiance of the council's advice and of Sigismund's prohibition. The majority of the council now fled to Poland; Sigismund was defeated by Charles at Stångebro in 1598; in 1599 he was deposed in Sweden and Charles became king in all but name, though he was not crowned until 1607.

Charles had taken a savage vengeance on his noble opponents and throughout his reign his relations with the nobility remained tense. He relied on the political support of the commonalty, exploiting their social grievances and playing on their emotions by crude but effective demagogy. The deposition of Sigismund entailed a war with Poland; and though Charles succeeded in preserving Estonia for Sweden, he suffered at Kirkholm (1605) one of the most disastrous defeats in Swedish military history. His intervention in Russia, though perhaps necessary to prevent Polish control of that country, proved unfortunate; and his provocative policy toward Denmark led to a costly war (1611).

Charles was an excellent administrator, a fair theologian and a competent commander who appreciated the value of the new tactics used by the Dutch. He greatly benefited Sweden by his vigorous development of metallurgical industries, by introducing foreign technicians and entrepreneurs and by sponsoring the printing of the medieval "Land-Law." He is popularly honoured as the saviour of Swedish Protestantism. But he was not an attractive character; ruthless, unscrupulous and choleric, brutal and coarse in speech and action, he tried to rule by means of a diet subordinated to his will and by a system of delation and terror which reflected the insecurity of his position. In 1579 he married Maria of the Palatinate (d. 1589) and in 1592 Christina of Holstein: the eldest son of this marriage was his successor, Gustavus II Adolphus. He died on Oct. 30, 1611.

Bibliography.—E. Hildebrand, *Gustav Vasas söner* (1923); S. U. Palme, *Söderköpings riksdag* (1952), *Sverige och Danmark, 1596–1611* (1942) and "Karl IX—bondekonung?" *Svensk tidskrift* (1943); H. Block, *Karl IX som teolog och religiös personlighet* (1918). (Mi. R.)

CHARLES X Gustavus (1622–1660), king of Sweden from 1654, was born at Nyköping castle on Nov. 8, 1622, the son of

John Casimir, count palatine of Zweibrücken, and Charles IX's eldest daughter Catherine. He received a thorough education, rounded off with an extensive tour abroad (1638–40). When he returned to the Swedish court he became secretly betrothed to Queen Christina, then still a minor. In 1642 he joined the Swedish armies in Germany, under Lennart Torstensson. Back in Sweden in 1645, he found that Christina had broken their engagement. His efforts to regain her hand proved fruitless, but she secured his appointment as generalissimo of the Swedish forces in Germany (1648), though many nobles, including Axel Oxenstierna (*q.v.*), opposed this move. In 1649 she went further and declared him her successor; next year he was recognized as heir to the throne. After her abdication he was crowned king (June 6, 1654).

Charles's first task was to tackle the country's chaotic finances. In the *riksdag* of 1655, with support from the commons, he imposed the so-called Reduction, a law requiring nobles to give up a quarter of their crown land holdings; and he reserved the right of further such request, much though the nobles opposed him. Little, however, was done to carry out these measures: during most of his reign, Charles was too busy with his wars.

In 1655 the estates sanctioned war against Poland. Charles's own advice no doubt influenced the decision, but Sweden's role as a new great power was at stake. War was declared because the Polish Vasas claimed the Swedish crown; the real reason was a hope for territorial gains on the southern Baltic shore to form a link between Sweden's eastern and western possessions there and to advance toward control of the Baltic. Besides, Charles feared that the Russians might exploit a time of Polish crisis by moving westward. The Poles would not ally themselves with him to check the Russians, so Charles had now to fight Poland.

At first success in Poland was so complete that Charles extended his aims. Before the end of 1655 Cracow had surrendered, John Casimir, the Polish king, had fled to Silesia and Charles had had himself proclaimed king. Early in 1656 Frederick William, elector of Brandenburg, was forced into an alliance and had to acknowledge Sweden's sovereignty over East Prussia. Yet despite his brilliant victories (*e.g.*, at Warsaw in July 1656), Charles could not subdue the growing opposition of the Polish guerrillas, and his various plans for the partition of Poland were never realized. In June 1656 the Russians had begun hostilities: the Swedish army in ravaged Poland was in danger. The Danish declaration of war in June 1657 therefore came almost as a relief. Charles left Poland with his army and directed a surprise attack against Denmark from the south—the stratagem that Torstensson had used against Christian IV in 1643. Jutland was occupied during the autumn of 1657, and early in 1658 the extremely severe frost led Charles to venture upon one of the most daring undertakings in modern military history—the crossing of the frozen Belts. In panic the Danes agreed to the hard terms imposed at Roskilde (Feb. 26, 1658) whereby Sweden received the provinces of Skåne and Bohuslän and other territories.

Charles now prepared for an attack on Brandenburg, which together with Austria had joined Sweden's enemies. For this, however, he required French or English support, and there was little likelihood of either. He therefore decided instead on a second attack on Denmark, as the Danes had become too friendly with the Dutch and stubbornly refused to comply with certain conditions of the peace. His aim this time was the complete conquest of Denmark and the creation of a unified northern state, but Copenhagen was energetically defended by the Danes. The Swedish position was already difficult when, on Feb. 13, 1660, Charles suddenly died in Göteborg at the *riksdag*, which had been summoned to decide on new taxes and levies. As a military commander Charles X was outstanding. In his campaigns he showed great daring, mobility and ruthless energy. As a diplomat and statesman he displayed the same qualities, but his active imagination and his fondness for new alignments to suit changing conditions make his plans seem somewhat hazardous and incoherent. In Oct. 1654 he had married Hedvig Eleonora of Holstein-Gottorp, by whom he had a son, Charles XI, who succeeded him.

Bibliography.—J. L. Carlbom, *Karl X Gustav* (1910); H. Rosengren, *Karl X Gustaf före tronbestigningen* (1913); T. Gihl, *Sverige och västmakterna under Karl X Gustavs andra krig med Danmark* (1913); S. Bonnesen, *Karl X Gustavus* (1957). (N. G. R.)

CHARLES XI (1655–1697), king of Sweden from 1660 to 1697, was born in Stockholm on Nov. 24, 1655, the only son of Charles X Gustavus and of Hedvig Eleanora of Holstein-Gottorp. He succeeded to the throne before he was five years old and, the provisions for a regency made by his father being set aside, the nobility gained complete control of state affairs during Charles's minority. The new king was not a strong child, and the queen mother, in her natural and sensible desire to improve his physical health, managed to limit strictly the time he spent on bookish studies. The shortcomings of Charles's formal education were not therefore due to neglect, as frequently asserted, but to a calculated preference for open air pursuits. However, the king was always an eccentric speller and throughout life tended to prefer oral consultation with experts to the perusal of letters and memoranda. From childhood onward he sought comfort and support in religion, which increasingly coloured and dominated his life.

When Charles was declared of age in 1672, observers took for granted his devoutness but many were taken aback by his shrewdness in political matters. It became obvious that he had been considerably influenced by men of the royalist party within his household, who advocated the resumption of alienated crown lands both as a measure directed against the power and the riches of the nobility and as a means to provide a sound financial backing for increases in the armed forces without recourse to foreign subsidy treaties. Charles XI's shyness as well as his loyalty to the former regents postponed sweeping changes and rendered his assumption of personal government rather nominal in the years 1672–75. But the war in which Sweden thereafter became involved (*see* SWEDEN: *History*) sealed the fate of the regents and of the nobility as a class. King and country alike were indignant at the bad state of the army and navy; Charles now broke with the majority of the council and began to rely on military and civil advisers of the reform party. Once peace was restored in 1679, a reform program was put into effect: former regents and councilors found guilty of maladministration were heavily fined, alienated crown lands were resumed and a strong army and navy financed from the proceeds, and a bureaucracy loyal to the crown was recruited. Parallel with this development—indeed a necessary complement to it—absolutism gradually emerged as the form of government.

The decisiveness of Charles XI's personal initiative in the events of 1675 to 1693 must remain a matter of opinion, but the importance of the moral command of the king, earned by his patriotic and inspiring role in the war years, should not be underrated. Although the previously accepted picture of an iron-willed, dominating personality has to be modified to show a ruler less consistent, more easily swayed by advisers, the persistence with which Charles XI stuck to the main aims of the reform program provides the essential continuity in the revolutionary 1680s and '90s, transcending changes in policy and personnel within the royalist party. In the war years Charles XI, though no great tactician, had provided leadership and had shown a willingness to take risks which materially contributed to Sweden's victory over Denmark; in the period of reform the king's drive, his suspicious control and his relentless devotion to hard work were significant factors in the success achieved. The military reorganization and the inspection and training of troops were of particular interest to him, as was the building of churches and the furthering of the religious instruction of his subjects. On religious grounds he objected to the serfdom which existed in the Swedish trans-Baltic provinces, but he was unable to abolish it owing to the opposition of the local estates.

In his personal life Charles loved very deeply his wife, the Danish princess Ulrika Eleonora, whom he married in 1680 and who bore him seven children before her death in 1693. He was a devoted father and his concern for the first-born boy (afterward Charles XII), his only son to survive infancy, found expression in a careful preparation of the prince for his future kingship.

Charles XI never felt well after his wife's death and he died, prematurely, of cancer of the stomach, in Stockholm on April 5, 1697. In adult life his temper had been hot; his long final illness he bore with marvelous patience. He was hated in his lifetime by those families hit by the resumption of crown land and by those who disapproved of the absolutist form of government, but the reforms carried out in his reign were of fundamental importance.

See A. Åberg, *Karl XI* (1958). (R. M. Ha.)

CHARLES XII (1682–1718), king of Sweden from 1697 to 1718, was born on June 17, 1682, the second child and eldest (and only surviving) son of Charles XI of Sweden and Ulrika Eleonora of Denmark. His early childhood was happy and secure, but the close family circle was broken by Ulrika Eleonora's death in 1693. Charles XI's chief consolation in his grief was a close companionship with his heir, and from this time onward Prince Charles accompanied his father on travels of inspection, on military exercises and on all kinds of official occasions as well as sharing his leisure hours. Charles XI's death in April 1697 meant that Charles XII had to take on the burden of absolute kingship—he was the first and only Swedish king born to absolutism—when he was barely 15 years old. Charles XI stipulated a regency for his son, but the regents (possibly influenced by what had happened to the regents of Charles XI's minority) proved anxious to get the new king's concurrence in all decisions and the *riksdag* called in Nov. 1697 declared him of age.

Charles XII had been carefully prepared for his task; he had been given excellent tutors and governors and was reckoned a model pupil. He showed, however, signs of an exceptionally strong will and gave repeated proof of his obstinate adherence to those standards he accepted from the religious and moral teaching of his family and his governors. In adolescence he gave much anxiety to those responsible for his safety by a personal program for toughening his physique. In particular, his intrepid horsemanship and his predilection for risks worried the old and staid among the courtiers. His nature had been open and confiding; but on succeeding to the crown he forced himself to assume a noncommittal and inscrutable behaviour in public, though in private he was much influenced by the instructions which his father had left for his guidance in matters of policy and by the men who had been in his father's confidence, especially Carl Piper.

Military Leader, 1700–09.—In accordance with traditional Swedish foreign policy, Charles sanctioned the marriage of his elder sister Hedvig Sophia with the duke of Holstein-Gottorp in 1699. Negotiations for his own marriage to a Danish cousin, the daughter of Christian V, were begun on Denmark's initiative but were kept inconclusive by Charles's advisers till the outcome of Danish negotiations with other powers should be known. These negotiations led in fact to a coalition between Denmark, Saxony and Russia, which, by attacking Sweden in the spring of 1700, began the Northern War (*see* Northern War; Sweden: *History*). The speedy success hoped for by the three allied powers did not materialize; rumours of rebellion by the Swedish nobility in case of war proved false and Charles XII soon showed that he had inherited a predisposition toward military skill which he did all in his power to develop. The early campaigns—the descent on Zealand (Aug. 1700) which forced Denmark out of the war, the battle of Narva (Nov. 1700) which drove the Russians away from the Swedish trans-Baltic provinces and the crossing of the Düna (1701) which scattered Augustus II (*q.v.*) of Poland's Saxon troops—were all planned and controlled by the officers whom Charles XII had inherited from his father and who had been guiding his own education in the art and science of war; but the king gave valuable help in fostering morale by his courage, his willingness to take risks, his religiously coloured optimism and his faith in the just cause of Sweden as the victim of a concerted attack.

Charles's actual responsibility in planning and executing armed operations constantly increased, so that from 1702 he became the equal of Karl Rehnskiöld and the superior of the rest of his officer corps. Also from 1702 the king began to take a greater part in political decisions, since the men who had done the preliminary work on such matters—Count Bengt Oxenstierna, Samuel Åkerhielm and Thomas Polus—died or retired through ill-health. Most significant of these personal decisions was that to fight Augustus II (elector of Saxony as well as king of Poland) in Poland and to transform Poland from a divided country, where Augustus had both partisans and opponents, into an ally and a base for the final campaign against Russia. This transformation was to be accomplished by dethroning Augustus and substituting a Polish-born king willing to co-operate with the Swedes. Charles argued that this might lead to the acquisition of the duchy of Courland by Sweden, while Poland would be compensated by land in the east and southeast lost to Russia in the 17th century. By the time this program had been brought to success and Stanislaw Leszczynski elected king of Poland—Augustus being forced to accept the settlement by a Swedish invasion of Saxony in Sept. 1706—Charles XII had matured both as a general and as a statesman. The war effort in its military and organizational aspects absorbed nearly all his energies. He was deeply conscious of the issue at stake—the fight for Sweden's great power status—and showed a predilection for radical solutions which he hoped would safeguard this position more permanently than had the efforts of his ancestors.

Charles was not unmindful of Sweden's role in central and western Europe; his support of the Silesian Protestants against the Catholic Habsburg emperor was firmly based on the Swedish guarantee of the peace of Westphalia and he continued that policy of the "balancing role" between the great coalitions of the west to which Swedish rulers and statesmen since 1660 had aspired in the hope of achieving prestige and territory by armed mediation in suitable circumstances. His first necessity in 1706, however, was to secure Sweden's position in relation to Russia, which, under Peter the Great, had from 1703 onward made good use of Charles XII's campaigns in Poland to train its army and undertake a piecemeal conquest of the Swedish east-Baltic provinces. Charles's troops left Saxony to invade Russia in the late autumn of 1707. They won the battle of Holowczyn in July 1708, but Russian scorched-earth tactics forced Charles to abandon his route to Moscow and turn instead into the Ukraine. Thereafter the Russians interfered successfully with the Swedes' communications and by the summer of 1709 Charles XII had no choice between accepting battle with the Russians or withdrawing once more into Poland. In the hope of a successful outcome which would strengthen his position in negotiations with Turkey, Charles, though wounded in the foot and unable to lead the army in person, chose battle and attacked the Russian fortified camp at Poltava on July 8 (new style; June 27, old style; June 28, Swed. style). The attack failed, and three days later the bulk of the Swedish army surrendered to the Russians. Charles was by then already on his way to Turkish-held territory, where he hoped to find allies.

Exile in Turkey, 1709–14.—Turkey's desire to reconquer Azov from Peter the Great augured well for its co-operation with Charles XII, but in the event—in spite of four Turkish declarations of war against Russia—the Swedish king was unable to pursue his plans vigorously since the army expected from Sweden never arrived. He became the object of Turkish intrigues and at one time (Feb. 1713) had to fight a regular battle, the *kalabalik* of Bender (mod. Bendery), to avoid a plot to deliver him into the hands of Augustus of Saxony, now restored in Poland. The closing of the Turko-Habsburg frontier due to an epidemic of plague, and the determination of the anti-French alliance in the War of the Spanish Succession to prevent Sweden from using its bases in Germany to attack its enemies, further circumscribed Charles XII's freedom of action in these years. The Swedish council, virtually in charge of affairs at home during his absence, was preoccupied with threats to Sweden from Denmark. The administrative and financial reforms which Charles promulgated from Turkey in order to distribute the burden of the war effort fairly and to increase both resources and efficiency were on the whole sabotaged and were put into effect only after his return to Swedish Pomerania in Nov. 1714 (having posted and ridden incognito, but with imperial permission, through

Habsburg and German lands, from Turkey to Stralsund, in 14 days and nights).

Last Years, 1714–18.—For more than a year Charles fought a delaying action in Pomerania to keep Swedish troops on German soil as long as humanly possible, attempting at one and the same time to restore the prestige of Swedish arms, to keep the war away from Sweden itself and to prepare his diplomatic offensive for splitting the coalition, now augmented by Hanover and Prussia. A subsidy treaty with France, intrigues with the Jacobites to threaten the elector of Hanover in his position as king of England, and separate negotiations with his enemies averted the danger to Sweden once Charles in Dec. 1715 had been forced to leave Stralsund and Wismar to their fate; and the projected invasion of Scania (Skåne) never took place.

From 1713 onward Charles had realized that sacrifice of territory would be necessary, but was set on retaining Sweden's great power status either by ceding land for money for a given number of years only, not in perpetuity, or by allowing outright cession only as the price for guaranteed and considerable military help. The complicated negotiations of the years 1715–18 for equivalents and compensations must be seen in this context. Charles XII argued that any satisfactory peace on these lines could only be gained if military action backed up the diplomatic effort; to some extent, therefore, all negotiations, and especially those with the Russians at Åland throughout the year 1718, were designed to gain time. By the autumn of 1718 Charles XII had collected an army of 60,000 men but his strategic plan was never fully unfolded, for at the siege of Fredrikshald (Halden) at an early stage in the invasion of Norway he exposed himself to fire from the fortress (as part of his morale-building example for troops digging trenches under bombardment) and was on Nov. 30, 1718, fatally shot through the head. Rumours that he had been killed by someone from his own side began to circulate shortly after his death. The historical debate on this question continues, but the weight of the available evidence favours the view that Charles XII was killed by an enemy bullet.

Character.—Charles XII was not the simple and uneducated soldier-king he has often been made out to be. His intellectual pursuits were many and varied. He was always interested in architecture and in painting; he had favourite books that accompanied him everywhere; he could quote contemporary Swedish poetry and liked to argue theology and philosophy. His real bent was mathematical and scientific. He liked travel and treasured the paintings and prints from the Holy Land and the near east which Swedes sent by him on expeditions from Turkey collected for him. He became increasingly occupied with new ideas in administration; with men like Casten Feif in Turkey he discussed the books of fashionable cameralists and economists and from these talks developed a correspondence, penned by Feif but frequently quoting the king's own words and penetrating comments, with learned men and practical reformers in Sweden. Against this background must be seen Charles XII's ordinances for a reshaping of the Swedish bureaucratic organization. Many of these reforms were far ahead of their time.

Charles's character was complex, involving opposing trends. Kindhearted, he had to steel himself to say no; yet by virtue of his own sacrifices and devotion to duty he came to demand if not equal at least considerable sacrifices on the part of those classes in Sweden who were lukewarm about the war effort once the years of bad fortune set in after 1709. A youthful longing for romantic love, to be loved for his own sake, had to be buried in the harsh life of the soldier and produced, not the profligate, but the ascetic and chaste leader whose habits of bachelorhood grew upon him to the extent that his surroundings hardly credited his reiterated, "I'll marry after the war is over." Affectionate to his family, he was torn in two by the factions within it which his own childlessness tended to produce.

In military matters Charles learned from experience to insist on utter secrecy and for this reason he kept even his own officers guessing until the last possible moment. He had a good eye for the strategic battle place; he was concerned—both by temperament and by the logic of the Swedish situation—with battles rather than with sieges. He believed in personal leadership in actual battle, founded on a psychological theory of the fighting qualities of the Swedish peasant, who, he argued, could only overcome his phlegmatic and cautious nature when seeing his king sharing the dangers of the fight. He was keenly interested in the improvement of tactics and worked continuously on evolutions and drills which he in person exercised with the various regiments in turn. His ideas on hygiene and his avoidance of camp quarters were based on experience and in many ways ahead of his time.

Firmly believing in his responsibility to God, Charles held that the fortunes of war had taught him that one could not always be lucky, but one could always be honourable. He was against double-dealing and against the easy pledging of one's word only to break it at the first suitable opportunity. A self-righteous contempt for the behaviour of rulers which did not fit into his own moral code is evident. He lacked psychological insight into men's motives, probably because of his early assumption of the crown, and having been born to absolutism did not realize the strength of the antiabsolutist forces in Sweden. However, he had no illusions about his real power: "They will not obey me now when I am alive," he said once in answer to an appeal to settle the succession: "how can I expect them to obey me when I am dead?"

See Frans G. Bengtsson, ***Karl XII:s Levnad***, 2 vol. (1935–36; Eng. trans. by N. Walford, ***The Life of Charles XII***, 1960); Otto Haintz, ***König Karl XII von Schweden***, 3 vol. (1958). (R. M. Ha.)

CHARLES XIII (1748–1818), king of Sweden from 1809 and Norway from 1814 to 1818, was born at Stockholm on Oct. 7, 1748, the second son of Adolphus Frederick, king of Sweden, and Louisa Ulrica, sister of Frederick II of Prussia. In 1772 Charles assisted his brother Gustavus III (*q.v.*) in his *coup d'état* against the regime of the Hat and Cap parties, and for his services he was created duke of Södermanland. During the Russo-Swedish War (1788–90) he served as admiral of the fleet at the battles of Hogland (July 1788) and Öland (July 1789). In March 1792, Gustavus III died and Charles became regent for the young king, Gustavus IV Adolphus. The real ruler of the country, however, was G. A. Reuterholm, under whom the regency, despite its liberal promises, slid into despotism, while indecision marked its foreign policy. On the accession of Gustavus IV in Nov. 1796, Charles lost his influence in politics. On March 13, 1809, however, Gustavus was deposed and Charles became regent again. He was proclaimed king of Sweden on June 6, 1809.

Charles had grown prematurely old: the government was taken over for him by J. Bernadotte (*see* CHARLES XIV) who landed in Sweden in Oct. 1810 and was adopted by Charles as his son. The only child of Charles XIII's marriage (1774) with his cousin Hedvig Elizabeth Charlotte of Holstein-Gottorp had died in infancy (1798). By the treaty of Kiel (Jan. 1814), which detached Norway from Denmark, Charles became the first king of Sweden and Norway. He died at Stockholm on Feb. 5, 1818.

See E. Hildebrand and L. Stavenow (eds.), *Sveriges Historia till våra dagar*, vol. x (1925), vol. xi (1923); I. Andersson, *History of Sweden* (1956). (E. O. H. J.)

CHARLES XIV JOHN (CARL JOHAN; originally JEAN BERNADOTTE) (1763–1844), king of Sweden and Norway, was born the son of an *avocat* at Pau in Béarn, France, Jan. 26, 1763. In 1780 he enlisted in the French army and in 1790 became adjutant, in Nov. 1791 a sublieutenant, and in 1794 brigadier general. During the campaigns in Germany, the Low Countries and Italy he restrained his troops from plundering and gained a reputation as a disciplinarian. Bernadotte first met Napoleon Bonaparte in 1797, in Italy. Their relationship, at first friendly, was soon embittered by rivalries and misunderstandings.

In Jan. 1798 Bernadotte, expected to succeed Bonaparte in command of the army of Italy, was appointed ambassador to Vienna, but his mission ended in April. On Aug. 17, 1798, having returned to Paris, he married Désirée Clary, Napoleon's former fiancée and the sister of Joseph Bonaparte's wife, Julie.

Bernadotte campaigned in Germany during the winter following his marriage, and from July to Sept. 1799 he was minister of war. His growing fame, however, and his contacts with the Jacobins, irritated the prominent director, E. J. Sieyès, who engineered his removal. In Nov. 1799 Bernadotte refused to assist Bonaparte at the *coup d'état* of Brumaire, but neither did he defend the Directory. He was a councilor of state from 1800 to 1802 and became commander of the army of the west. In 1802 he fell under suspicion of complicity in the Rennes plot and, although no evidence has been found that he was involved, it is clear that he would have favoured constitutional limitation of the powers of the first consul or even his overthrow. In Jan. 1803 Bonaparte appointed Bernadotte minister to the United States, but Bernadotte delayed his departure because of rumours of approaching war between France and England and remained in Paris inactive for a year. When, on May 18, 1804, Napoleon proclaimed the empire, Bernadotte declared full loyalty to him and, in May, was named marshal of France. In June he took up the post of military and civil governor of Hanover. While in office there, he attempted to set up an equitable system of taxation. At this time also he began to accumulate a sizable fortune with the "gifts" from Hanover and Bremen.

In 1805, Bernadotte was given command of the I corps during the Austrian campaign. Difficulties delayed his march toward Vienna, and in the battle at Austerlitz the corps played a dramatic but somewhat minor role; nevertheless Napoleon gave Bernadotte command of the occupation of Ansbach (1806) and on June 5, 1806, made him prince of Pontecorvo. Bernadotte and his corps did not participate actively in the battles of Jena and Auerstädt (Oct. 1806), but nevertheless he was given enlarged responsibility in the Polish campaign, and in Jan. 1807 he defeated the Russians at Mohrungen. In July 1807 Bernadotte was named governor of the occupied Hanseatic cities. He was scheduled to lead a campaign against Sweden but this was abandoned, and in 1809 he took part in the Austrian campaign as commander of the IX corps. In the battle of Wagram he lost more than one-third of his soldiers and then returned to Paris "for reasons of health" but obviously in deep disfavour. Napoleon, however, next put him in command against the threatened British invasion of the Netherlands; Bernadotte ably organized the defense, but the British Walcheren expedition was fatally weakened by disease and had to withdraw. When Bernadotte returned to Paris, political suspicions still surrounded him, and his position remained uncertain.

Dramatic new possibilities, however, now opened up to him: he was invited to become crown prince of Sweden. In 1809 a palace revolution had overthrown King Gustavus IV of Sweden and had put the aged, childless Charles XIII (*q.v.*) on the throne. The Danish prince Christian August had been elected crown prince but died suddenly in 1810, and the Swedes turned to Napoleon for advice. The emperor, however, was reluctant to exert a decisive influence, and the initiative fell to the young Swedish baron Otto Mörner. Mörner approached Bernadotte since he respected his military ability, his skilful and humane administration of Hanover and the Hanse towns and his charitable treatment of Swedish prisoners in Germany. The *riksdag*, influenced by similar considerations, by their regard for French military power and by financial promises from Bernadotte, abandoned other candidates, and on Aug. 21, 1810, Bernadotte was elected Swedish crown prince. On Oct. 20 he accepted Lutheranism and landed in Sweden; he was adopted as son by Charles XIII and took the name of Charles John (Carl Johan). The crown prince at once assumed control of the government and acted officially as regent during the illnesses of Charles XIII. Napoleon now tried to prevent any reorientation of Swedish foreign policy and moreover sent an immediate demand that Sweden declare war on Great Britain; the Swedes had no choice, but though technically in a state of war between 1810 and 1812 Sweden and Great Britain did not come to active hostilities. Then, in Jan. 1812, Napoleon suddenly occupied Swedish Pomerania.

Charles John was anxious to achieve something for Sweden which would establish him and his dynasty in power. To that purpose he could, as many Swedes wished, have regained Finland from Russia, either by conquest or by negotiation. Political developments, however, prompted another solution, namely the conquest of Norway from Denmark, based on a Swedish alliance with Napoleon's enemies. An alliance was concluded with Russia in April 1812, others with Great Britain and Prussia in March and April 1813, the British granting a subsidy for the proposed conquest of Norway. Urged by the allies, however, Charles John agreed to take part in the great campaign against Napoleon and to postpone his war with Denmark. The crown prince landed his troops at Stralsund in May 1813 and soon took command of the allied army of the north. Although the Swedish troops contributed to the allied successes, Charles John intended to conserve his forces for the war with Denmark, and the Prussians bore the brunt of the fighting.

After the decisive battle of Leipzig (Oct. 1813) Charles John succeeded in defeating the Danes in a swift campaign and forced King Frederick VI of Denmark to sign the treaty of Kiel (Jan. 1814), which transferred Norway to the Swedish crown. Charles John now had dreams of becoming king or "protector" in France. But he had become alienated from the French people, and the victorious allies would not tolerate another soldier in charge of French affairs. Bernadotte's dream dissolved, and his brief visit to Paris after the armistice was not glorious.

New difficulties recalled him to Scandinavia. The Norwegians refused to recognize the treaty of Kiel, and in May 1814 a Norwegian assembly adopted a liberal constitution. Charles John conducted an efficient and almost bloodless campaign and in August the Norwegians signed the convention of Moss whereby they accepted Charles XIII as king but retained the May constitution. Thus, when main force might have established any system (for a time at least), the crown prince insisted on a constitutional settlement.

At the congress of Vienna (1814–15) Austria and the French Bourbons were hostile to the parvenu prince, and the son of the deposed Gustavus was a potential pretender to the throne. But thanks to Russian and British support the status of the new dynasty was undisturbed, and in Sweden its opponents were very few. Upon the death of Charles XIII, on Feb. 5, 1818, Charles John became king of Sweden and Norway and the former republican and revolutionary general became a conservative ruler. His failure to learn Swedish increased his difficulties; yet his experience, his knowledge and his magnetic personal charm gave him preponderant political influence. Though blunt in speech, he was cautious and farsighted in action. His foreign policy led in a long and favourable period of peace, based on good relations with Russia and Great Britain. In domestic affairs, farsighted legislation helped the rapid expansion of Swedish agriculture and the Norwegian shipping trade; in Sweden the famous Göta canal was completed, postwar financial problems were solved and during the reign both countries enjoyed a rapid increase in population. On the other hand, the king's autocratic tendencies, restrictions on the liberty of the press and his reluctance to introduce liberal reforms in commercial and industrial policy and in the organization of the Swedish *riksdag* led to a growing opposition, which culminated during the late 1830s and led to some demands for his abdication. In Norway there was opposition to the Swedish predominance within the union and to the royal influence over the legislature. But the king rode out the storms, and the jubilee in 1843 was an occasion for popular acclaim. Charles John died on March 8, 1844.

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CHARLES XV (1826–1872), king of Sweden and Norway from 1859 to 1872, was born at Stockholm on May 3, 1826, the eldest son of Oscar I of Sweden and Norway and Josephine of Leuchtenberg. In 1850 he married Louisa, daughter of Prince Frederick of the Netherlands. In 1857 his father was struck by illness and Charles became president of the council (June) and regent (September). He succeeded to the throne when his father died (July 8, 1859). Though Charles tried to uphold his rights against the government and the *riksdag*, the royal power was much curtailed during his reign. Among important new liberal measures enjoying his support was the *riksdagsordning* of 1866, which introduced a bicameral system instead of the old estates. A champion of "pan-Scandinavianism" and political solidarity among the three northern kingdoms, Charles gave half-promises of help to Denmark on the eve of the German-Danish War of 1864 over the Schleswig-Holstein question, but Sweden's army was unprepared and the other powers abstained, so that Charles had to remain neutral. He died at Malmö on Sept. 18, 1872. Charles was a stylish and warm-hearted man with a vivid interest in the other sex and was much liked in both his kingdoms. He was an amateur painter and a poet. He left one child, Louisa Josephina Eugenia, who in 1869 had married the crown prince Frederick of Denmark. His brother Oscar II succeeded him as king.

See S. Eriksson, *Carl XV* (1954). (S. C. O. C.)

CHARLES, Prince, of Lorraine (1712–1780), field marshal in the Austrian service distinguished chiefly for his governorship of the Austrian Netherlands. The youngest son of Leopold, duke of Lorraine, he was born at Lunéville on Dec. 12, 1712. After his eldest brother Francis had married the future empress Maria Theresa (Feb. 1736), he became an Austrian officer.

Charles's first taste of active service was against the Turks in 1737 and 1738. When the War of the Austrian Succession broke out in Silesia (1740), Maria Theresa made him a field marshal, and in May 1742 he had his first hostile encounter with Frederick the Great at Chotusitz. In 1743 he was successful against the French and Bavarians.

In Jan. 1744 he married Maria Anna of Austria, Maria Theresa's sister. He and his wife were made joint governors of the Austrian Netherlands, but the princess died within a few months. When hostilities began again (April 1744) Charles crossed the Rhine at the head of an Austrian army, but hurried back to Bohemia when Frederick reopened the Silesian war. He had an early success and the Prussians were quickly expelled. In 1745 he took the field again, but was defeated by Frederick at Hohenfriedeberg and at Soor. Later, as commander in chief in the Low Countries, he was heavily defeated at Roucoux by the French under Marshal Saxe.

Opinions differ as to Charles's ability as a commander; but he was a great success as governor of the Austrian Netherlands during the peace from 1749 to 1756, introducing some enlightened reforms. After the early reverses of the Seven Years' War (*q.v.*) Maria Theresa recalled Charles to supreme command. At the time of Frederick's great victory at Prague (1757) he was shut up in that fortress and took no part in Daun's relief of the city or in the victory at Kolin. Subsequently he beat the Prussians at Breslau; but, after his success over the French at Rossbach, Frederick returned to Silesia and inflicted a crushing defeat on Charles at Leuthen (Dec. 5, 1757), whereupon the prince was relieved of his command. Shortly after he returned to Brussels as governor and remained there until his death at the castle of Tervueren on July 4, 1780.

See L. Perey, *Charles de Lorraine et la cour de Bruxelles sous le regne de Marie Thérèse* (1903). (C. N. B.)

CHARLES (Karl Ludwig Johann) (1771–1847), archduke of Austria and duke of Teschen, third son of the Holy Roman emperor Leopold II, was born at Florence (his father then being grand duke of Tuscany) on Sept. 5, 1771. His youth was spent in Tuscany, at Vienna (1790) and in the Austrian Netherlands, where he began his career of military service in the war of the French Revolution. He commanded a brigade at Jemappes, and in the campaign of 1793 distinguished himself at the action of Aldenhoven and the battle of Neerwinden. In the remainder of the war in the Low Countries he held high commands, and he was present at Fleurus. In 1795 he served on the Rhine, and in the following year he was entrusted with the chief control of all the Austrian forces on that river. At the same time he was given the rank of field marshal general of the empire (*Reichsgeneralfeldmarschall*).

Charles's conduct of the operations against Jourdan and Moreau in 1796 marked him out at once as one of the greatest generals in Europe. At first falling back carefully and avoiding a decision, he finally marched away, leaving a mere screen in front of Moreau; falling upon Jourdan, he defeated him in the battles of Amberg and Würzburg, and drove him over the Rhine with great loss. He then turned upon Moreau's army, which he defeated and forced out of Germany. For this campaign, one of the most brilliant in modern history, *see* French Revolutionary Wars.

In 1797 he was sent to arrest the victorious march of Bonaparte in Italy, and he conducted the retreat of the overmatched Austrians with the highest skill. In the campaign of 1799 he was once more opposed to Jourdan, whom he defeated in the battles of Ostrach and Stockach, following up his success by invading Switzerland and defeating Masséna in the (first) battle of Zürich, after which he re-entered Germany and drove the French once more over the Rhine. Ill-health, however, forced him to retire to Bohemia, from which he was soon recalled to undertake the task of checking Moreau's advance on Vienna. The result of the battle of Hohenlinden, however, had foredoomed the attempt, and the archduke had to make the armistice of Steyer.

In the short and disastrous war of 1805 the archduke Charles commanded what was intended to be the main army, in Italy, but events made Germany the decisive theatre of operations, and the defeats sustained on the Danube neutralized the success obtained by the archduke over Masséna in the desperately fought battle of Caldiero. With the conclusion of peace began his active work of army reorganization, which was first to be tested on the field in 1809. As field marshal of Austria (since the old empire was dissolved) and as president of the council of war, supported moreover by the prestige of being the only general who had proved capable of defeating the French, he promptly initiated a far-reaching scheme of reform, which replaced the obsolete methods of the 18th century, the chief characteristics of the new order being the adoption of the "nation in arms" principle and of the French war organization and tactics. The new army was surprised in the process of transition by the war of 1809, of which Charles was commander in chief; yet even so it proved a far more formidable opponent than the old, and, against the now heterogeneous army that Napoleon controlled (*see* Napoleonic Wars) it succumbed only after a desperate struggle.

At the end of the campaign the archduke gave up all his military offices, and he spent the rest of his life in retirement, except for a short time in 1815 when he was governor of Mainz. In 1822 he succeeded to the duchy of Saxe-Teschen. Charles married, in 1815, Princess Henrietta of Nassau-Weilburg (d. 1829). He had four sons, the eldest of whom, the archduke Albert (*q.v.*), became one of the most celebrated generals in Europe, and two daughters, the elder of whom, the archduchess Theresa, was married to the king of the Two Sicilies in 1837. Charles died at Vienna on April 30, 1847.

The caution that the archduke preached so earnestly in his strategical works (*Grundsätze der Strategie, erläutert durch die Darstellung des Feldzugs von 1796 in Deutschland*, 3 vol., 1814; *Geschichte des Feldzugs von 1799 in Deutschland und der Schweiz*, 2 vol., 1819), he displayed in practice only when the situation seemed to demand it, though his education certainly prejudiced him in favour of the defensive at all costs. He was at the same time capable of forming and executing the most daring offensive strategy, and his tactical skill in handling of troops was certainly equal to that of any leader of his time, with the single exception of Napoleon.

As a military writer, his position in the evolution of the art of war is very important, and his doctrines had the greatest weight. Nevertheless, they cannot but be considered as antiquated even in 1806. Caution and the importance of "strategic points" are the chief features of his system. Charles's theory and his practice form one of the most curious contrasts in military history. In the one he was often unreal, in the other he displayed, besides great skill, a vivid activity that made him for long the most formidable opponent of Napoleon.

See O. Criste, *Erzherzog Carl von Österreich*, 3 vol. (1912).

CHARLES of Blois (*c.* 1319–1364), duke of Brittany, was the son of Guy of Châtillon, count of Blois, and Margaret of Valois, sister of Philip VI of France. His marriage (1337) to

Joan the Lame of Penthièvre (d. 1384), daughter of Guy of Brittany, count of Penthièvre, gave him a right to the succession to Brittany, of which Guy's elder brother John III was duke. When John III died (April 1341), Joan's right of succession was disputed by her surviving uncle John, count of Montfort-l'Amaury, though he had promised to recognize it. John of Montfort was supported by Edward III of England, but Philip VI supported Charles, who captured John at Nantes (1341), besieged his wife Joan of Flanders at Hennebont (1342) and took Quimper (1344). John, however, escaped from prison and defeated Charles's partisans at Cadoret (1345). When John himself died (1345), his widow defended the claims of his son, John IV of Brittany, and Charles was taken prisoner at La Roche-Derrien (1347). Joan the Lame then defended his rights against Joan of Flanders until his release in 1356. English successes prevented the French from giving much help to Charles, but the young Bertrand du Guesclin defended Rennes against Edward III in 1357. Finally Charles was defeated and killed at Auray (Sept. 29, 1364), and Joan of Penthièvre renounced Brittany by the treaty of Guérande (1365). Charles in his lifetime had been venerated as a saint and wonder-worker by the people, and a cult grew up round his grave and relics at Grâces, near Guingamp. A papal inquiry (1371) produced 194 testimonies to his holiness, and in 1904 his beatification was proclaimed.

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CHARLES the Bold or le Téméraire (1433–1477), duke of Burgundy from 1467, was born at Dijon on Nov. 10, 1433, the son of the duke Philip the Good and Isabella of Portugal. French by his paternal ancestry, the count of Charolais (*q.v.*), as he was at first styled, was brought up in the French manner as a friend of the dauphin, afterward Louis XI (*q.v.*) of France, who spent five years in Burgundy before his accession. Betrothed in 1439 to Catherine (d. 1446), the dauphin's sister, and married in 1457 to Isabella (d. 1465), daughter of Charles I of Bourbon, Charles in fact showed no hostility to France until he took over the government of Burgundy in April 1465, during his father's last illness. On his father's death (June 15, 1467), Charles became duke. He then gave rein to his overriding ambition to make Burgundy wholly independent of France and to raise it, if possible, to a kingdom.

Charles was almost entirely successful until 1474. He extended his possessions, organized them as a state and freed them from French control. Much annoyed by Louis XI's repurchase of the towns on the Somme which had been temporarily ceded to Philip the Good by the treaty of Arras (1435), he entered upon his lifelong struggle against Louis and became one of the principal leaders of the League of the Public Weal. After the battle of Montlhéry (July 16, 1465), he forced Louis to restore to him the towns on the Somme in the treaty of Conflans (Oct. 1465) and to promise him the hand of his daughter Anne of France, with Champagne as dowry. But when Louis encouraged Dinant in its revolt against Burgundy, Charles sacked it (1466); and the Liégeois, whom the French were continually inciting to revolt, were defeated in battle and deprived of their liberties after the death of Philip the Good (1467). Charles moreover outdid Louis by obtaining the alliance of Edward IV of England, whose sister Margaret of York he married as his third wife (July 1468). Louis now tried negotiations with Charles at Péronne (Oct. 1468). There, in the course of the discussions, Charles was informed of a fresh revolt of the Liégeois, secretly fomented by Louis. Looking on Louis as a traitor, Charles nevertheless treated with him but at the same time forced him to remove Flanders, Ghent and Bruges from the jurisdiction of the Paris *parlement* and to assist in quelling the revolt; Liège was destroyed and the inhabitants were massacred. The truce was not lasting. Louis cited Charles to appear before the *parlement* of Paris and seized some of the towns on the Somme (1470–71). The duke retaliated by invading Normandy and the Île-de-France, ravaged the country as far as Rouen, but failed in an attack on Beauvais (1471–72). A truce was made (Nov. 1472) and Charles decided to wait, before renewing his attempt, for assurances of further help from Edward IV and for the solution of the problem relative to the eastern border of his states.

Charles wished to extend his territories as far as the Rhine and to make them into a single unit by acquiring the lands between Burgundy, Luxembourg and the Netherlands. He lost no opportunity: he purchased the county of Ferrette, the landgraviate of Alsace and some other towns from the archduke Sigismund of Austria in 1469; he secured for himself the inheritance of the old duke Arnold of Gelderland in 1473; and he set nominees of his own in certain other places and wished to do the same at Cologne, where he intended to install a garrison as it was both an important centre of trade and an imperial electorate. To achieve his territorial aims, it only remained for him to subdue the Swiss cantons and to get Lorraine from René II (René of Vaudémont).

Meanwhile Charles had been reorganizing his army and the administration of his territories. Statutes promulgated at Thionville (1473) instituted companies of four squadrons, at his expense, and made rules for discipline and tactics; Charles also had many excellent guns cast. He hired mercenaries and took many Italian *condottieri* into his service. Intending to centralize the government, he created by statute a single *chambre des comptes* for the Netherlands, a *chambre du trésor* to survey the administration of the domain and a *chambre des généraux* to control the collection of taxes. He exacted very heavy taxes indeed from the estates-general, which became a regular institution in his territories. Moreover, he established the *grand conseil* at Malines, with jurisdiction to supersede that of the *parlement* of Paris, which he no longer recognized, and another *parlement* meeting alternately at Beaune and at Dole.

It remained for Charles to acquire a royal title. For a short time he entertained designs on the imperial crown; but this he renounced. On the other hand, he believed that he had persuaded the emperor Frederick III, in the course of conversations at Trier (Trèves), to agree to crown him king. The royal insignia were ready and the ceremony arranged, when Frederick precipitately fled by night (Sept. 1473). He probably was suspicious of the ambitious Charles.

In less than three years, Charles's dream vanished. The crown had slipped through his fingers. He was obliged to give up his plan of taking the little town of Neuss, which he had unsuccessfully besieged for 11 months (July 1474 to June 1475), from the citizens of Cologne. Moreover, the treaty of Picquigny (Aug. 29, 1475) concluded by Edward IV and Louis XI made certain the defection of his English ally. Attacked by René of Lorraine, who had signed an agreement with Louis XI (Aug. 1474), and by a coalition of the Swiss, Sigismund of Austria and the towns on the upper Rhine, Charles took Nancy in Nov. 1475; but in March and in June 1476, he was defeated by the Swiss, at Grandson and at Morat. Next October he lost Nancy. Then, on Jan. 5, 1477, a further battle was fought outside Nancy, and Charles himself was killed; his mutilated body was discovered some days later.

The fragility of his achievement is proved by its rapid disintegration during the minority of Mary, his daughter by Isabella of Bourbon. Yet Charles the Bold was not merely a belated representative of the chivalrous spirit; he was a man of wide knowledge and culture, already a prince of the Renaissance. His haste, his lack of adaptability and his obstinacy lost him much more than did his visionary approach and his boldness.

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CHARLES (953–*c.* 992), duke of Lower Lorraine, was a younger son of Louis IV, king of France, and thus a member of the Carolingian family. He received the duchy of Lower Lorraine in 977 from the emperor Otto II, with whom he allied himself against his own brother King Lothair. After Otto's death (983) he was reconciled with Lothair. When Lothair's son and successor Louis V died without issue in 987, Charles was the only Carolingian claimant to the French crown, but Hugh Capet was chosen as king instead and war broke out between them. Charles gained some successes and captured Reims (989) but was treacherously seized by Adalberon, bishop of Laon, in 991. Handed over to Hugh, he was imprisoned at Orléans with his wife and younger children and died in prison about 992. His eldest son Otto, duke of Lower Lorraine, died about 1012.

See F. Lot, *Les Derniers Carolingiens* (1891).

CHARLES II (1365–1431), duke of Lorraine, was the son of the duke John, whom he succeeded in 1391. Whereas Charles's grandfather, the duke Rudolph (Raoul), had always remained loyal to France, John had already been susceptible to Burgundian influences, and Charles brought Lorraine completely into the Burgundian camp. Married in 1393 to Margaret of Bavaria, daughter of the future German king Rupert, he disputed with the French king's agents at Toul (1402) and about Neufchâteau (1410) and withstood the encroachments of the duc d'Orléans (Louis de France), whose forces he defeated at Champigneulles in 1407. Openly siding with John the Fearless (*q.v.*), duke of Burgundy, he acted as his representative at the Council of Constance (1414) and entered Paris with him on July 24, 1418, with the title of constable of France.

In his first will (Aug. 13, 1407; confirmed Feb. 7, 1409) Charles even forbade his daughters to marry French subjects, but plans for marrying the elder one, Isabella, to John of Lancaster, duke of Bedford, came to nothing, and Charles finally married her in 1420 to René of Anjou, heir to the duchy of Bar. The union of Bar to Lorraine was ensured when Charles disinherited his nephew Antoine, comte de Vaudémont, in his second will (Jan. 13, 1425) and proclaimed female succession to the ducal crown of Lorraine (Dec. 13). Charles died at Nancy on Jan. 25, 1431.

See, in addition to histories of Lorraine, P. Géant, "Étude sur le règne de Charles II . . . ," *Annales de l'Est* (1902); M. François, *Histoire des comtes et du comté de Vaudémont* (1935). (Mi. F.)

CHARLES III THE GREAT (1543–1608), duke of Lorraine from 1545 to 1608, was born at Nancy on Feb. 18, 1543, the son of Francis I of Lorraine and Christina of Denmark. On his father's death (1545) his mother became regent for him, and in 1552 he was taken to Paris by Henry II of France after the French seizure of Metz, Toul and Verdun. In 1559 he was married to Henry's daughter, Claude de France.

After the death of Francis II of France (1560), Charles returned to Nancy to rule his duchy. He maintained good relations with the Holy Roman empire and was able to extend his frontiers eastward by the acquisition of Bitche, Phalsbourg, Marsal and St. Avold. In the French civil wars between Catholics and Huguenots he long took no part, despite the activity of his cousins of the house of Guise, but in 1584 he adhered to the League. He then tried to set up his eldest son Henry to dispute the right of the Protestant Henry of Navarre (the future Henry IV of France) to the French succession. Consequently German Protestant mercenaries ravaged Lorraine on their way into France (1587), and in Jan. 1592 Henry IV declared war. Henry's conversion to Catholicism, however, made Charles more conciliatory, and hostilities between them ended in 1594.

The reign of Charles III was the most brilliant in the history of Lorraine. He reformed the judiciary and the finances and encouraged economic development, creating a royal salt monopoly and establishing new mines and glassworks. He founded the University of Pont-à-Mousson in 1572, which he gave over to the Jesuits to combat Protestantism. He encouraged art and enlarged his capital, Nancy. He died at Nancy on May 14, 1608. (Ro. M.)

CHARLES IV (1604–1675), duke of Lorraine and Bar, was born at Nancy on April 5, 1604, the son of Duke Henry II's brother Francis of Vaudémont. Married in 1621 to Henry's daughter Nicole, he became duke consort when she succeeded as duchess in 1624. He and his father, however, wanted to abolish female succession to the duchies, and Francis was proclaimed Henry's rightful successor in Nov. 1625. A few days later he abdicated in his son's favour. Resenting French intervention in Lorraine, Charles let Mme de Chevreuse (*q.v.*) involve him in the English coalition against France in 1627. From 1629, moreover, he encouraged Gaston, duc d'Orléans (*q.v.*), against the French government. The French having made him sign the treaty of Liverdun in 1632 and occupied Nancy in 1633, he abdicated in Jan. 1634 in favour of his brother Nicolas Francis, who renounced his cardinalate and married Nicole's sister Claude. Charles then went first to the Spanish Franche-Comté, then to Germany, revoked his abdication and entered the Habsburg service, to fight at Nördlingen (1634) and in several campaigns on the French frontier (*see* THIRTY YEARS' WAR). Nicole having gone to France in 1634, Charles in 1637 went through a bigamous marriage with Béatrix de Cusance (1614–63), the widowed countess of Cantecroy. Asking Pope Urban VIII to annul his marriage with Nicole, he refused to leave Béatrix pending judgment and was excommunicated from 1643 to 1645. Meanwhile the treaty of St. Germain (1641) had restored his duchies to him, with some diminution, but the French occupied them again in 1644 as he had resumed his intrigues. He then re-entered the Habsburg service, remaining with the Spaniards after the peace of Westphalia (1648). In 1652 he led two incursions into France to help the prince de Condé during the Fronde (*q.v.*), but in 1654 the Spaniards arrested him for dealings with Cardinal Mazarin. Imprisoned first at Antwerp, then at Toledo until the peace of the Pyrenees (1659), he recovered Lorraine and Bar by the treaty of Vincennes (1661) and then arranged for them to pass on his death to France under the treaty of Montmartre (1662), which however was annulled by the treaty of Noméuy (1663). Nicole having died in 1657, Charles married Béatrix when she was dying in 1663, though he had meanwhile entertained some alternative and quite unsuitable matrimonial plans. Finally he married the 13-year-old Marie d'Aspremont in 1665. Driven from Lorraine by the French again in 1670, he went again to Germany. He won the battle of Konzer Brücke against François de Créquy on Aug. 11, 1675, took Trier on Sept. 6, but fell ill on Sept. 18 and died at Allenbach, near Trier, on Sept. 20.

CHARLES V (1643–1690), duke of Lorraine and Bar, was born in Vienna in April 1643, the son of Charles IV's brother Nicolas Francis. Brought up in France from 1656, he escaped to the Franche-Comté during Charles IV's negotiations of 1662 and thence to Germany. The emperor Leopold I gave him a regiment in 1664, and he distinguished himself at the battle of St. Gotthard. He was a candidate for the Polish crown in 1668–69 and again, when the French were occupying Lorraine, in 1674. Recognized by all save France as his uncle's heir in 1675, he was never to possess his duchies. Promoted field marshal by the emperor in 1675, he took Philippsburg in 1676. He married Eleonora Maria, dowager queen of Poland and the emperor's sister, in 1678. The peace of Nijmegen offered him his duchies under conditions that he rejected. In 1683, with a weak imperial army, he opposed the Turkish advance on Vienna. Two months after the Turks had invested the city, Jan Sobieski's Poles and the Bavarian and Saxon contingents arrived to reinforce Charles, and on Sept. 12 the Christians routed the enemy and raised the siege. Advancing into Hungary, Charles besieged Buda (1684), stormed Neuhäusel (1685), finally took Buda (1686) and, in Aug. 1687, won the great victory of Mohács. Transferred to the Rhine for the War of the Grand Alliance, Charles took Mainz and Bonn in 1689 but died suddenly at Wels, in Austria, on April 18, 1690. As well as the military genius that made him one of Louis XIV's most respected adversaries, he had qualities of statesmanship: his *Testament politique*, written in 1687, foretold the development of the Spanish succession crisis and also proposed the transformation of the Holy Roman empire into a centralized state. At the peace of Rijswijk (1697) Lorraine and Bar were assigned to his son Leopold Joseph Charles (1679–1729).

CHARLES (1270–1325), count of Valois from 1285 and of Anjou and Maine from 1290, was born in March or April 1270, the third son of Philip III of France and Isabella of Aragon. Son of a king, brother of a king, uncle of three kings and father of a king of France, he was never to rule as king himself, though he was pretender to two crowns. In 1284, during the papacy's dispute with Aragon over Sicily, Pope Martin IV recognized Charles as king of Aragon, but Philip III's campaign on his son's behalf ended disastrously. Philip, who died on his return from Spain (1285), left Charles the countship of Valois in appanage. In 1290 Charles married Margaret of Anjou, daughter of Charles II of Naples, who gave him Anjou and Maine as her dowry in compensation for his renouncing his Aragonese claims. His brother Philip IV moreover gave Charles the countships of Alençon (1291) and Chartres (1294). Charles's second marriage (1301), to Catherine de Courtenay, granddaughter of the Latin emperor of Constantinople, Baldwin II, gave him a claim to the Byzantine succession, and Pope Boniface VIII thereupon invited him to help the papal cause in Italy. Charles subdued Florence for the pope and fought for Charles of Naples in Calabria and Apulia, but the attempt to recover Sicily failed. Catherine having died in 1307, Charles next married Mahaut (Maud) of Châtillon in 1308. He then gave up his pretensions to the Eastern empire and sought election to the Western, but Pope Clement V gave his support to Henry of Luxembourg. In France, meanwhile, Charles had loyally served Philip IV, commanding his armies in Guienne in 1295 and in Flanders in 1297, 1299, 1300 (when he reduced Guy of Dampierre to submission) and 1303. In 1304 he contributed to Philip's victory of Mons-en-Pevèle. He also served in the abortive Flanders campaign of 1314. When his nephew Louis X became king (1314), Charles led the reaction against Philip's old minister, Enguerrand de Marigny (*q.v.*). On Louis X's death (1316), he tried to become regent of France. After a last campaign in Guienne (1324), Charles died at Le Perray near Rambouillet on Dec. 16, 1325. He had had four sons and ten daughters. His eldest son, Philip, became king of France in 1328, the first of the house of Valois.

See J. Petit, *Charles de Valois* (1900).

CHARLES, JACQUES ALEXANDRE CÉSAR (1746–1823), French mathematician and physicist, was an acute physical researcher and inventor. He was born at Beaugency, Loiret, on Nov. 12, 1746. From being a clerk in the ministry of finance, he turned to scientific pursuits. He was the first, in 1783, to employ hydrogen for the inflation of balloons (*see* Balloon), and about 1787 he anticipated Gay-Lussac's law of the expansion of gases with heat, which on that account is sometimes known by his name. He improved the Gravesand heliostat and the aerometer of Fahrenheit and invented a "thermometric hydrometer," a "goniometer by reflection" and many other ingenious physical devices. In 1785 he was elected to the Academy of Sciences, and subsequently he became professor of physics at the Conservatoire des Arts et Métiers. He died in Paris on April 7, 1823. His published papers are chiefly concerned with mathematical topics.

CHARLES, THOMAS (1755–1814), Welsh religious leader, a founder of Calvinistic Methodism (*q.v.*) in Wales and an inspirer of missionary activities, was born in Carmarthenshire on Oct. 14, 1755, and educated at the dissenting academy in Carmarthen and at Jesus college, Oxford. After holding curacies in Somerset, he settled in 1783 in the neighbourhood of Bala, Merioneth, his wife's home. He failed to find a living in the established church, but his wife's shop provided some economic security and in 1784 he joined the Methodist society at Bala and became, in effect, a free lance. From his student days he had been under the influence of the Methodist revival, and he was deeply concerned to evangelize and, with a view to evangelism, to educate. Himself training the teachers, he set up numbers of schools, which at first circulated like those founded earlier by Griffith Jones, rector of Llanddowror, but soon settled into Sunday schools. He compiled a dictionary of the Bible and edited a quarterly magazine, both in Welsh; he composed a catechism in Welsh and English, and set up a printing press at Bala. He made a plea for more cheap Bibles in translation, and helped to found the British and Foreign Bible society (1804), which printed a Welsh Bible in 1806, and the London Missionary society. In Wales Methodism was still nominally within the establishment, but few clergy besides Charles were sympathetic. The rapid growth of Methodist societies and associations as a result of his labours led, insensibly yet inevitably, to the demand for a separate organization with its own ministers. Charles, who like Wesley never repudiated his own episcopal orders, long opposed this, but in 1811 he drew up a form of ordination and himself ordained eight lay preachers. He died at Bala on Oct. 5, 1814.

See D. E. Jenkins, *Life of Thomas Charles* (1908). (G. F. N.)

CHARLES ALBERT (1798–1849), king of Sardinia-Piedmont from 1831 to 1849, a ruler whose character, motives and impact on Italian history have been much debated by historians, was born in Turin on Oct. 2, 1798, the son of Charles Emmanuel (1770–1800), prince of Carignano, and Christina, daughter of the former duke of Courland, Charles of Saxony. Just after his birth the French annexed Piedmont, but Charles Albert was not taken into exile in Sardinia with his cousin King Charles Emmanuel IV (who abdicated in 1802). Instead he spent his early years in France and Geneva. Prince of Carignano in succession to his father (1800), he received the title of count from Napoleon in 1810 and began his career by being commissioned in a French dragoon regiment. When his cousin Victor Emmanuel I was restored in Piedmont (1814), French influences were unfashionable in Turin, and in 1817 Charles Albert was married to Maria Theresa, daughter of the Habsburg grand duke of Tuscany. Their son Victor Emmanuel II, afterward king of Italy, was born in 1820.

The nature of the restoration in Piedmont gave rise to subversive discussion and conspiracy. There were among the younger nobility some who hoped for reforms and others, members of the revolutionary secret societies, who wanted a constitution based on the Spanish model of 1812. The excitement over the revolution of 1820 in Naples brought these elements together. Several of the leaders of the plot which now took shape were men well known to the young prince. The Austrian intervention against the Neapolitan revolution precipitated an outbreak, and early in March 1821 Charles Albert was told by some of his friends that a military coup was about to take place. Its aim was to persuade the king both to grant a constitution (its precise nature was vague) and to lead a war against the Austrians. Charles Albert's conduct at this point is very difficult to follow. Certainly he tried to hold the conspirators in check and seems to have promised to confer with the king as a go-between, yet he himself would not support the conspiracy. When the garrison of Alessandria detonated the plot by mutinying, Cesare Balbo (*q.v.*) tried to persuade Charles Albert to assume the leadership of the constitutionalist movement. Even the king was in fact prepared to give way, but news arrived of the decisions of the congress of Laibach (*q.v.*) and both he and Charles Albert hesitated too long. A rising took place at Turin; the king was unwilling to suppress the rebels firmly and abdicated in favour of his brother Charles Felix (night of March 12–13). Charles Albert found himself acting as regent for the new king, who was not in Turin at the time. He swore to observe the Spanish constitution (March 15)—in order, he later said, to prevent further disturbance. Charles Felix ordered him to report at Novara, where he was put under arrest while the movement was crushed with Austrian help. The episode ended with the exile of Charles Albert to Florence. He had by his actions won himself the suspicions of the legitimists and the hatred of the liberals, who from this time regarded him with deep distrust. He was restored to favour with the king after serving with the French army in Spain in 1823 and took an oath to maintain the existing institutions of the kingdom when he should ascend the throne. His reputation with the liberals, on the other hand, never fully recovered.

Charles Albert succeeded to the throne on April 27, 1831, at Charles Felix's death. Almost at once he was addressed by Giuseppe Mazzini (*q.v.*) in an open letter which urged him to be the Napoleon of liberty and national independence for Italy, but he showed no inclination to be anything of the sort and began his reign on a distinctly conservative note. He omitted the revolutionaries of 1821 from the operation of the usual accession amnesty. When another conspiracy was discovered in 1833 it was punished by a wave of executions. Vincenzo Gioberti was exiled and Mazzini condemned *in absentia*. An oppressive censorship stifled the expression of thought: Cavour remarked that Turin was an intellectual hell. Nevertheless, there was some material and administrative progress; tariffs were reformed, the legal system was tinkered with, and the development of Genoa was pushed on by railway building, connecting that port with central Europe. In foreign policy as in domestic, the predominant tone was reactionary. The France of the July monarchy was regarded by Charles Albert's government both with suspicion as the source of liberal infection and with greed because it was a possible source of territorial acquisitions. Correspondingly, Piedmontese policy leaned hopefully toward Austria, and in 1842 Charles Albert's son Victor Emmanuel was married to a Habsburg. Piedmontese support was also forthcoming for the legitimists in Spain and Portugal.

This reactionary phase had already begun to show signs of change before the revolution of 1848. The first good relations with Austria gave way to rivalry when Charles Albert saw that he must attempt to capture the moral leadership of Italian nationalism for his house and began to hope for territorial gains in Lombardy. In 1845 he assured Massimo d'Azeglio that the liberals would find him at their service when the day came, but recommended that they should cease agitation until circumstances presented Piedmont with a favourable opportunity. Once more, his policy was equivocal and cautious. The repudiation of an agreement with Austria on the salt trade in 1846 was regarded by many as a hopeful sign, and the election of Pius IX to the papacy and the Austrian occupation of Ferrara encouraged Charles Albert to move more quickly. It seems, however, that the dismissal of the reactionary conte della Margherita (Clemente Solaro) from the foreign ministry and the beginnings of reform in 1847 were prompted especially by a growing awareness that Piedmont might lose the leadership of the Italian movement. There were abortive discussions with Tuscan and papal representatives about the possibility of a customs union. Finally, the concessions to constitutionalism made by Ferdinand II of the Two Sicilies forced Charles Albert's hand, and on March 5, 1848, he granted the constitutional *statuto* which was eventually to become the fundamental law of Italy down to the fall of the monarchy. It was not a democratic or radically liberal document: the king still retained control of foreign policy and his ministers were responsible to him and not to parliament.

The revolt at Milan against the Austrians in March 1848 forced Charles Albert to take up a definite position on the question of a national movement against Austria. Again he hesitated. He held up the formation of a defensive league because he both wanted Piedmont to have all the credit for victory over the Austrians and hoped for pickings in Lombardy to forestall any successful widespread republican movement. Unfortunately, much of the Piedmontese army was unavailable because it was deployed on the French frontier. He then refused co-operation from the radicals, would not accept their offer of the formation of a potentially dangerous Lombard army and won the hostility of Carlo Cattaneo (*q.v.*) by his demand that Lombardy should be immediately united to the crown of Piedmont. Eventually Parma, Piacenza, Modena and Lombardy were all temporarily annexed. The delays and shilly-shallying caused by Charles Albert's behaviour gave the Austrians under J. Radetzky time to recover and on July 24–25 the Piedmontese army was defeated at Custozza. Charles Albert refused an armistice the terms of which would have meant independence for Milan because he still hoped to acquire the whole of Lombardy for Piedmont; he left the city amid the insults of the populace and finally accepted terms on Aug. 9. After a stormy period of unstable government in Turin he again attacked Austria in March 1849 and was defeated after three days' fighting at Novara (March 23). Thereupon Charles Albert abdicated. He then went to Portugal, where he died four months later, at Oporto, on July 28, 1849.

Metternich remarked of Charles Albert that he was "ambitious as well as vacillating" and this explains much of his failure. Probably he damaged the cause of Italian unity more than he advanced it because of the alarm that he caused to other Italian monarchs and the distrust and hatred that he aroused for Piedmont among liberals and radicals; because he sacrificed Italian interests to those of Piedmont in his dealings with the Austrians; and because even in his own kingdom he achieved little in effective economic and administrative reform—as the work of Cavour was later to show. *See* further ITALY: *History*.

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CHARLES AUGUSTUS (KARL AUGUST) (1757–1828), grand duke of Saxe-Weimar-Eisenach, whose court was the great centre of intellectual Germany at the end of the 18th century and who is chiefly remembered as the patron of Goethe, was born at Weimar on Sept. 3, 1757, the son of Constantine of Saxe-Weimar-Eisenach (d. 1758) and Anna Amalia of Brunswick. In 1771 C. M. Wieland was called to Weimar to become the young prince's tutor. In 1774, on a journey to Paris, Charles Augustus visited Frankfurt, where he first met Goethe; at Karlsruhe he met Louise of Hesse-Darmstadt whom he married the next year. In Sept. 1775 Charles Augustus took over the government, and in November Goethe was called to Weimar as privy councilor. Now began a period of reform, fiscal, administrative, legal and above all educational, the philosopher J. G. von Herder (who was appointed superintendent and court preacher in 1776) being responsible for a reorganization of the duchy's schools.

Charles Augustus exercised great personal influence in German affairs and worked for German unity. Opposed to any further acquisition of German lands by the Habsburgs, he concluded an alliance with Prussia in 1785 and was a leading member of the league of princes (*Fürstenbund*) established under Frederick II of Prussia in the same year to withstand the German policies of the emperor Joseph II. However, he wisely refused the offer of the Hungarian crown, made to him in 1787 by Frederick William II of Prussia at the instance of the Hungarian malcontents. In 1788 he became a major general in the Prussian army. He was present, with Goethe, at the cannonade of Valmy in 1792, and in 1794 he took part in the siege of Mainz and the battles of Pirmasens and Kaiserslautern. He resigned his commission after the battle of Kaiserslautern but returned to Prussian service in 1798 with the accession of his friend King Frederick William III to the Prussian throne. On Oct. 14, 1806, after the battle of Jena, Weimar fell to the French, and Charles Augustus was forced to join the Confederation of the Rhine. From this time until after the Moscow campaign of 1812 his contingent fought under the French flag. In 1813, however, he joined the allies against Napoleon, and at the beginning of 1814 he took the command of a corps operating in the Netherlands.

At the congress of Vienna, Charles Augustus gained an extension of territory and the title of grand duke, but he protested against the reactionary spirit of the congress. On May 5, 1816, he granted a liberal constitution to his state, under article xiii of the Act of Confederation. He was the first German prince to do so; indeed his concession of full liberty to the press made Weimar for a while the focus of journalistic agitation against the existing order in Europe. In 1818 he lent his patronage to the founding of the Allgemeine Deutsche Burschenschaft (*see* BURSCHENSCHAFT). In the same year he was compelled to yield to the remonstrances of Prussia, Austria and Russia; the liberty of the press was again restricted in the grand duchy, though the era inaugurated by the repressive Carlsbad decrees (*q.v.*; 1819) was less oppressive in Weimar than in other German states.

Charles Augustus died on June 14, 1828. Under him not only the court at Weimar but also the university at Jena enjoyed a period of brilliance: in 1789 Schiller became a professor at the university, in 1798 Schelling and in 1801 Hegel began to lecture there. He himself took an informed interest in both literature and science and conducted a correspondence with Goethe (published in two volumes in 1863, edited by K. Vogel).

See W. Wachsmuth, *Herzog Karl August und Goethe* (1911); H. von Egloffstein, *Karl August auf dem Wiener Kongress* (1915).

CHARLES EDWARD, THE YOUNG PRETENDER (1720–1788), known also as the "Young Chevalier," was the last serious Stuart claimant to the British throne. He was born in Rome on Dec. 31, 1720, the grandson of King James II of England and elder son of James, the Old Pretender, by whom (as James III) he was created, at his birth, prince of Wales, the title he bore among the British Jacobites during his father's lifetime.

The Old Pretender had relied on foreign aid in his attempts to regain the throne; his son believed that a rising might succeed without invasion or outside support. Charles was sent to Paris in Jan. 1744, his father having appointed him prince regent, to further a definite scheme for a French invasion, linked with a Scottish rebellion. Bad weather and a strong English fleet in the Downs gave the French government an excuse to abandon the project, however, and Charles was left to a life of retirement in Paris. There he was led to believe by John Murray of Broughton that it was worth going alone to Scotland. Messages from his supporters in Scotland, discouraging an expedition without French support, failed to reach him, and Charles left Belle Île in the brig "Du Teillay" on July 5, 1745, accompanied by a war frigate, the "Elisabeth," carrying supplies and ammunition. On July 20 the "Elisabeth" had to return to France after an encounter with the "Lion," an English man-of-war. Charles arrived in the Hebrides at Eriskay on July 23, but receiving a cool reception he set sail again and reached the bay of Loch nan Uamh in Inverness-shire.

The Macdonalds of Clanranald and Kinlochmoidart, among others, attempted in vain to dissuade Charles from the rashness of an unaided rising, but Cameron of Lochiel and other chieftains now called out the clans. On Aug. 19, in the valley of Glenfinnan, the standard of James III and VIII was raised. Within a week about 2,000 men, mainly from the Macdonald clan, had joined Charles. Sir John Cope left Stirling for Inverness on Aug. 20, leaving the road to the south open. In the beginning of September the Jacobite army, reinforced by some accessions, notably by Lord George Murray, entered Perth. Crossing the Forth unopposed at the Fords of Frew Charles arrived within a few miles of Edinburgh, and on Sept. 16 his skirmishers routed Col. James Gardiner's dragoons in what was known as the Canter of Coltbrig. Some of Cameron's Highlanders having on the following morning, by a happy ruse, forced their way through the Canongate, Charles entered the city at noon. On Sept. 17 he publicly proclaimed James VIII of Scotland at the market cross and occupied Holyrood.

Cope had by this time brought his forces by sea to Dunbar. On Sept. 21 Charles met and defeated him at Prestonpans. He then returned to prosecute the siege of Edinburgh castle, which, however, he raised on Gen. Joshua Guest's threatening to lay the city in ruins. He still hoped for French assistance, definitely promised on Oct. 24 by secret treaty. At the beginning of November Charles left Edinburgh to invade England. He was at the head of at least 5,000 men, but the ranks were gradually thinned by the desertion of Highlanders. Having passed through Kelso, on Nov. 10 he laid siege to Carlisle which capitulated in a week. Manchester provided the prince with 150 recruits under Francis Towneley. On Dec. 4 he had reached Derby, but his officers, jealous of each other and discouraged by lack of French and English support and the strength of the armies defending London, advised retreat. Charles headed northward on Dec. 6. Closely pursued by the duke of Cumberland, he marched by way of Carlisle across the border and stopped to invest Stirling castle. At Falkirk, on Jan. 17, 1746, he defeated Gen. Henry Hawley, who had marched from Edinburgh to intercept his retreat. The Jacobite army had been strengthened by Gordons, Mackintoshes and others, but the accessions were counterbalanced by desertions. A fortnight later, Charles raised the siege of Stirling, and after a weary march rested his troops at Inverness. Having taken Ft. George and Ft. Augustus, and after varying success against the supporters of the government in the north, he at last prepared to face the duke of Cumberland, who had passed the early spring at Aberdeen. On April 8 the duke marched thence to meet Charles, whose little army, exhausted with a futile night march, half-starving and broken by desertion, was completely worsted at Culloden on April 16, 1746.

This decisive defeat sealed the fate of Charles Edward and the house of Stuart. Hunted hither and thither Charles, upon whose head a reward of £30,000 had been set a year before, was for more than five months relentlessly pursued by the troops and spies of the government. Helped by loyal supporters, in particular the devoted Flora MacDonald (*q.v.*), he wandered around the west of Scotland and the islands until the arrival of two French ships at Loch nan Uamh enabled him to sail for France. He reached Roscoff, near Morlaix, on Sept. 29, 1746. He remained in France for two years, but after his brother Henry's acceptance of a cardinal's hat in July 1747, he broke off communication with his father in Rome (who had approved the step), nor did he ever see him again. When, by the treaty of Aix-la-Chapelle (1748), France agreed to expel the Stuarts, Charles refused to go. His persistent refusal to leave was met with force; he was apprehended, imprisoned for a week at Vincennes and on Dec. 17 conducted to the French border. After a short stay at Avignon, which he was ordered to leave early in 1749, Charles disappeared, probably retiring to Paris incognito. He was in London in 1750 and, it is thought, in 1754, risking his safety to hatch futile plots. During the next ten years he wandered around Europe in disguise, accompanied by his mistress Clementina Walkinshaw. He tried to revive his hopeless cause, but his debauchery (he was drinking heavily) and his temper alienated his friends. On his father's death in 1766 he went to live in Rome, but the pope received him coldly and the great Catholic powers openly repudiated his title to the British throne. Charles, now calling himself count of Albany, married Princess Louise de Stolberg in 1772, but the marriage was childless and unhappy and they were formally separated in 1784 (*see* ALBANY, LOUISE MAXIMILIENNE CAROLINE, Countess of). Lonely and ill, Charles summoned his daughter Charlotte Stuart, Clementina Walkinshaw's child, to Florence. She was declared legitimate and created duchess of Albany. She managed to reconcile Charles and his brother Henry, and in 1785 Charles returned to Rome. Charlotte looked after him until his death at the old Palazzo Muti on Jan. 31, 1788. She never married, and died at Bologna in Nov. 1789.

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(W. FE.)

CHARLES EMMANUEL I (1562–1630), duke of Savoy, was born at Rivoli, Piedmont, on Jan. 12, 1562, the son of Emmanuel Philibert (*q.v.*) and Margaret, daughter of Francis I of France. Succeeding his father as duke in 1580, he soon showed himself a bold and intelligent statesman, prompt at intrigue and resolute in danger. His constant ambition was to secure for Savoy the marquisate of Saluzzo, Geneva and Monferrato (Montferrat). In 1588, while the French were preoccupied with civil wars, he took Saluzzo, but subsequently his forces suffered reverses in Provence and the French invaded his territory. Finally Henry IV of France, in the treaty of Lyons (1601), acknowledged his title to the marquisate in exchange for the cession of Bresse, Bugey and Gex. Charles Emmanuel's final attempt on Geneva, a surprise assault (Dec. 23, 1602), came to nothing.

When the treaty of Bruzolo (April 24, 1610) between Savoy and France for concerted action against the Habsburgs had been made abortive by the assassination of Henry IV, Charles Emmanuel's designs on Monferrato had to be suspended till the death, in 1612, of his son-in-law, Francesco Gonzaga, duke of Mantua. He then seized Monferrato (1613) and brought Savoy without allies into war with Spain. This lasted till 1617, and though he had finally to restore Monferrato to Mantua, his European reputation was immeasurably enhanced by his performance.

In the Thirty Years' War (*q.v.*) Charles Emmanuel's policy was at first directed against the Habsburgs once more. When, however, in Dec. 1627, the question of the succession to the Gonzaga dukes of Mantua arose, Charles Emmanuel secretly came to terms with Spain on the partitioning of Monferrato, thus contriving to save Casale from Spanish occupation. Savoy, overrun by contending armies, suffered great hardships. Charles Emmanuel died at Savigliano, Piedmont, on July 26, 1630.

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CHARLES FREDERICK (1728–1811), grand duke of Baden, was born at Karlsruhe on Nov. 22, 1728, the son of Frederick (d. 1732), heir apparent to the margraviate of Baden-Durlach, and Anna Charlotte of Nassau, and grandson of Charles William, margrave of Baden-Durlach (d. 1738). As a young man Charles Frederick visited France, the Austrian Netherlands, the United Provinces, England and Italy and studied for a time at the university of Lausanne. When he came of age in 1746 he succeeded to a well-ordered land which his grandfather had, by careful administration, restored after the ravages of the War of the Spanish Succession. During the peaceful first 50 years of his reign Charles Frederick and his advisers so continued this work that his government was admired throughout Germany and beyond. Benevolent despots have often been criticized for their paternalism, but here it proved a blessing, because Charles was a conscientious ruler whose foremost guide was the good of his people. His main concern was the improvement of agricultural techniques on the principles of the physiocrats, among whom he personally knew the marquis de Mirabeau and P. S. du Pont de Nemours. Industrial activity was stimulated. The emancipation of the peasantry in 1783 attracted widespread attention. Educational and ecclesiastical organizations were thoroughly reformed.

Charles Frederick and his wife Caroline Louise of Hesse-Darmstadt, whom he married in 1751, were devoted to art and science beyond mere patronage, and men such as Goethe, Herder, Klopstock, Voltaire and Linnaeus spent some time at the Karlsruhe court or corresponded with its rulers.

In 1793 Charles Frederick tried in vain to form an alliance with neighbouring states against the threat of revolutionary France; in 1796 he signed a truce with France and in 1797 was obliged to accept the peace of Campo Formio. As a result of territorial treaties from 1803 to 1810 Baden (*q.v.*) considerably enlarged its possessions, and in 1806 Charles Frederick assumed the title of grand duke. He died on June 11, 1811.

See F. Lautenschlager, *Bibliographie der badischen Geschichte*, vol. i, 2nd ed. (1930). (M. Kr.)

CHARLES MARTEL (*i.e.*, the Hammer) (*c.* 688–741), mayor of the palace in Austrasia from 717 and undisputed master of the Frankish kingdom from 725 to 741, was the illegitimate son of Pepin of Herstal, the Austrasian mayor of the palace, and Chalpaïda. Pepin, acting in the name of the Merovingian kings, had reorganized and reunified the Frankish realm; but the assassination of his surviving legitimate son in 714, followed a few months later by the death of Pepin himself, opened the way to renewed separatism and civil war. The Neustrians chose for themselves as mayor of the palace a certain Ragenfrid, under whom they immediately sought alliance with all the tribes surrounding Austrasian territory; the Frisians and the Saxons were particularly quick to throw off the Austrasian yoke.

The sole surviving claimants to supreme authority, apart from young Merovingian king Dagobert III, were Pepin's legitimate grandsons and Charles. Plectrude, Pepin's widow, imprisoned Charles and attempted to govern in the name of her grandchildren. In the anarchy which her rule engendered, Charles escaped, took command of the Austrasian forces, and defeated the Neustrians in battles at Amblève near Liège (716) and at Vincy near Cambrai (717). He then wrested from Plectrude his father's treasure and the Austrasian territory nominally under her control.

Assured of Austrasia, Charles now attacked Neustria itself, finally subduing it after one last battle in 724. He also attacked Aquitaine, whose ruler, Eudes, had been an ally of Ragenfrid; but he did not gain effective control there or anywhere else in the south until later in his reign. He conducted long campaigns, some of which took place as late as the 730s, against the Frisians, Saxons and Bavarians: the Saxons in particular continued to raid his territory whenever opportunity offered.

Faced with adversaries from Africa and eastern Europe who fought on horseback, it was essential for Charles to provide his army with a strong cavalry force. To finance this costly enterprise, he appropriated some of the ecclesiastical lands recently acquired and consolidated by various fighting bishops, mostly in Burgundy. This action aroused no contemporary censure, and the tenure of the lands was to be regularized later under Charles's sons Pepin and Carloman, when it was decided that the warriors to whom they had been granted should hold them for life only, as *precaria*, the church being still the actual owner. Again, no contemporary disapproval was shown at Charles's severity toward bishops, such as Rigobert of Reims, who were resentful or tardy in surrendering their land. Charles, indeed, came himself of a family rich in saints and noted for its patronage of monasteries, and it was to him that Pope Gregory II wrote in 722 to enlist support for Boniface's mission in the Rhineland. From then onward Charles constantly supported Boniface and also helped Pirmin and Willibrord, apostles respectively of the Alamanni and of the Frisians.

Fresh events were destined to enhance Charles's prestige. Ever since their arrival in Spain in 711, the Muslims had been raiding Frankish territory in order to test the degree of resistance that a full-scale invasion of Gaul was likely to encounter. On one occasion, in 725, they had reached Burgundy and sacked Autun. Then, in 732, Abd-al-Rahman, governor of Córdoba, led an army against Eudes, duke of Aquitaine, who had contrived hitherto to maintain himself against the Muslims and had been intriguing continually with Abd-al-Rahman's rebellious subjects. Defeated, Eudes appealed for help to Charles, who had already disposed his cavalry near the Loire to defend the city of Tours. Tradition asserts that it was near Poitiers that the Muslim onslaught was broken by Charles's cavalry but it is impossible to identify the battlefield. The battle itself may indeed have been only a small engagement, but after it there were no more great invasions of Frankish territory by the Muslims. Moreover, Charles derived profit as well as glory from his victory: he was at last able to assert his authority in Aquitaine, where, having forced Eudes to swear allegiance to him, he allowed him to continue to rule as duke.

Between 733 and 739 Charles completely subdued the petty chieftains in Burgundy. His armed occupation of Provence and Septimania, made on the pretext of protecting these lands from Muslim attack, brought them again, after a long intermission, into the orbit of Frankish influence. Charles however could have had no success in southern France if the Lombards had not been willing to maintain a friendly neutrality.

Charles had now consolidated and stabilized his power, and he was careful to attempt no rash enterprise. If he put no king in the place of the Merovingian Theuderic (Thierry) who died in 737, he at least did not try to transfer the crown to his own dynasty; and when Pope Gregory III appealed to him in 739 for help against the Lombards, he considered the risk too great and withheld his aid.

In 741 Charles made a division of the Merovingian kingdom between his two legitimate sons, Pepin and Carloman, thus acting as if he were in fact king. He died on Oct. 22, 741, at Quierzy-sur-Oise, and was buried at St. Denis.

See also references under "Charles Martel" in the Index volume.

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CHARLES D'ORLEANS: *see* Orléans, Charles, Duke of.

CHARLESTON, a city of South Carolina, U.S., an important port of entry on the Atlantic coast, the seat of Charleston county and centre of a large urbanized area, is notable for industries, defense installations, and the beauty and historic interest of the city and its surroundings. It is situated on a peninsula between the estuaries of the Ashley and Cooper rivers, facing a bay, 7½ mi. in length, leading to the Atlantic ocean.

History.—The settlement of Charleston in 1670 began the colonization of South Carolina. A friendly Indian led the colonists to a generally excellent harbour which proved to be the most defensible one in the region between Virginia and Florida. For security the town was begun on the west bank of the Ashley. At the time the lower part of the site of the present city was reserved for a port town. About 1672 this was laid out in streets and lots as a town, and in 1680 Charles Town was moved there.

Through the colonial and provincial periods of South Carolina Charleston remained the civic centre of a closely integrated community. The colony grew up isolated from its fellows to the northward by distance and by dangerous Cape Hatteras, threatened by Spanish Florida to the south, and much more closely connected with Barbados and the other of the West Indies islands than with any other parts of British America. Colonization was at first pushed along the coast by plantation communities following natural intracoastal waterways. These remained the principal traffic routes of the rich plantation section, known as the low country, that was Charleston's particular area of the developed state. By 1674 rice began there its long career as the classic South Carolina staple. The town also came to be the centre of one of the most extensive and valuable Indian trades in the British colonies. Extended to the Mississippi by 1698, it kept South Carolina embroiled with Louisiana over the businesses with the great southern Indian tribes. In the War of the Spanish Succession Charleston's community ran deeply into debt attempting to destroy both Florida and Louisiana. The southeastern portion of the town was enclosed with fortifications. In 1706 an enemy flotilla was driven out of the harbour. Following this war the community had to fight another with an extensive Indian confederacy led by the Yemasees. It had also to clear its coast of large companies of pirates. The inertia of the proprietors of Carolina through these performances led to the revolt at Charleston that in 1719 introduced the royal government of South Carolina (*see* SOUTH CAROLINA: *History*).

As the centre of a crown province, Charleston attained the wealth and liberal culture that caused it to be termed the Lima of North America. When the War of the Austrian Succession closed the principal markets for Carolina rice, in Spain, Portugal and their Wine islands (Madeira and the Canaries), indigo was introduced as a substitute. It remained one of Charleston's chief exports until its English market was lost by the American Revolution.

The state of South Carolina came into existence in Charleston on the formation of the provincial congress in Jan. 1775. On June 28, 1776, a British fleet commanded by Adm. Sir Peter Parker was defeated in the harbour by a half-finished fort on Sullivan's Island commanded by Col. William Moultrie. In May 1779 the town narrowly escaped capture by the land force of Gen. Augustine Prevost. On May 12, 1780, after a siege by land and water for 45 days, the town was surrendered to Sir Henry Clinton. It was evacuated by the British Dec. 14, 1782. Charleston lost much wealth and a number of excellent loyalist citizens by the break with the mother country.

In 1722 the town had been briefly incorporated as Charles City and Port. In 1783 it was incorporated again, under its present name. It ceased to be the capital of the state in 1790. Freed from British restriction, it throve until the War of 1812 as the winter port of the United States and by a large trade in the Caribbean. Tidal culture increased the rice exports. Cotton became a staple of the inner country and the development of the most valuable variety began near Charleston on the Sea Islands, whence it got its name. Increasing business with the inner country was facilitated by a canal connecting the Cooper with the Santee river system. After the War of 1812 the city suffered a long depression that was aggravated by the protective tariffs and that made Charleston the heart of the nullification movement of South Carolina in 1832.

As its senior civic centre, Charleston led the south's fight for states rights from the beginning to the formation of the Confederate States of America, and South Carolina's ordinance of secession was passed in Charleston Dec. 20, 1860. The capture of Fort Sumter, in Charleston harbour, by Confederate forces on April 12–13, 1861, opened the war. Blockaded from May 1861, the port was served by a number of blockade runners. A Union army was defeated in sight of the city's steeples in 1862. From July 10, 1863 to Feb. 18, 1865, the harbour works were heavily and steadily attacked by land and water and the city harassed by bombardments. A siege marked by the extraordinary perseverance and ingenuity of both sides ended only when Sherman's advance through the state forced the evacuation of Charleston.

SAMUEL CHAMBERLAIN

JOSEPH MANIGAULT HOUSE, CHARLESTON, S.C.; 1803

Population.—The city's population has a cosmopolitan background. West Indians predominated at first. Before 1700 there were added large proportions of Huguenots and of Puritans from England and New England and a lesser number of Scottish covenanters. The royal government after 1730 sent into the province numbers of Swiss, German and Ulster protestants. The American Revolution brought in a group of Hessians. Revolutions in France and Haiti and the Irish Rebellion of 1798 added notable groups to the population. At the same time Charleston contained the largest Jewish community in the United States. The descendants of African slaves, imported mostly in the 18th century, make up a large proportion of the city's population. Pop. (1960) 65,925; standard metropolitan statistical area (Charleston county) 216,382. (For comparative population figures *see* table in SOUTH CAROLINA: *Population*.)

Commerce and Industry.—The fertilizer industry, begun in 1867 and at first based on local minings of phosphoric marl, helped the city to recover from the great war losses and those inflicted by the Reconstruction government. In 1886 a severe earthquake seriously injured the city. The completion of jetties through the harbour bar in 1896 provided a deep-water entrance. In 1901 the navy yard was established on Cooper river. Expanded in both World War I and II, this became a U.S. naval base. A U.S. air force base was opened during World War II. Both wars stimulated the growth of the urbanized area. Its industrial development was promoted after 1942 by the Santee-Cooper hydroelectric project, which supplies a large amount of power and diverts to the Cooper river an estimated 10,000,000,000 gal. of industrial water daily. Major imports through Charleston harbour are petroleum and petroleum products, industrial chemicals and ores, and fresh bananas. Major exports are petroleum products, paper and wood pulp, fertilizer, iron and steel scrap. Major industries are paper and pulp mills, oil refineries, fertilizer works, metallurgical works and cigar and clothing factories.

Education and Cultural Activities.—Institutions of higher learning are the College of Charleston, founded in 1770 and taken over by the city in 1837; the Medical College of the State of South Carolina, a state institution founded in 1823; and the Citadel, the military college of South Carolina, created by the legislature in 1842. The principal cultural institutions are the Charleston Library society (founded 1748); the Charleston museum (1773);

the Carolina Art association (1858), in the Gibbes Memorial Art gallery; and the South Carolina Historical society (1855). Cultural monuments are the Heyward-Washington house (1770) and the Joseph Manigault house (1803) maintained by the museum; the Nathaniel Russell house (c. 1806), maintained by the Historic Charleston foundation; and the Dock Street theatre (reconstructed 1937), maintained by the city. The Footlight Players and the Charleston Symphony orchestra are two of the more modern cultural organizations.

Features.—With buildings dating from 1686, picturesque streets and several notable parks and gardens, the city and its surroundings attract large numbers of tourists. White Point gardens in Charleston, better known as the Battery, stands at the southern extremity of the city overlooking the rivers and the harbour. It is conspicuous for its monuments and its military relics. The most celebrated of the out-of-town gardens are Middleton Place, a large formal garden of the mid-18th century; Magnolia gardens, with a superb collection of azaleas and camellias; and Cypress gardens, created from the romantic surroundings of the old water-reserves of a great rice-plantation. About Charleston are a number of fine beach resorts and hunting and fishing areas.

See also references under "Charleston" in the Index volume. (S. G. S.)

CHARLESTON, a city of central West Virginia, U.S., located at the confluence of the Kanawha and Elk rivers; the seat of Kanawha county and capital of the state of West Virginia. Pop. (1960) city 85,796; standard metropolitan statistical area (Kanawha county) 252,925. The metropolitan area includes the important suburban town of South Charleston, three miles distant. (For comparative population figures *see* table in West Virginia: *Population*.)

Charleston was named for Charles Clendenin, the father of George Clendenin, who made the first settlement in 1788 and built Ft. Lee, where Charleston now stands. It was chartered as a town in 1794 by the Virginia assembly. Located on the route of migration to the Ohio valley, Charleston became a transfer and shipping centre. Daniel Boone and Simon Kenton, noted frontiersmen, operated in the area and Boone represented Charleston in the Virginia assembly, 1790–91.

Both Federal and Confederate troops occupied Charleston during the American Civil War and it contributed soldiers to both sides. In 1870 it was incorporated as a city by the West Virginia legislature. Its population at that time was only 3,160; by 1900 it was 11,099 and after that, with the increasing industrialization of the Kanawha valley, increased rapidly.

Charleston is the centre of coal and gas industries but its chief support comes from the large chemical manufacturing companies in the Kanawha valley. There are also important sheet glass and glass bottle manufacturing companies. Government is also an important function and employs a considerable number of people. A new capital was completed in 1932 to rcplace the one destroyed by fire in 1921.

Charleston is the northern terminus of the 88-mi. West Virginia turnpike, completed in 1954. The city is served by several railways and river transport on the Kanawha is also important, shipping chiefly coal, gasoline and chemicals. The Charleston airport is the major airport of West Virginia.

Morris Harvey, a private liberal arts college founded in 1888, is located in Charleston. West Virginia State college is 16 mi. down the Kanawha river. Kanawha State forest is near the city. (K. K. McC.)

CHARLESTON, an informal dance of American Negro origin that can be done as a solo, with a partner or in a group. It consists of pivoting in on the ball of the supporting foot while raising the inactive leg (knee bent) at an oblique angle, followed by pivoting out on the supporting foot and stepping on the inactive foot (toes pointed out), the step being repeated on the other foot.

The Charleston music is in 4/4 time, the rhythm consisting of a dotted quarter note, followed by an eighth note tied to a half note—a syncopation which creates the jerky, staccato rhythm of the Charleston.

Frequently the Charleston step is interspersed with such strenuous movements as kicking forward and backward, diagonally across—in closed position or away from one's partner—in place or traveling forward. (B. We.)

CHARLESTOWN, a small section of the city of Boston (*q.v.*), Mass., U.S., separated from the main part of the city by the Charles river. The first settlement was made there in 1628 and the original large area of the town was continuously whittled away as new cities and towns were formed from it. The remainder was annexed by Boston in 1874.

Charlestown lies on a small peninsula between the estuaries of the Mystic and Charles rivers. Several low hills dominate the area, including the famous Bunker and Breed's hills. Paul Revere crossed to the Charlestown shore on the evening of April 18, 1775, to begin his famous ride through the country to Lexington. The British force in Boston landed on that same shore on the morning of June 17, 1775, to be repulsed again and again by the motley patriot force dug in on Breed's hill. The American forces finally withdrew, leaving most of Charlestown a smouldering ruin. A granite obelisk (220 ft.) on nearby Bunker hill commemorates the battle.

The U.S. navy established one of its more important navy yards in Charlestown in 1800. As the city grew older the size and character of its population changed, especially as waves of Irish and, later, Italian immigrants moved in. By 1860 the population was over 25,000. During the next century the area became run down.

Charlestown was the birthplace of Samuel F. B. Morse, inventor of the telegraph, and contains the grave of John Harvard, for whom Harvard university is named. (G. K. L.)

CHARLES WILLIAM FERDINAND (1735–1806), duke of Brunswick-Lüneburg-Wolfenbüttel, field marshal in the Prussian army, famed as a strategist and an enlightened ruler, was born at Wolfenbüttel on Oct. 9, 1735, the son of Charles I of Brunswick-Lüneburg and Philippina Charlotte, a sister of Frederick II of Prussia. The prince received an excellent classical and French education and was brought up by the Protestant court chaplain J. F. W. Jerusalem in the spirit of rational Christianity. During the Seven Years' War (1756–63) Charles distinguished himself repeatedly and gained a great reputation both for his valour and for the special favour accorded him by Frederick II. In Jan. 1764 he was married in London to Augusta, the sister of George III, and in 1766 he undertook an extensive European tour. In 1780 his father died and Charles succeeded to the small and debt-ridden duchy. He zealously applied himself to government, reforming the administration and organizing the educational system on the principles of the Enlightenment. Under the influence of the educationalist J. H. Campe (d. 1818) he even attempted to rid the schools of all clerical influence, but failed through the resistance of the Lutheran clergy.

In 1773 Charles had become a Prussian general of infantry and thenceforward maintained a close political alignment with Prussia. He supported Frederick II's "league of princes" (1785) directed against the Austrian influence in Germany and sought to bring about better relations between Prussia and Great Britain-Hanover. In 1787 Frederick William II of Prussia appointed him field marshal and conferred on him the high command of the Prussian troops in the war against the Dutch patriots. This brief and bloodless campaign confirmed Charles's military reputation in Europe and in 1792 Frederick William gave him the command of the Prussian forces mobilized against revolutionary France.

Charles accepted the appointment rather from a military sense of duty than from conviction, for he was not in principle opposed to the aims of the Revolution. His reputation as an enlightened thinker was such that even the revolutionary government had considered approaching him to reorganize the French army. Hence it is hard to understand how he signed the immoderate "manifesto" of July 25, 1792. This had been drafted by an *émigré* and announced humiliating punitive measures against revolutionary France, especially against Paris. As early as Sept. 1792 the hesitant Prussian advance on Paris was brought to a halt by the cannonade of Valmy (*q.v.*). The ensuing retreat of the allies was in the tradition of Frederick II's strategy. Using this strategy, Charles in 1793 regained Mainz, and defeated the French at

Pirmasens and Kaiserslautern; but in Jan. 1794, irritated by Frederick William's constant meddling in the conduct of operations, he resigned the high command. However, he gained influence at the court of Berlin and advocated Prussia's joining the Grand Alliance against Napoleon. In 1806 he was sent on a diplomatic mission to St. Petersburg to improve relations between Prussia and Russia. In the same year he resumed the Prussian high command in the War of the Fourth Coalition against France, but sustained an annihilating defeat at the hands of Marshal L. N. Davout near Auerstädt (*q.v.*) on Oct. 14, 1806. Charles was fatally wounded and died at Ottensen, near Hamburg, on Nov. 10, 1806.

Charles preferred music to the distractions of court life and the joys of hunting and played the violin well. In his views, his manner of government and way of life he typified the enlightened despotism of 18th-century Germany. In appearance he resembled Frederick II of Prussia, whom he admired and whom he took as his example.

See S. Stern, *Karl Wilhelm Ferdinand, Herzog zu Braunschweig und Lüneburg* (1921). (S. Sk.)

CHARLEVILLE-MÉZIÈRES, twin towns in northeast France, Ardennes (*q.v.*) *département*, are 83 km. (51.6 mi.) N.E. of Reims by road and 15 km. (9.3 mi.) S.W. of the Belgian frontier. Pop. (1954) 33,609. Both Mézières and Charleville are built inside loops of the Meuse river, which separates them. Mézières is the prefecture.

Despite heavy damage in both world wars, Mézières, which lies to the south, still has traces of the early fortifications (those by Vauban were removed in 1886): the Milard tower (14th century); the King's tower (16th century); the Burgundy gate (14th century); and the citadel (16th century). The basilica of Notre Dame, begun in 1499, has a Gothic choir and nave; the west front, not completed until the end of the 16th century, is Renaissance. The prefecture was built between 1770 and 1790; the town hall is modern, rebuilt after World War I.

In contrast with Mézières, Charleville, on the north, is a rapidly growing town. It has the railway station, the chamber of commerce and the law courts and is also the commercial centre. The Place Ducale is a fine example of 17th-century French classic style. The poet Rimbaud was born near this square and composed his *Le Bateau ivre* near the old mill which still stands over the Meuse nearby. From Mont Olympe, across the Meuse to the north, fine views can be obtained of the twin towns. The municipal library has 50,000 books, of which 400 are manuscripts from the 11th to the 16th centuries, and there is a museum. South of Mézières is Mohon, which is included in the twin town.

Charleville-Mézières is on the main railway line from Calais and Lille to Metz and Strasbourg; another main line runs to Reims and Paris. The chief industries are construction of cranes and other heavy equipment, as well as the making of brushes, motor cars, bicycles and bricks.

Mézières, founded in the 9th century, was a stronghold belonging to the bishops of Reims, later passing to the counts of Rethel. The town grew by immigration from Liège (people fleeing first from the emperor Otto and afterward from Charles the Bold) and also as a result of concessions from the counts of Rethel. Its walls were built in the 16th century, and in 1521 it was successfully defended by the chevalier Bayard against the Imperialists. In 1815 it kept the Germans at bay for six weeks, and in 1871 the town capitulated only after heavy bombardment. Charleville was founded in 1606 and was laid out according to a plan. Charleville-Mézières was captured in Aug. 1914 by the Germans, who made Charleville the seat of their western high command. It was reoccupied on Armistice day, 1918. In World War II the twin town was occupied again by the Germans from May 1940 to Sept. 1945. (L. De.)

CHARLEVOIX, PIERRE FRANÇOIS XAVIER DE (1682–1761), French Jesuit missionary, author of an early descriptive account of North America, was born at St. Quentin, on Oct. 29, 1682. In 1719 he was sent to Canada, where he had previously stayed for four years, to discover a new route from Acadia westward. Between 1720 and 1722 Charlevoix traveled up the St. Lawrence river, through the Great Lakes and down the Mississippi, was shipwrecked in the Gulf of Mexico and visited the island of San Domingo. He spent the rest of his life writing and teaching in France and died at La Flèche, on Feb. 1, 1761. Charlevoix, Mich., is named for him.

Charlevoix's works include *Histoire du Japon* (1715), *Histoire de Saint-Domingue* (1730), *Histoire et description générale de la Nouvelle France* (1744; Eng. trans., 1866–72) and *Histoire de Paraguay* (1756).

CHARLOTTE, empress of Mexico: *see* Carlota.

CHARLOTTE, a city of North Carolina, U.S., and seat of Mecklenburg county, in the southern part of the state about midway between Atlanta, Ga., and Richmond, Va., is a trading centre for the central Piedmont region in North and South Carolina. Manufacturing firms in the area are devoted principally to textiles, machinery, chemicals, food processing and printing. Government of the city follows the council-manager plan, which went into effect in 1929; that of the county is by commissioners.

Charlotte was incorporated in 1768, six years after the creation of Mecklenburg county, and named for Princess Charlotte of Mecklenburg-Strelitz, who became the wife of George III of England in 1761. On May 20 citizens of Mecklenburg celebrate the signing of the Mecklenburg Declaration of Independence (*q.v.*) in 1775. For a few days in 1780, Lord Cornwallis occupied the town and because of the hostile reception he received named it "the hornet's nest," since then the official emblem of the city. After the discovery of gold in Cabarrus and Mecklenburg counties, a branch of the U.S. mint was opened in Charlotte in 1837 and remained in operation until 1861. The building, removed in 1935 to a new site, serves as a museum. During the American Civil War a naval yard for the Confederacy operated in Charlotte. Near Charlotte, presidents Andrew Jackson and James Polk were born, and in 1865 the Confederate president, Jefferson Davis, fleeing from Richmond, met his full cabinet for the last time in Charlotte.

The first college in North Carolina, Queens College in the Town of Charlotte, was chartered by the colonial legislature in 1771. Disallowed by authorities in England, this became for a short time after 1777 Liberty hall. The present Queens college (Presbyterian) for women was chartered in 1857. The metropolitan area also is served by two other Presbyterian schools, Davidson college (at Davidson) for men, founded in 1837, and Johnson C. Smith university, coeducational, founded in 1867; and by two municipal junior colleges, Carver and Charlotte.

The population of Charlotte was 201,564 in 1960; that of the standard metropolitan statistical area (Mecklenburg county) was 272,111. For comparative population figures *see* table in North Carolina: *Population*. (R. N. E.)

CHARLOTTENBURG, a town of Germany, on the Spree river, was incorporated in the greater Berlin scheme of 1912, which came into full operation in 1920. Its earlier name was Lietzenburg. The central part of the town is connected with Berlin by an avenue, the Charlottenburger Chaussée. The castle, built in 1696 for the electress Sophie Charlotte, queen of the elector Frederick, after whom the town was named, contains a collection of antiquities and paintings. In addition to the famous royal porcelain factory, there are many industries, notably ironworks, grouped along the banks of the Spree.

After World War II Charlottenburg was included in the British sector of west Berlin. In 1959 construction of a new university quarter, designed to house 5,000 students of Berlin's Technical university, was begun in the Am Knie part of Charlottenburg. (T. C. Pe.)

CHARLOTTESVILLE, a city of central Virginia, U.S., seat of the University of Virginia, is located 70 mi. W. of Richmond in an immense natural bowl of the Blue Ridge mountain foothills. (For comparative population figures *see* table in Virginia: *Population*.)

In colonial times Charlottesville was on a main trail from the Tidewater region to the west. Peter Jefferson, the father of Thomas, settled there in 1737. Seven years later Albemarle county was created, and in 1761 the county government moved to Charlottesville, named for the queen of George III. During the American Revolution numerous British and Hessian prisoners captured at Saratoga were quartered there, and in 1781 Col. Banastre Tarleton raided the town in an attempt to capture Thomas Jefferson and other state officials fleeing westward after the fall of Richmond. The Central Virginia (later part of the Chesapeake and Ohio) railroad reached Charlottesville in 1848, ending the use of the nearby Rivanna river for commerce. During the American Civil War the buildings of the University of Virginia, founded by Jefferson in 1819 (*see* Virginia: *Education*), were used for hospitals. Gen. Philip Sheridan's troops occupied the town but did little damage. Charlottesville was chartered as a city in 1880.

Overlooking the town is Monticello, home of Thomas Jefferson, who supervised its design and construction. The mansion, of red brick with white porticoes and an octagonal clerestory topped by a dome, contains numerous examples of Jefferson's inventiveness, including his one-armed writing desk, folding doors, disappearing beds and a wind-direction indicator. After Jefferson's death the estate suffered from periods of neglect but was restored after the Civil War and purchased in 1923 by a private foundation which turned it into a national shrine.

Other points of interest are the George Rogers Clark and the Lewis and Clark memorials, statues of Washington, Jefferson and Lee, and the James R. McConnell winged aviator memorial on the university campus. Industries, some of them attracted by the University of Virginia, include textiles, lumbering and precision instruments. (F. B. S.; X.)

CHARLOTTETOWN, the capital of the province of Prince Edward Island, Can., and the seat of Queens county, is located on Northumberland strait, on the south shore of the island. Pop. (1961) 18,318. The Charlottetown harbour and water-front facilities are excellent. Principal exports are agricultural products, chiefly potatoes, a famed product of the island; and principal imports are gasoline and oil. The city is the commercial centre of the province and has a large trade with Newfoundland. Manufactures are woolen goods, canned goods, lumber and machine and foundry products.

There was a French settlement in the area in 1720, called Port la Joie. The present site was chosen after the island passed under British rule in 1763, and it was named in honour of Queen Charlotte, wife of George III. It was incorporated as a city in 1855.

The Provincial building (1844) contains the so-called Confederation chamber, where the first meeting to discuss the union of the colonies was held in 1864 (*see* Canada: *History*), and the city was selected as the site of the 1964 Centennial Confederation building. The distinguished colonial mansion Government house, the official residence of the lieutenant governor of the province, was built in 1844. Educational institutions include Prince of Wales college (founded 1860) and a normal school, both supported by the province, and Saint Dunstan's university (1855), Roman Catholic. (Fk. Wr.)

CHARNAY, CLAUDE JOSEPH DÉSIRÉ (1828–1915), French traveler and archaeologist who did much research on the origins of the prehistoric Mexican people. He started his travels in Mexico under a commission from the French ministry of education (1857–61). After visiting other parts of the world, he returned to the ruined cities of Mexico (1880–82), his expenses being paid by Pierre Lorillard of New York. Charnay gave the name "Ville Lorillard" to a great, ruined city near the Guatemalan boundary. Charnay elaborated a theory of Toltec migrations and considered the prehistoric Mexicans to be of Asiatic origin because he found evidence of similarities to Japanese architecture, Chinese decoration, Cambodian dress and the Malay language. His works include *Les Anciennes Villes du Nouveau Monde* (1885; Eng. trans., 1887). Charnay died at Paris in 1915.

CHARNOCK, JOB (d. 1693), English founder of Calcutta, went to India in 1655 or 1656 and soon joined the East India company's service. He was stationed at Cossimbazar and then at Patna. In 1686 he became chief agent at Hugli. Besieged there by the Mogul viceroy of Bengal, he put the company's goods and servants on board his light vessels and dropped down the river 27 mi. to the village of Sutanati, a place well chosen for the purpose of defense, which occupied the site of what is now Calcutta. It was only, however, at the third attempt that Charnock finally settled down at this spot, and the later selection of Calcutta as the capital of British India was entirely due to his stubborn resolution. Charnock died in Calcutta in Jan. 1693.

See N. N. Raye, *The Annals of the Early English Settlement in Bihar* (1927).

CHARNOCKITE, a series of rocks first described from Madras, southern India, by Sir T. H. Holland, who named this particular type of rock in honour of Job Charnock, the founder of Calcutta.

Composition.—The term charnockite is often limited to the characteristic hypersthene granite of the series. However, the charnockite series comprises rocks with chemical composition ranging from acidic granitic over granodioritic, dioritic and gabbroic to ultrabasic. (*See* Granite; Diorite; Gabbro; *see* also Petrology: *Habit of Igneous Rocks; Chemical Characters.*) Anorthosite is often associated with the charnockite series as, for example, in southwest Norway and the Adirondacks.

Members of the charnockite series contain certain characteristic minerals which distinguish these rocks from others of comparable bulk chemical composition. Hypersthene (*see* Pyroxene) is, for example, a typical mineral for all rock members of the series. The plagioclase of these rocks is usually antiperthitic (*see* Feldspar: *Unmixing at Low Temperature*). The alkali feldspar may be intermediate between ordinary microcline and orthoclase, a fine microperthitic texture being common. Dark colour and clouding of the feldspars are typical features of these rocks; so is a bluish tint in quartz. For these reasons hand specimens and outcrops of quartzo-feldspathic charnockites look considerably more basic than they really are. Some charnockites contain a brownish-green hornblende of hastingsitic affinity and often rather rich in titanium (*see* Amphibole). The garnet characteristic for these types of rocks is enriched in the pyrope "molecule."

Occurrence.—Rocks of charnockitic affinity are found all over the world, preferably in deeply eroded Pre-Cambrian basements. In India they occur in the Nilgiri hills, the Shevaroys, in the Western Ghats and southward to Cape Comorin. The charnockite area of Ceylon probably is a continuation of the Indian province.

Charnockites occur in South and Western Australia, in Enderby Land and Adélie Coast in Antarctica and on the Ivory Coast and in Uganda in Africa. Rocks belonging to the charnockite series are reported from Ellesmere Island and from five separate vast regions on the west coast of Greenland. In north Finland, southwest and west Norway and south Sweden rocks of this character have been studied. At several localities in the United States, Brazil and Canada charnockites and closely allied rocks are found.

Origins.—When Sir T. H. Holland described this type of rock for the first time, he—and probably most contemporary petrologists—assumed that they were of magmatic origin developed by fractional crystallization from a silicate melt. Later studies of field relationships combined with laboratory studies have, however, made it clear that many if not all rocks of these characters are metamorphic—formed by recrystallization in closed or open systems at high pressures and moderately high temperatures.

For discussion of theories of rock formation *see* Geochemistry: *Geochemistry of the Lithosphere;* Metamorphism. *See* also Granulite. (H. Rg.)

CHARNWOOD FOREST, an upland tract with craggy Pre-Cambrian rocks and bracken-covered slopes in Leicestershire (*q.v.*), Eng., lying southwest of Loughborough and northwest of Leicester. Much of it is barren, and it has been extensively quarried. More than 6,000 ac. are over 600 ft. high; the loftiest point, Bardon hill, is 912 ft.

CHAROLAIS, an ancient region of France, in southern Burgundy, consisting of the country round Charolles (in the modern *département* of Saône-et-Loire). It was formed from the southern part of the countship of Autun with a district that Hugh IV, duke of Burgundy, detached from the countship of Chalon in 1239. Robert II of Burgundy gave it in 1275 to his niece Béatrix de Bourbon. Through a granddaughter of hers the seigniory passed to the house of Armagnac, under whom it acquired the title of countship. In 1390 Philip the Bold, duke of Burgundy, bought Charolais back for the heirs of Margaret of Bavaria, wife of the future duke John the Fearless. Thenceforward the eldest son of the duke held the title of comte de Charolais in his father's lifetime, as did Philip the Good and Charles the Bold.

After Charles the Bold's death, Charolais was temporarily occupied by the French (1477), but at the final partition of the Burgundian inheritance between the French and the Habsburgs it was secured by the latter, though the duchy of Burgundy was held by the French. The Holy Roman emperor Charles V left it to his son Philip II of Spain. The kings of Spain, however, held Charolais as a fief of the kings of France, who levied taxes there and seized the countship when they were at war with Spain. In 1684 the prince de Condé (Louis II de Bourbon), as the king of Spain's creditor, secured ownership of Charolais by a court judgment. Charolais long enjoyed administrative autonomy, having its own estates which met every third year until 1751, when they were incorporated with the estates of Burgundy.

See L. Laroche, "Le Bailliage comtal de Charolais," *Annales de Bourgogne* (1933). (J. B. R.)

CHARON, in Greek mythology, the son of Erebus and Nyx (Night), whose duty it was to ferry over the rivers Styx and Acheron those souls of the deceased who had duly received the rites of burial. In payment for this service he received the coin that regularly was placed in the mouth of the corpse. He is probably a product of popular belief and is not mentioned in Homer or Hesiod. He is represented as a morose and grisly old man. In Etruscan he is called Charun and appears as a death demon, armed with a hammer. Finally he came to be regarded as the image of death and of the world below. As such he survives in Charos, or Charontas, the angel of death in modern Greek folklore.

See the classical dictionaries, especially W. Roscher, *Ausführliches Lexikon der griechischen und römischen Mythologie.*

CHARONTON, ENGUERRAND: *see* QUARTON, ENGUERRAND.

CHARPENTIER, GUSTAVE (1860–1956), French composer, whose fame rests on one work, his opera *Louise,* was born at Dieuze, Moselle, on June 25, 1860. He studied at the Lille conservatory and later under Jules Massenet (*q.v.*) at the Paris conservatory, where he won the Prix de Rome (1887). The popularity of *Louise,* first produced in Paris at the Opéra-Comique on Feb. 2, 1900, and performed over 1,000 times there in the following 60 years, is probably due to the sentimental realism of the plot, to the picturesque setting (Montmartre), to the businesslike vocal writing in the Massenet tradition and to the mildly Wagnerian scoring. *Julien* (1913), a sequel to *Louise,* achieved less success. Earlier works included *Les Impressions fausses* for voice and orchestra (1895) and *Chant d'Apothéose,* written in 1902 for the Victor Hugo centenary. In 1902 Charpentier founded the Conservatoire populaire de Mimi Pinson, which provided free music lessons for working people. He died in Paris on Feb. 18, 1956. (F. E. G.)

CHARPENTIER, MARC ANTOINE (1634–1704), generally considered the most important composer of his generation in France, and writer of much music for plays, was born in Paris in 1634. On his return to France after studying in Rome with Giacomo Carissimi, he wrote the music for a new version of Molière's *Le Mariage forcé* (1672) and collaborated with him again in *Le Malade imaginaire* (1673). After Molière's death Charpentier continued to work for the Théâtre Français until 1685; his greatest stage work, *Médée,* to Corneille's text, was produced in 1693.

In his own lifetime he was considered by many to be a finer musician than Lully, who until his death in 1687 ruled French music with an iron hand. From 1680 to 1688 Charpentier was director of music to the princesse de Guise; from 1679 he composed music for the dauphin's private chapel; in about 1692 he began teaching composition to the duc d'Orleans, the future regent of France; and in 1698 his official functions were further increased when he was made *maître de musique* at the Ste. Chapelle in Paris.

His works include, besides 24 works for the stage (*comédie-ballets, pastorales,* etc.), many masses, motets, *Te Deums* and other sacred choral works; he made use of a comparatively large orchestra and double chorus. In his music for the sacred tragedies performed by the Jesuit community in Paris he established the oratorio in France, and one of these works, *Le Reniement de St. Pierre,* is considered his masterpiece. (B. P.)

CHARRIÈRE, ISABELLE AGNÈS ÉLISABETH DE (1740–1805), Dutch-born Swiss novelist, whose work anticipated early 19th-century emancipated ideas, was born at Utrecht, Oct. 20, 1740, the daughter of Baron van Tuyll van Seroskern van Zuylen. She married her brother's Swiss tutor and settled at Colombier near Neuchâtel.

Influenced by Diderot and Rousseau, she expressed critical views of aristocratic privilege, moral conventions (*Trois femmes,* 1797), religious orthodoxy and poverty but was opposed to revolutionary radicalism (*Lettres trouvées sous la neige,* 1794). Her novels, of which the most important are the excellent *Caliste, ou lettres écrites de Lausanne* (1786) and *Lettres neuchâteloises* (1784), abound in philosophic reflection, refined psychological observation and local colour but lack coherent plot. They reflect her solitude and inner contradictions, characteristic in many ways of an early type of emancipated woman. She died at Colombier, Dec. 27, 1805.

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CHARRON, PIERRE (1541–1603), French philosopher and theologian, whose attack on traditional philosophical views and whose controversial form of skepticism made him one of the major contributors to the new thought of the 17th century, was born in Paris. He studied at the Sorbonne, Orléans and Bourges and became a lawyer. Later, he turned to theology and won renown, serving as preacher in ordinary to the queen of Navarre (Margaret of France), as theological adviser in several dioceses and as canon in Bordeaux. In 1589, in spite of his immense success, he tried to give up worldly pursuits and retire to a cloister. He was turned down because of his age. That same year, he met Michel de Montaigne (*q.v.*) and became his intimate friend and disciple. Charron died in Paris on Nov. 16, 1603.

In his major works, *Les Trois Vérités* (1593) and *De la Sagesse* (1601), which appeared after Montaigne's death (1592), Charron presented his mentor's skeptical views coupled with a fideistic advocacy of Catholicism. The first book was intended primarily as a Counter-Reformation tract against Calvinism. Charron began with a "Discours de la cognoissance de Dieu," showing that God's nature and existence cannot be known because of our weakness and God's infinitude. No rational knowledge of the divine is possible. Hence, one should accept Christianity by faith, remaining in the traditional church, and not adopt the dogmatic presumption of the Reformers, who try to measure God by their own lights.

The more sensational *De la Sagesse* examines what man can know outside of revealed truths. In a systematic form, Charron develops the skepticism of Montaigne, showing that "The only true principles men possess are revealed ones. Everything else is only a dream." The proper conclusion of the wise man is complete doubt, because of the weakness and unreliability of his mental capacities. The skeptical attitude will free us from prejudices and enable us to be dispassionate. Moreover, Charron insists, this attitude will help us to reach religious truth, since it will leave our minds "blank, nude and ready" to receive the revelation. The true skeptic will never be a heretic, since, in having no opinions, he cannot have the wrong ones.

The skeptic, Charron asserts, will live according to nature, if he has not received divine commands. Natural morality is that of the "noble savage." In his picture of the wise natural man, Charron presents one of the first modern moral theories developed apart from religious considerations. Thus he is important for having separated ethics from religion as an independent philosophical discipline.

De la Sagesse, which went through many editions, was immensely popular and influential throughout the 17th century, being read by most thinkers in France and by many in England (the first English translation appeared in 1608). The work was immediately attacked as irreligious both because of Charron's natural moral theories and for its skepticism. Charron was accused of insincerity in his professed Catholic views and of undermining genuine religious belief. The Jesuit François Garasse called *De la Sagesse* the "breviary of the *libertins* ['freethinkers']" and accused the author of being a secret atheist. Charron was defended by prominent churchmen, including Claude Dormy, bishop of Boulogne, and the abbé de St. Cyran (Jean Duvergier de Hauranne, who succeeded in having Garasse's attack on Charron condemned by the Sorbonne in 1626). Charron's views were also admired by Cardinal du Perron, Pierre Gassendi, Gabriel Naudé and others. Many considered him a leading Counter-Reformer, who used skepticism as a means of destroying the arguments of the Calvinists.

From the 17th century onward there has been disagreement in assessing Charron's (as well as Montaigne's) real intentions. Was he raising doubts in order to make way for faith or to get rid of faith? His *Discours chrestiens* (1600) and his religious life would indicate that he was a sincere Christian, while some portions of *De la Sagesse*, together with his influence on several of the *libertins*, suggest that he was not. There is still genuine difficulty in determining his true views.

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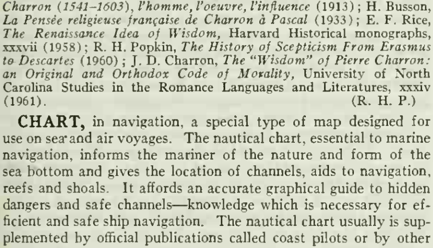
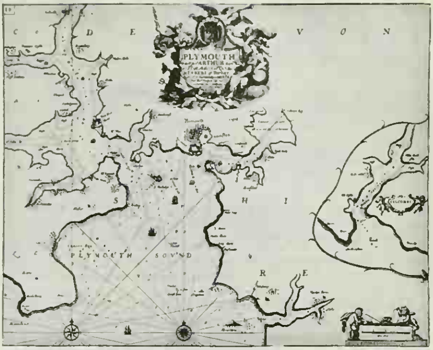
CHART, in navigation, a special type of map designed for use on sea and air voyages. The nautical chart, essential to marine navigation, informs the mariner of the nature and form of the sea bottom and gives the location of channels, aids to navigation, reefs and shoals. It affords an accurate graphical guide to hidden dangers and safe channels—knowledge which is necessary for efficient and safe ship navigation. The nautical chart usually is supplemented by official publications called coast pilots or by other types of sailing directions which provide pertinent descriptive details that cannot be shown conveniently on the chart itself.

Much more recent than the nautical chart is the aeronautical chart, which is essential to air navigation. Whereas a nautical chart is a graphic representation of an area consisting chiefly of water, the aeronautical chart, like a map, most often represents an area that is predominantly land. Aeronautical charts, being designed for one special purpose, often violate the established usage of conventional maps. They differ from maps that are prepared in accordance with definite conventions based on the relative importance of features to be mapped and the emphasis to be given each. Features normally included in an ordinary map often are omitted, while other features are exaggerated beyond topographic justification to enhance their landmark value. *See* Map; Navigation.



BY COURTESY OF THE BRITISH MUSEUM

FIG. 1.—CHART OF TOBAGO, WEST INDIES, BY JOHN SELLERS; ABOUT 1688



BY COURTESY OF THE TRUSTEES OF THE NATIONAL MARITIME MUSEUM, GREENWICH, LONDON

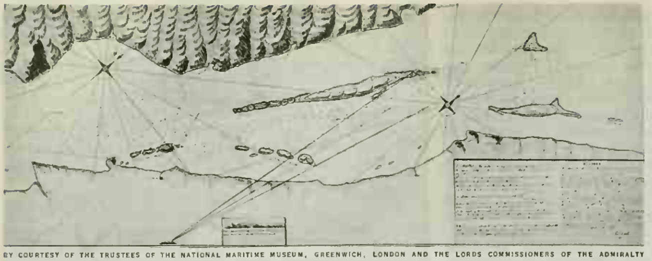
FIG. 2.—CHART OF PLYMOUTH SOUND, ENGLAND, FROM COASTING PILOT BY GREENVILLE COLLINS; 1693

HISTORY OF NAUTICAL CHARTING

Early mariners ventured upon the sea with little to guide them save their own experience and instinct. Charting evolved slowly and painfully from obscure origins, with the first hydrographic charts making their appearance in the middle ages. The portolan charts, which marked the real beginning of the nautical chart, came into being in the 14th century. They carried descriptive notes, loxodromic (rhumb) lines and a network of lines corresponding to the principal points of the compass. Copies were reproduced by hand on skins or parchment by specialized draftsmen. No projection was used on these charts, but the coasts of the various countries were drawn in their correct relationship based on bearings, and actual distances were indicated between ports.

In 1569 Gerhard Kremer, better known by his Latin surname, Mercator, published his famous world map on a new system, which became known as the Mercator projection. His results were derived by mathematical formulas and originally were referred to as "a new proportion and a new arrangement of the meridians with reference to the parallels." Because of its improvement over methods existing before his time, Mercator's map or nautical chart of 1569 stands alone as the greatest achievement in cartographic history.

Great Britain.—Marine surveying basic to accurate charting developed slowly in England, and the charts published in that country as late as the 17th century were based on Dutch work. Until about 1675 no official charts of any coasts outside Europe were available to merchant ships. Navigators had to rely on sea atlases until John Seller in 1670 published his *Atlas Maritimus*, which soon was followed by his *English Pilot*. A milestone was achieved when a naval captain, Greenville Collins, produced Great Britain's *Coasting Pilot* in 1693; this contained charts based on the first surveys to be conducted by an Englishman. A number of more complete editions of the *English Pilot* appeared between 1743 and 1761. Notable progress in marine charting was made during British colonial expansion on the North American continent in the 18th century. Between 1774 and 1783 British engineers, under the direction of Joseph Frederick Wallet des Barres, produced the noted Neptune series of hydrographic charts, which covered the Atlantic coast of colonial America from Maine to Florida.



BY COURTESY OF THE TRUSTEES OF THE NATIONAL MARITIME MUSEUM, GREENWICH, LONDON AND THE LORDS COMMISSIONERS OF THE ADMIRALTY

FIG. 3.—CHART OF A SECTION OF THE ST. LAWRENCE RIVER, CANADA, ABOUT 100 MI. N.E. OF QUEBEC CITY; ORIGINAL MANUSCRIPT DRAWING BY JAMES COOK; 1760

The invention by John Hadley in 1731 of the reflecting octant, and the independent and nearly simultaneous discovery of the same principles by Thomas Godfrey in America, pointed the way to more accurate navigation. In the period 1729–60 John Harrison, a Yorkshire carpenter, developed his marine chronometer, which gave to the world an accurate timekeeper for determining longitude at sea.

Advancements during the 18th century were accelerated by the mariners' demands for an accuracy in keeping with new methods of navigation and also by the expansion of maritime commerce. The work of Alexander Mackenzie, Matthew Flinders, George Vancouver and William Bligh, as well as the massive work of James Cook, characterized this period, which immediately preceded the establishment of the British hydrographic office. Cook's contribution to world charting is the most outstanding example of the extent and quality of the work of the early marine surveyors. During his first voyage alone about 5,500 mi. of coast line were surveyed, with untiring devotion to accuracy and detail that has ever been an inspiration to the science of hydrography.

Until the formation of the hydrographic office in the British admiralty, charts were distributed to both the Royal Navy and the merchant fleet by private publishing firms. Even though the admiralty had commissioned many of the surveys, the charts themselves were published by a number of well-established firms. The fact that the publishers, whose decisions inevitably took into account salability, prescribed what charts would be available to mariners was a serious disadvantage. Many surveys commissioned by the admiralty lay untouched in admiralty files, and British navigators were thus deprived of a substantial amount of chart information.

The undigested mass of material accumulating in the admiralty offices at long last resulted in the issuance of an order in council dated Aug. 12, 1795, creating the post of hydrographer, and this was actually the birth of the hydrographic department of the admiralty. Alexander Dalrymple, a distinguished geographer with a long record of marine surveying as hydrographer to the East India company, was appointed the first hydrographer of the admiralty. With great energy and concentration, supported by a small staff, he reduced the huge mass of material into new engraved charts. Like the great Ferdinand Rudolph Hassler, who shortly afterward became the first superintendent of the coast survey in the United States, Dalrymple established from the beginning a high standard of accuracy and scientific integrity for the charts to be issued by the admiralty. He met the same type of pressures and opposition in England that Hassler later encountered in the United States.

In the first 15 years of the 19th century the "hydrographical" office, although not yet an admiralty department, expanded rapidly. A great deal of charting was accomplished under Capt. Thomas Hurd. Toward the end of his years as hydrographer, he made admiralty charts available to the public by removing them from the jealous privacy of naval use. For this act he earned the lasting gratitude of the merchant marine of succeeding ages. Captain Hurd is also remembered for his accomplishment of the first detailed hydrographic survey. This great scientific milestone, the survey of Bermuda (1791–99), set new standards of precision and thoroughness. Many famous hydrographers, such as the admirals Sir William Edward Parry, Sir Francis Beaufort and Sir William Wharton, subsequently made important contributions. Much credit also is due Vice-Adm. Sir John A. Edgell, whose term as head of the hydrographic department extended from 1932 to 1945. (*See* SURVEYING: *Hydrographic Surveying*.)

United States.—In the United States, nautical charting and hydrographic surveying came into being in 1807 with the creation of the survey of the coast for the primary purpose of producing charts of the coastal waters of the new republic. From the beginning, this great undertaking was based on a solid foundation of scientific accuracy. Superintendent Hassler prescribed a system of rigid triangulation control to ensure that the edges of a chart of any location would align with those of charts of adjacent areas. This new concept of co-ordinated surveys marked a new era in chart making.

The first chart produced by what is now the U.S. coast and geodetic survey was a stone engraving of Newark harbour issued in 1839; however, the early charts of the survey were produced mainly as copperplate engravings. Lithographic methods were employed in reproducing nautical charts as early as 1897. After 1916 copperplate engraving gradually was discontinued, until today all charts are produced by modern photolithographic methods.

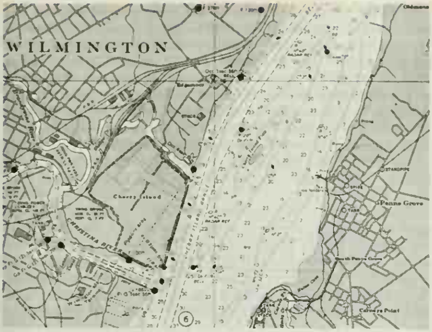
Charting in the United States, unlike that in Great Britain, is conducted separately to meet merchant-marine and naval requirements. Whereas the coast and geodetic survey produces charts of the domestic waters of the nation, charting to meet naval requirements of foreign areas is accomplished by the navy hydrographic office. These two agencies hold individual membership in the International Hydrographic bureau and work together closely in co-ordinating surveying and charting activities to ensure the best possible results.

The U.S. navy hydrographic office, one of the principal depositories and distributors of world navigational information, originated from the navy depot of charts and instruments, which was established in 1830. Future development of the navy hydrographic office was influenced greatly by Matthew Fontaine Maury, who assumed charge of the depot in 1842. He introduced an extensive system of collecting information from the logs of naval and merchant ships. This information was compiled into pilot charts, which enabled ships to shorten sea voyages by following the tracks prescribed by Maury. The depot also introduced trade wind charts, thermal charts and storm and rain charts.

International Hydrographic Bureau.—Under Maury's able guidance the first international marine conference was held in Brussels, Belg., in 1853 to promote a uniform system of observations at sea. This meeting was the forerunner of what was later to become the International Hydrographic bureau. This organization had its inception at an international hydrographic conference held in London in 1919 at the invitation of the British admiralty. After due consideration the seat of the organization was established in the principality of Monaco, where it has remained to this day. Notable achievements have been made by the International Hydrographic bureau in establishing, co-ordinating and promoting the highest possible collaboration and co-operation among the principal maritime nations of the world.

NAUTICAL CHART CONSTRUCTION

The compilation of a nautical chart requires strict cartographic application on a plane surface of all pertinent data concerning some particular navigable water area. The position of the features and the charted detail in the compilation must bear a correct



BY COURTESY OF THE U S COAST AND GEODETIC SURVEY

FIG. 4.—NAUTICAL CHART OF DELAWARE RIVER AT WILMINGTON, DEL.

mathematical relationship to the relative positions of terrestrial features that have been located by precision methods on the curved surface of the earth.

Chart Scales.—Charts made for marine navigation are designed with varying scales. Complete chart coverage of a coast consists of several different series of charts, each series made at a certain scale for a particular purpose and for specific coverage. The smallest-scale charts are for use in approaching a coast from the open sea while making a landfall. Larger-scale series are constructed for use in navigation in more constricted areas, where dangers are more critical. The largest-scale charts are the harbour charts, where it is necessary to show the greatest amount of detail.

Projection.—The parallels of latitude and the meridians of longitude constitute the framework of the chart and afford a means of placing every detail in its correct relative position. Therefore, the computation and construction of the projection are very important factors. Computations are made to the nearest thousandths of a millimeter. Mediums on which the chart drawing is made must be stable and resistant to shrinkage and distortion.

The Mercator projection is used almost universally for hydrographic charting. On this projection the meridians are parallel, equidistant straight lines which do not converge, as they do on a globe. The parallels of latitude are also straight lines and intersect the meridians at right angles. The spacing of these parallels of latitude on the meridians is determined by the law of the projection, in order that the scale along a meridian at any point will equal exactly the increase in scale along the parallel at that point. The published scale of a chart is generally the scale at the middle latitude. Variation in the chart scale north or south of the middle latitude is small or negligible, depending on the latitudinal extent.

The primary reason for world-wide use of the Mercator projection is that the rhumb line, which specifies the track of a ship on a constant compass course, is a straight line on the projection. Other advantages of this projection are its conformality (*i.e.*, the retention of correct angular relationships at each point), simplicity of construction and convenience in plotting positions from border subdivisions.

Symbolization and Other Features.—The finished nautical chart delineates nautical and geographical features, partly in the form of reduced outline and partly in the form of symbols of various kinds. Chart symbolization is no more than approved conventionalism, and symbols are employed which will best meet the needs of the potential user. In the early years of sea navigation many chart users were unable to read, and symbols that were pictorial representations of the charted features were of necessity employed. As the peoples of the world became more literate, symbolization underwent a slow change, until today charts are produced that reflect the ultimate in refinement, legibility, clarity and unity of style.

In addition to the proper use of conventional signs and symbols, close attention is given to details, such as lettering, place names, legends and notes, in order to produce charts that are legible and easily interpreted. A critical study of hydrography is made in order to secure a selection of soundings that will be simple, representative and practical. The cartographer must supply the artistic element indicative of good charting without sacrificing any essential details, and he must always present a faithful portrayal of the charted area. The hallmark of good charting is accuracy and simplicity.

Fixed aids to navigation and landmarks are usually plotted first so that placement of these important features can be readily verified in comparison with survey material subsequently applied. The amount of topography applied depends upon the needs of the navigator and the scale of the chart. Shore-line detail and all important topographic features visible from the waterway are reduced to chart scale and plotted in their exact geographic position. Vertical relief is represented by contours or form lines, sometimes supplemented by hachures in areas of bold or rugged terrain.

Hydrographic features are applied to the chart from various types of surveys. Information on such things as hidden shoals, rocks, reefs and underwater obstructions is checked meticulously in the examination of all source materials used. Indications of dangers, such as the presence of breakers and kelp, are also noted for charting. The soundings and depth curves that will delineate channels, navigable areas and shoals must be accurately positioned in the compilation. Floating aids that mark these features are also plotted. The finished drawing is a clear and complete portrayal of submarine relief. In general, the distribution of soundings to complete the compilation depends upon the scale of the chart, the number of shoals and the bottom configuration (*see* SOUNDING).

Auxiliary information, such as the chart title, geographic names, reference notes, data for magnetic compasses, cable and pipeline locations, and special anchorage or danger areas, is then added. Also included in the compilation are survey data and information received from miscellaneous sources. To provide maximum safety for navigation, all reported wrecks, uncharted reefs and shoaling in channels are represented. The published chart is the culmination of precise geodetic, topographic, hydrographic and cartographic work.

Colouring.—Charts are published in various colours. The principal reason for using colour in a map or chart is to aid in the selective reading of its content. On the nautical chart, all data that must be accurately positioned with respect to the chart projection are shown in black, as are the projection lines. Black is the most legible colour under all conditions of illumination. A buff tint makes the land area stand out from the water areas and also furnishes a good background for showing up black lettering of notes and place names on the chart. Since buff fades out under a red light, which is often used in night navigation, some charting agencies use a gray tint for the land areas. Blue tints mark the shallower water areas and indicate critical areas where dangers may exist. Green tint is used for marsh areas and also to mark the foreshore areas of the coast that extend between the high- and low-water lines. Magenta tints are generally used to indicate lighted aids to navigation and special water areas of importance to the mariner. Compass roses may also be printed in magenta. On modern charts brown and green are generally used for loran lines of position, each colour representing a pattern of position lines.

Depth Curves.—Sanding symbolization, a technique that used evenly spaced dots to bring out the gradation of depth, to emphasize dangers and to make channels and other safe waters apparent at a glance, was common practice when the copper engraver's art was needed to provide the selective reading quality of the chart. Copper engraving, however, could not meet the modern requirements for charts and has been replaced by photolithography. Sanding symbolization has been replaced by tinting. New techniques eliminate voluminous soundings so that depth configuration can be delineated more accurately. The appearance of present-day nautical charts differs considerably from those formerly printed from copper plates.

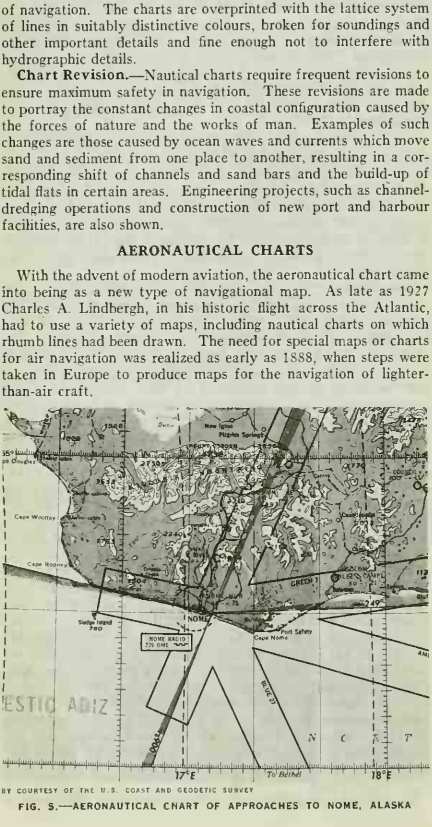
Echo-sounding equipment on merchant and naval ships enables the navigator to determine water depths under his ship without slowing down or stopping (*see* Echo Sounder). This technique resulted in the development of a new type of chart characterized by the special prominence given to depth curves. Prior to the introduction of echo sounding, charts were distinguished by many soundings and few depth curves. In contrast, nautical charts are now characterized by many depth curves and fewer soundings. Formerly, such charts were not possible, due to the fact that the delineation of depth curves, unless based on detailed and highly accurate hydrographic surveys, would serve to mislead the navigator and might, under certain conditions, give him a false sense of security.

The development of the new type of nautical chart was a logical outgrowth of the application of acoustics to marine surveying and to navigation. Echo sounding, together with improved methods of position determination, furnishes an economical means of obtaining a wealth of submarine information useful to the navigator. With the introduction of various electronic systems to marine navigation, the need developed for special treatment of nautical charts in order to show the intersecting sets of hyperbolas required for interpretation of the electronic navigation data. The standard nautical charts have been adapted for use with new electronic aids in such a manner as to make them practicable for all types of navigation. The charts are overprinted with the lattice system of lines in suitably distinctive colours, broken for soundings and other important details and fine enough not to interfere with hydrographic details.

Chart Revision.—Nautical charts require frequent revisions to ensure maximum safety in navigation. These revisions are made to portray the constant changes in coastal configuration caused by the forces of nature and the works of man. Examples of such changes are those caused by ocean waves and currents which move sand and sediment from one place to another, resulting in a corresponding shift of channels and sand bars and the build-up of tidal flats in certain areas. Engineering projects, such as channel-dredging operations and construction of new port and harbour facilities, are also shown.

AERONAUTICAL CHARTS

With the advent of modern aviation, the aeronautical chart came into being as a new type of navigational map. As late as 1927 Charles A. Lindbergh, in his historic flight across the Atlantic, had to use a variety of maps, including nautical charts on which rhumb lines had been drawn. The need for special maps or charts for air navigation was realized as early as 1888, when steps were taken in Europe to produce maps for the navigation of lighter-than-air craft.



BY COURTESY OF THE U.S. COAST AND GEODETIC SURVEY

FIG. 5.—AERONAUTICAL CHART OF APPROACHES TO NOME, ALASKA

With the limited air speeds of the early days of aviation, the aviator could make use of standard topographic maps for identifying prominent landmarks. British pioneers in aeronautical charting incorporated special features into an aerial map produced in 1912, to emphasize details pertinent to the aviator. This early aeronautical map emphasized roads, railways and lakes by hand colouring on a photoprint of an ordnance survey map at the scale of one inch to the mile. During World War I the British government produced special air maps for use over the coastal waters of the British Isles and also produced a special aviation map of France. These maps were the first ever produced in quantity for use in air navigation.

The air corps of the United States army first considered the need for aeronautical charts in the early 1920s. The U.S. coast and geodetic survey co-operated with the army in producing for military use strip maps covering limited areas between major air corps fields. Pursuant to the Air Commerce act of 1926, aeronautical charting became a reality in the United States and has been developed progressively since that time. Production of aeronautical charts in the United States now greatly exceeds that of nautical charts, with the U.S. coast and geodetic survey issuing annually about 40,000,000 charts of domestic areas to meet civilian and military requirements. The U.S. air force also has a greatly expanded aeronautical charting program, which includes the production of charts on a world-wide basis.

Chart Types and Format.—In contrast to the simple charts originally used, modern aeronautical charts are of numerous types and formats to accommodate the complexities of modern aviation. Included are a wide range of charts to meet specific needs for planning and for both instrument and visual (contact) flight operations. In the United States the sectional charts at the scale of 1:500,000, which cover the entire country in 87 sheets, constitute the basic series. The sectional charts are designed for contact flight of aircraft operating at slow to medium speeds. For this reason particular care is taken to show those items which are prominent and distinctive when viewed from the air. The basic world-wide series is the world aeronautical chart series at the scale of 1:1,000,000, which provides coverage of the land areas of the world in about 900 sheets. The smaller scale of these charts makes them more suitable than the sectionals for long-range, high-speed flights.

Various other types of charts are produced to satisfy the needs of aviation, such as aircraft position, jet navigation and instrument flight. The instrument series consists of radio-facility charts, which are designed for en route navigation; instrument-approach-procedure charts, used for airport approach and landing; and terminal-area charts.

Aeronautical charts constituted a new development in cartography, with the primary objective of providing rapid solution of problems inherent in determining direction and distances. The features stressed on the charts are clearly defined airway routes, prominent landmarks and the general trend of railways and highways and their intersections. Minor roads and other details that might confuse the aviator are omitted.

Projection.—Aeronautical charts require a suitable system of projection to facilitate laying out courses, fixing features and measuring distances. The Lambert conformal conic projection has world-wide application for the production of co-ordinated aeronautical charts within the middle latitudes. This projection permits a suitable junction between any number of charts in any direction for an area of limited latitudinal coverage. It is excellent for scaling distances in all directions over a large geographical area. Azimuths obtained from it correspond closely to directions on the earth, and it affords a simple and satisfactory solution for all problems of dead reckoning. The Lambert projection provides for practical great-circle navigation and is well suited for celestial navigation and for all types of radio navigation.

Symbolization.—The aeronautical data which provide the specific information required by the aviator are overprinted on a base chart which has been designed specifically to complement these data. The overprint includes the symbolization which has been developed and standardized. This symbolization is entirely different from that used on nautical charts, but it is designed to serve the same practical purpose in air navigation that nautical chart symbolization serves in sea navigation.

Chart Standardization.—International standardization of aeronautical charts is provided through the International Civil Aviation organization, with headquarters in Montreal, Can. *See* also NOMOGRAPHY; PHOTOGRAMMETRY. (H. A. KA.)

CHARTER, a written instrument issued by a governmental body and conferring some right or privilege, such as the Great Charter of King John (*see* DIPLOMATIC; MAGNA CARTA). In modern times the term is used principally with reference to the privilege of carrying on business by way of a corporation or a company. Corporate charters today are typically issued by administrative officials pursuant to general statutes rather than by special legislative act. The charter is the basic document defining the powers of the corporation and regulating its government. (*See* CHARTERED COMPANY; COMPANY; CORPORATION.) As the equivalent of the term "charter party," the term is also commonly used in connection with the carriage of goods by sea. *See* AFFREIGHTMENT; MARITIME LAW. (B. CE.)

CHARTERED ACCOUNTANT, a public accountant who belongs to one of the chartered professional societies or institutes of accountants in Great Britain, the commonwealth and related areas. The term is often abbreviated to C.A. and is roughly equivalent to the U.S. term "certified public accountant" (C.P.A.). A chartered accountant must meet the standards of education and experience established by the society or institute. *See* ACCOUNTING.

CHARTERED COMPANY, the name given to a corporation enjoying certain rights and privileges, and bound by certain obligations, under a special charter granted to it by the sovereign authority of the state, such charter defining and limiting those rights, privileges and obligations and the localities in which they are to be exercised. The charter usually confers a monopoly upon the company in its sphere of operations. In Great Britain the sovereign has power at common law to incorporate by charter any number of persons desiring to be incorporated; formerly the pope, as well as the crown, possessed the power of creating corporations by grant. A charter may be granted for any period of time and may be renewed; for example, the British Broadcasting corporation was thus incorporated by charter for ten years in 1927, and its charter has since been renewed for further periods.

Medieval Companies.—The earliest English chartered companies were the Merchant Adventurers and the Merchant Staplers. These two were the only ones in existence up to 1550, and in the middle ages a large share of English trade was in the hands of foreign merchants who were not resident in England and who carried on a ceaseless struggle with the English authorities. Merchants from Lübeck, Brunswick and Denmark had received a charter from Henry III in 1257, and the Hanseatic league (*q.v.*) continued to enjoy its privileges until the end of the 16th century. The Merchant Adventurers were of great commercial importance and were largely responsible for establishing the eventual ascendancy of the English traders over their rivals from Germany and the Netherlands.

The early companies were regulated companies, deriving the principles of their organization from the medieval trade guilds. The regulated company was a corporation of merchants, each of whom traded on his own account but was subjected to a rigid set of common rules that regulated his operations within narrow limits.

Developments in the 16th–18th Centuries.—A great increase in the number and activities of the chartered companies took place during the second half of the 16th century, when the discovery of the new world, the glamour of the orient and the opening of new trade routes to the Indies had given a great stimulus to commerce, shipping and industry throughout western Europe. The English, French and Dutch governments were ready to assist trade and encourage exploration. Changes also occurred in the organization of chartered companies. The regulated company, which had been very convenient for trading with countries where conditions were stable, was not so suitable for ventures to remoter lands, where the risks, commercial and political, were greater. To meet the requirements of the new trading conditions the joint-stock organization, where the capital was provided by shareholders who then participated in the profits from the joint enterprise, was evolved. In some cases the companies alternated between one form and the other according to prevailing circumstances, and in some joint-stock companies a certain amount of restricted individual trading was permitted. In all charters provisions were inserted designed to secure the "good government" of the company.

English Companies.—The Muscovy, or Russia, company, incorporated in 1555 as a sequel to the search for a northeast passage, was at first joint stock and later regulated. To this company England owed its first commerce with Russia, and in the 18th century the company enjoyed a large part of Russia's foreign trade. It also led to direct trade with the Levant and Persia. The Turkey company, founded in 1581, became the Levant company in 1592, after amalgamation with the Venice company (founded 1583). Both the Muscovy and Turkey companies had an important effect upon British relations with those empires. They maintained British influence and paid the expenses of ambassadors sent there. Other companies were established in this period for similar trading ventures: the Spanish company (1577, regulated), the Eastland company, for trade with the Baltic (1579, regulated), and the French company (1611, regulated). The first company for African trade was founded in 1585, and others were granted charters in 1588, 1618 and 1631.

But it was the chartered companies which were formed during this period for trade with the Indies and the new world which had the most wide-reaching influence. The East India company (*q.v.*) was established in 1600 as a joint-stock company with a monopoly of the trade to and from the East Indies. Its political achievements form a large part of the history of the British empire, and its economic power was enormous, contributing substantially to the national wealth and causing the company to be the centre of most of the economic controversies of the 17th century.

In North America the importance of the chartered company lay in a different sphere: as a colonizing, rather than a trading, agency. The Hudson's Bay company (*q.v.*) was an exception. A joint-stock company founded for trade with Canada in 1670, it still exists as a commercial company and was launched as a result of attempts to discover a northwest passage, just as the Muscovy company arose from similar voyages of discovery to the northeast. It did not concern itself with colonization. But many of the British North American colonies were founded by chartered companies. Of the two classes of charters in force among the early American colonies, the first class was those charters granted to private individuals or to trading associations, which were often useful when the colony was first founded, but which were later withdrawn when the country had become settled and was looking forward to commercial expansion. The colonies were then brought under the direct control of the crown, and their trade subject only to regulation by the government. Thus the London company lost its charter in 1624 (*see* VIRGINIA: *History*). The substitution of royal and, later, of parliamentary control for that of the company was an important factor in the growth of the navigation acts. The second class of charters was those granted to the settlers themselves as a guarantee of their system of government. This, for example, was the effect of the charter granted to the Massachusetts Bay company (*see* MASSACHUSETTS: *History*). In the later 17th century, however, the cancellation or amendment of the charters and the growth of legislative assemblies tended to produce a uniformity of colonial practice, irrespective of the original character of the colony.

Chartered companies continued to be formed for the development of new trade, for instance the Royal African company in 1672, the short-lived Canary company in 1665 and the South Sea company in 1711. There was frantic speculation in the shares of the South Sea company, which resulted in a severe setback to joint-stock enterprise. The Bubble act of 1720 was designed to make it much more difficult to obtain a charter.

European Companies.—In France and the Netherlands, chartered companies had also been used for similar purposes by the governments. In France from 1599 to 1789 more than 70 such companies came into existence. Under J. B. Colbert the French East India company was founded (1664), and the colonial and Indian trade was placed in the hands of chartered companies in which the king himself had large financial interests. The French companies, however, were largely destroyed by the "Mississippi scheme" of John Law (*q.v.*), in which trading companies like the Senegal and French East India companies were incorporated in a plan to take over the public debt. The financial crash in 1720 destroyed public confidence, and although the French East India company continued to trade until 1770, the chartered company was virtually dead before the Revolution finally destroyed all such privileges. In the Netherlands the Dutch East India and West India companies (*qq.v.*) were the basis of the commercial and maritime supremacy of the Dutch in the 17th century. The success of the East India companies caused the foundation of the Ostend company (*q.v.*), whereby the emperor Charles VI sought to acquire the trade of England and the Netherlands. In 1723 participation by British subjects in the company was made a criminal offense.

Later History.—The monopolistic character and privileges of the exclusive corporations created by charter, while in tune with the philosophy of the age of mercantilism and doctrines of economic nationalism, were repugnant to the individualistic outlook of the 19th century. In each country there had been criticism of the chartered companies from their beginnings, on the grounds that they prevented competition. The French companies were more exclusive than the English and Dutch although more fettered than their rivals by royal power. By the 19th century the old chartered companies had declined, and their political functions had been taken over by the state. Consequently when new chartered companies were created in Great Britain at the end of the 19th century to encourage colonial development, any monopoly of trade was expressly prohibited. The charters prescribed a detailed set of regulations for the administration of the territories, the treatment of natives and relations with foreign powers. It was on this basis that the British East Africa company (*q.v.*), the British South Africa company (*q.v.*), for the development of Rhodesia, and the Royal Niger company were granted charters. And, as with the old colonial companies, the state took over the political powers of the new companies when the colonies were established.

The development of the modern limited liability company under successive companies acts has led to a decline in the importance of chartered companies. Some of the older ones still exist, however, including the Hudson's Bay company, the London Assurance corporation (inc. 1720), the Peninsular and Oriental Steam Navigation company (inc. 1840), the British North Borneo company (incorporated 1881) and the British South Africa company. Although of importance in developing domestic commerce and industry and in rewarding inventors, the chartered company has a special place in the history of the growth of foreign trade, the encouragement of exploration and the development and administration of overseas territories. By fostering the principle and practice of joint-stock enterprises, chartered companies pioneered the modern trading company. *See* COMPANY; CORPORATION.

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(F. W. Mu.)

CHARTERHOUSE, a corruption of the French *chartreuse* (Anglo-French *chartrouse*); *i.e., maison chartreuse,* "house of the Carthusians" (*q.v.*). The name is found in various places in England (*e.g.,* Charterhouse on Mendip, Hinton Charterhouse) where the Carthusians were established but is usually applied to the Charterhouse, London. Near the old city wall, west of the modern thoroughfare of Aldersgate, a Carthusian monastery was founded in 1371 by Sir Walter de Manny (*q.v.*). After its dissolution in 1535, the property was owned, among others, by Sir Edward (later Lord) North and the 4th duke of Norfolk. In 1611 the Charterhouse came into the hands of Thomas Sutton (*c.* 1532–1611), of Knaith, Lincolnshire, who later settled in London. In the year of his death, he endowed a hospital on the site of the Charterhouse, calling it the hospital of King James, and he bequeathed money to maintain a chapel, hospital (almshouse) and school. This foundation was finally constituted to afford a home for 80 male pensioners and to educate 40 boys. The school developed, and in 1872 it was removed to new buildings near Godalming in Surrey. Famous old pupils include Roger Williams, founder of Rhode Island, Richard Crashaw, Richard Lovelace, Joseph Addison, Sir Richard Steele, John Wesley, Sir William Blackstone, William Thackeray and Lord Baden-Powell (*qq.v.*).

The pensioners or "brothers," who must be bachelors or widowers and members of the Church of England, occupy the picturesque buildings in Charterhouse square, London, which include a paneled chapel, containing the founder's tomb, and the fine dining hall, which was the old library. Many of the buildings were damaged in World War II. The master's house and adjacent buildings were burned out, but the chapel was unharmed. The notable ceiling and chimneypiece of the Elizabethan great chamber were completely restored after serious damage.

CHARTER PARTY: *see* AFFREIGHTMENT.

CHARTIER, ALAIN (*c.* 1385–*c.* 1433), French poet and political writer, whose style—didactic, elegant and latinate—was regarded as a model by succeeding generations of poets and prose writers. He was born at Bayeux probably in 1385, educated at the University of Paris and entered the royal service, acting in the dual capacity of secretary and notary to both Charles VI and the dauphin, later Charles VII. He also carried out diplomatic missions to the emperor Sigismund in Germany in 1424 and to Rome and Venice in 1425. Three years later he was sent to Scotland to negotiate the marriage of Margaret of Scotland with the future Louis XI; the famous story of the kiss later bestowed on him by Margaret, who claimed that she saluted the golden words not the ugly lips from which they came, is apocryphal. Nothing is known of his career after 1428 nor is it possible to determine the date of his death, which took place between 1430 and 1440, possibly at Avignon.

His work, which was written mainly during the years 1415–30, is distinguished by its variety of subject matter and form. Chartier —poet, orator, historian, moralist and pamphleteer—wrote verse and prose, Latin and French. His earliest known poem, the *Livre des quatre dames* (1415 or 1416), takes the form of a discussion between four ladies who have lost their *amis* at Agincourt. He used the same technique in the *Quadrilogue invectif,* a prose work written in 1422, where the dialogue is between France and the three estates of the realm. This work exposed the sufferings of the peasantry and the abuses of the feudal army, but maintained that the cause of France, though to all appearances lost, could yet be saved if the contending factions in the kingdom would lay aside their differences in face of the common enemy. Other prose compositions were the *Curial,* a description of the court of Charles VII, later translated into English by William Caxton, and the *Traité de l'Espérance,* a long work concerned with moral, political and philosophical questions. His poems are mostly allegories in the courtly tradition but showing the influence of his interest in classical learning in their frequent Latinisms. They include *La Belle Dame sans merci, Le Lay de Paix* and *Brevaire des nobles,* of which the first, a tale of unrequited love, is the best known and was translated into English in the 15th century by Richard Ros. The first edition of his complete works appeared in 1489 under the title *Les Fais maistre Alain Chartier, notaire et secrétaire du roy Charles VI.* The last edition, *Les Oeuvres de maistre Alain Chartier, clerc, notaire et secrétaire des Roys Charles VI et VII,* was published in 1617.

BIBLIOGRAPHY.—There are modern editions of *Le Quadrilogue invectif,* with introduction by R. Bouvier (1944), and *La Belle Dame sans merci,* by A. Piaget, 2nd ed. (1949). *See* also E. J. Hoffman, *Alain Chartier: His Work and Reputation* (1942).

CHARTISM, the first specifically working-class national movement in Great Britain, took its name from the People's charter, a bill drafted and published in May 1838, based on six points: equal electoral areas, universal suffrage, payment of members of parliament, no property qualifications, vote by ballot and annual parliaments. These points were already familiar to radicals in 1838; what was distinctive about Chartism was its deliberate emphasis on working-class organization and objectives. Behind the six points lay not only distaste for the half-reformed political system brought into being by the Reform act of 1832: there was also hunger, despair and the dream of a new social order. Chartism, as Thomas Carlyle put it, was a "knife and fork question." It took shape against the economic depression of 1837 and 1838, and its fortunes moved with the trade cycle. Its waning coincided with the onset of the relative prosperity of mid-Victorian Britain.

The charter was drafted in London as a result of the initiative of the London Working Men's association, founded by William Lovett, among others, in 1836. Before it was published, however, there was evidence of increasingly vocal working-class discontent in other parts of the country. In Birmingham the Political union was revived in May 1837, when local unemployment reached an ominously high level. In the north of England there was a bitter protest movement, half-Tory, half-radical, against the introduction into the north of the new Poor law of 1834. The objectives of radical workingmen varied in different parts of the country as did the extent of their willingness to put their trust in middle-class leaders. The working classes in 1838 were heterogeneous in structure: there were sharp differences between the better-paid artisans and the poverty-stricken handloom weavers, between the workers in factories and those who worked at home, between the educated and the illiterate. As Chartism became a national movement, collecting varied local discontents, it inevitably reflected all these differences and in the long run suffered from them. It was the great achievement of Feargus O'Connor (*q.v.*) that he won a following in all parts of the country and made the original London sponsors of the charter seem too moderate and too weak. O'Connor addressed meetings everywhere and by the end of 1838 had taken over the leadership of a movement which he had not brought into existence. He had weaknesses as a leader, but it is difficult to see how Chartists could have been effectively led, given their social composition and aspirations.

The Chartist plan of campaign was to call a convention of delegates, which would sit as a rival to the house of commons and prepare a national petition for parliament. Elections for the convention took place at crowded meetings all over the country in the autumn of 1838. The Chartists explained that if the commons refused to accept the petition then they would fall back on "ulterior measures," including a general strike—the so-called "Sacred Month." There was little agreement between them, however, on tactics. Some leaders were more militant than others, and the militancy of the movement as a whole varied at different times. When the convention met in Feb. 1839, it was very soon torn by dissension. Some of the more moderate Chartists left its ranks, and in the course of heated debates there was little agreement about exactly what form "ulterior measures" would take.

In May the convention moved to Birmingham, where it immediately ran into difficulties. Riots led to the arrest of Lovett and J. Collins, two of the more moderate Chartist leaders. The rump of the convention returned to London, and when the petition was discussed in parliament (July 1839), only 46 members of parliament expressed any desire to discuss Chartist grievances in detail. From this point onward the position was confused. The convention was disbanded in Sept. 1839. There was talk in some Chartist circles at this time of co-ordinating the "physical force" of Chartism in various parts of the country, and in November there was a skirmish between Chartists and the military at Newport, known as the Newport rising. However, the rising was not supported by Chartists elsewhere. Its leaders, the most important of whom was John Frost, were sentenced to death, afterward mitigated to transportation. The police rounded up nearly every other Chartist leader in 1839, and many of them were sentenced to one or two years' imprisonment.

Emphasis was now placed by the more responsible Chartists on the need for improved organization—an emphasis which corresponded to the natural inclinations and traditions of the Scottish Chartist leaders, many of whom took the initiative. In Sept. 1839 the *Chartist Circular* was founded in Glasgow: its message was more restrained than that of O'Connor's *Northern Star*, which had first appeared in Leeds in Nov. 1837. In July 1840 the National Charter association was founded in Manchester in an attempt further to tighten and to centralize working-class organization. Ultimately, however, all such efforts were likely to founder because of working-class poverty and lack of political experience. Chartism could not vie with the far better-organized Anti-Corn Law league. Although the Chartists collected 3,315,752 signatures to their second national petition of 1842, parliament again refused to listen to their claims. The year 1842 was a bleak one in British social history, and in the north of England there were serious strikes and riots in the industrial areas.

With a revival of trade in the mid-1840s, largely as a result of the increase in employment generated by the construction of railways, Chartism lost some of its mass support. O'Connor, who maintained his supremacy despite fierce faction fights both locally and nationally, paid increasing attention to his land plan, a scheme for settling Chartists on the land as small holders by means of the National Land company. The scheme is explicable in terms of the social conditions of the age, yet it was a financial failure. Subscribers to the company numbered 70,000, and the opening in 1847 of the first estate—O'Connorville in Buckinghamshire—was heralded as the beginning of a new era which would eventually end female and child labour in the factories and restore the workingman to his proper importance. This conservative element in Chartism was by no means its only ideological component: some Chartists, like James Bronterre O'Brien, were genuinely radical; others, like George Julian Harney and a later convert, Ernest Charles Jones (*qq.v.*), were socialists.

The last great burst of Chartism was in 1848. In a year of bad trade at home and revolution on the continent, a third national petition was promoted and a national assembly summoned. The petition was to be presented by a procession of Chartists marching from Kennington common to the house of commons on April 10. The government took careful precautions, and the procession did not march. Thereafter, Chartism remained active in the provinces, but its appeal as a national mass movement was ended. O'Connor went insane, and Ernest Jones became the most prominent leader in the declining years of Chartism. Many of the people who had been Chartists continued to serve other working-class causes in changing economic and social circumstances, and the Chartist spirit and name lingered on long after the collapse of the organization. All but the last of the six points have since been secured: in that sense there has been a "victory of the vanquished."

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CHARTRES, a city of northwestern France, capital of the *département* of Eure-et-Loir, 86 km. (53.4 mi.) S.W. of Paris by road. Pop. (1954) 26,478. Chartres is on the left bank of the Eure, on a hill crowned by its famous cathedral, the spires of which are a landmark on the plain of Beauce, "the granary of France." The Eure, which within the city divides into three branches, is crossed by several bridges, some ancient, and is fringed by remains of fortifications; the Porte Guillaume (14th century), most notable of the remains, was largely destroyed in World War II. The steep, narrow streets of the old town contrast with the boulevards that encircle it and divide it from the suburbs.

The great cathedral of Notre Dame, one of the most magnificent examples of High Gothic architecture, was founded by Bishop Fulbert (11th century) on the site of a church that had been destroyed by fire. In 1194 another fire made new building necessary, and the present church was finished by the mid-13th century; there have been minor additions and alterations since that time. A fire in 1836 destroyed the upper woodwork. The statuary of the portals, the 13th-century stained glass and the Renaissance choir screen are all unique. The south spire, the Clocher Vieux (351 ft. high), dates from the 12th century; the Clocher Neuf (377 ft.) was not completed till the 16th century. The cathedral is about 440 ft. long, its choir measures 150 ft. across and the vaulting is 121 ft. high. (*See* also GOTHIC ARCHITECTURE; SCULPTURE: *Gothic Sculpture.*)

Chartres also has several other churches of note: the abbey church of St. Pierre, chiefly 13th century, contains fine stained glass; St. Martin-au-Val is a 12th-century church, with a crypt rebuilt about 1000 with sculptures attributed to the 6th century; the church of St. Aignan is Renaissance, with windows dating from that time; the church of St. André is Romanesque. The museum, housed in the former episcopal palace (17th and 18th century) near the cathedral, contains 12 representations of the apostles in enamel (1547) by Léonard Limosin, among a large number of valuable exhibits.

Chartres is on the main line from Paris to Le Mans and Nantes. It is a market town for the region of Beauce. Industries include flour milling, timber sawing, brewing, distilling, iron and bronze founding, leather manufacture, dyeing and the manufacture of stained glass and glass for ships' portholes, billiard requisites, hosiery, agricultural machinery, cranes, electronic equipment, car accessories and plastic work.

Chartres was one of the principal towns of the Carnutes and by the Romans was called Autricum, from the river Autura (Eure). It was burned by the Normans in 858 and unsuccessfully besieged by them in 911. It was occupied by the English during 1417–32. Attacked unsuccessfully by the Protestants in 1568, it was taken in 1591 by Henry IV, who was crowned there three years afterward. During the middle ages Chartres gave its name to a countship held by the counts of Blois and Champagne and afterward by the house of Châtillon, a member of which in 1286 sold it to the crown. It was raised to the rank of a duchy in 1528 by Francis I. The Germans seized the town on Oct. 21, 1870, and used it as a centre of operations. In World War II it was again occupied by the Germans, from June 1940 until Aug. 1944.

See also references under "Chartres" in the Index.

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CHARTREUSE, a liqueur made by the monks of La Grande Chartreuse, the motherhouse of the Carthusian order, near Grenoble, France. It is said that over 130 different herbs are used in its production, while the flavour of angelica root is apparent. Some believe it to be the finest liqueur obtainable. The finer green chartreuse contains 55% alcohol and the yellow kind 43% (by volume).

In 1605 Maréchal d'Estrées gave the Carthusians of Paris the recipe for the elixir, and in 1735 the Parisian fathers passed the recipe to the monastery of La Grande Chartreuse, where Brother Gérôme Maubec, "a very clever apothecary," perfected it in 1757. The secret of the formula has remained with the monks ever since and has never been discovered by analysis. In 1792 the Carthusians were expelled by the Revolution but returned in 1816, when they began to commercialize their secret; by 1860 the sales of their liqueur were so large that they built a big distillery at Fourvoirie, five miles from the monastery. In 1903 they were again expelled from France and eventually found asylum at Tarragona in Spain, where they were able to buy a distillery. In the meantime the distillery at Fourvoirie had been sold by the French government together with the original trade-mark, under which an imitation liqueur soon appeared. The monks therefore adopted a fresh trade-mark. However, in 1929 the firm making chartreuse in France ceased operations, the field being left to the genuine chartreuse made at Tarragona, and in 1940 the monks were allowed to return to La Grande Chartreuse, after which they resumed manufacture there. Their original trade-mark was readopted at Tarragona in 1929 and is still in use. (C. C. H. F.)

CHARTREUSE, LA GRANDE, one of the world's most famous monasteries, the motherhouse of the order of Carthusian monks (*see* CARTHUSIANS) and model for all the other charterhouses of the Carthusians. It is situated in a solitary valley of the French Alps, about 15 mi. from Grenoble.

Founded in 1084 by St. Bruno (*q.v.*), the original settlement took its name from the surrounding mountains of Chartreuse (Lat., Cartusia; English, Carthusian; anglicized, charterhouse). The first monastery was completely destroyed by an avalanche in 1132, and the monks rebuilt about one mile south in a more suitable location, where La Grande Chartreuse now stands. Apart from a few transepts of the ancient church, very little remains of the 12th-century monastery, which was ravaged several times by fire. A considerable part of the present monastery dates from the 14th century: to this Dom Le Masson made major additions after a fire in 1676.

Entirely surrounded by a high enclosure wall, the monastery buildings comprise three functional groups: service facilities, conventual buildings and eremitical dwellings. Thirty-five monks' cells, each consisting of ambulatory, living-bedroom, oratory, workshop and private garden, open on the main cloister. The main cloister, longer than St. Peter's at Rome, measures 705 ft., and one section, the handsome Gothic north cloister, dates from the 14th century. The main cloister connects the monks' cells with the church. The principal conventual buildings, church, chapter and refectory, all of the 14th century, are grouped according to the traditional monastic plan around a small cloister. In the vicinity of the church, about 25 chapels serve for the celebration of private masses. Contiguous to the conventual buildings are vast pavilions for the reception of the priors who gather there annually for the general chapter.

In the workshops, utilities and barns, modern machinery and equipment fit more or less comfortably into the 17th-century architecture.

Characteristic of the Carthusian order's spirit, the buildings give the impression of exceptional solidity and stability. The massive stone construction, high slate roofs, cross-surmounted turrets and stately clock tower seem as eternal as the sheer limestone palisade of the Grand Som, which rises majestically to 6,000 ft., directly behind the monastery.

The monks, expelled in 1792 by the Revolutionary government, returned to La Grande Chartreuse in 1816. Again expelled in 1903, the community remained in exile until 1940, when political conditions once more permitted its return. Before the French Revolution the library contained a fine collection of books and manuscripts, most of which are now at the public library of Grenoble. Classed as a historical monument by the government, La Grande Chartreuse is one of the most visited places in France, both because of the scenic beauty of the area and the spiritual and historic interest of the monastery. Visitors are not permitted to enter the monastery, but a Carthusian museum presents a comprehensive view of the monks' life and history. *See* also MONASTERY. (S. M. B.)

CHASE, PHILANDER (1775–1852), U.S. Protestant Episcopal bishop and founder of Kenyon college, Gambier, O., was born in Cornish, N.H., on Dec. 14, 1775, the 15th child of Dudley and Allace Chase. He entered Dartmouth college, Hanover, N.H., in 1791, graduating four years later. Brought up a Congregationalist, he became converted to the Protestant Episcopal Church during his sophomore year at college as the result of studying the Book of Common Prayer. After graduation, he went to Albany, N.Y., to study for the ministry under the Rev. Thomas Ellison, rector of St. Peter's church. He married Mary Fay in 1796 and, after her death, took a second wife, Sophia May Ingraham, in 1819. After being ordained deacon on May 10, 1798, he served for a time as itinerant minister in western New York state, then in the stage of early settlement. He became rector of Christ church, Poughkeepsie, N.Y., in 1799. In 1805 he was called to Christ church, New Orleans, La., where he was the first regularly settled Protestant minister. He served there until 1811, when he became rector of Christ church, Hartford, Conn. In 1817, feeling that the new settlements in the west offered the greatest missionary challenge, Chase went to Ohio, though he had no regular appointment and no assured means of support. In 1818 the few

Episcopal clergy in the state organized a diocese and elected him bishop. He was consecrated on Feb. 11, 1819. Believing that the needs of the west could best be served by western-trained clergy, he founded Kenyon college and its affiliated theological seminary, Bexley hall, in 1824, with the aid of funds raised in England. He resigned his jurisdiction in 1831 in consequence of a dispute over the control of the college. After residing a few years in Michigan, he was elected first bishop of Illinois in 1835. He served in that position and as president of Jubilee college, which he founded in 1838, until his death on Sept. 20, 1852. He was presiding bishop of the Protestant Episcopal Church from 1843 to 1852. His *Reminiscences* were published in 1848.

See L. C. Smith, *The Life of Philander Chase* (1903).

(W. W. Ms.)

CHASE, SALMON PORTLAND (1808–1873), U.S. senator, governor, secretary of the treasury and chief justice of the United States, was born in Cornish, N.H., on Jan. 13, 1808. He graduated from Dartmouth college in 1826, and after conducting a school for boys in Washington, D.C., and studying law under Attorney General William Wirt, was admitted to the bar in 1829. Chase settled in Cincinnati, O., in 1830 and edited the *Statutes of Ohio* (3 vol., 1833–35).

In the late 1830s Chase, influenced probably by James G. Birney (*q.v.*), associated himself with the politically active wing of the antislavery movement. His services as legal counsel for fugitive slaves, particularly in the famous case of John Vanzandt, one of the "conductors" of the Underground Railroad (*q.v.*), led him to become known as the "attorney general for runaway Negroes." Slavery was the central issue in Chase's political life. In 1841 he abandoned the Whig party and for seven years was the outstanding leader of the Liberty party in Ohio. His skill in drafting platforms and addresses is exemplified by the Liberty platform of 1843 and the Liberty address of 1845. Realizing that a third-party movement confined to a single issue could not succeed, he sought to capture the Democratic party for the antislavery cause. He took the lead during the campaign of 1848 in combining the Liberty party with the "Barnburner" faction of the Democratic party to form the Free Soil party (*q.v.*), and was influential in obtaining the nomination in that year of former Pres. Martin Van Buren as the Free Soil candidate for the presidency. In 1849 a coalition between the Democrats and a small group of Free Soilers in the Ohio legislature led to his election to the United States senate. In the senate (1849–55) Chase was a pre-eminent spokesman against the extension of slavery in the territories. He opposed the Compromise of 1850 (*see* COMPROMISE OF 1850), and in 1854 denounced Sen. Stephen A. Douglas' Kansas-Nebraska bill in the "Appeal of the Independent Democrats." His policy throughout was to restrict the expansion of slavery and to free the Democratic party from proslavery control. The passage of the Kansas-Nebraska bill and the subsequent troubles in Kansas ultimately convinced him of the futility of trying to influence the Democrats, and the dissolution of the Whig party opened the way for a new party organization. Chase was active in the formation of the Republican party to oppose the extension of slavery. He was the first Republican governor of Ohio (1855–59).

Chase was an active candidate for the Republican presidential nomination in both 1856 and 1860. Although, with the exception of William Seward, he was the most widely known Republican in the country, he failed to secure the nomination in either year, partly because the old-line Whig element could not forgive his long flirtation with the Democrats and partly because his uncompromising views on slavery were too well known. However, as secretary of the treasury during the first three years of the Civil War (1861–64), he rendered services of the greatest value. That period of crisis witnessed two great changes in U.S. financial policy: the establishment of a national banking system and the issue of inconvertible U.S. treasury notes (greenbacks) as legal tender. The former, Chase's own particular measure, was a most important contribution to U.S. economic development; to the latter he reluctantly acceded as a necessary measure of war finance.

Chase's chief defect as a statesman was an insatiable desire to become president. His willingness in 1864 to head an anti-Lincoln movement, while retaining his place in Pres. Abraham Lincoln's cabinet, verged on disloyalty and led to such "mutual embarrassment" that Lincoln accepted his resignation in June 1864. Nevertheless, several months later (Dec. 6, 1864) Lincoln, despite misgivings created by Chase's presidential ambitions, appointed him to the supreme court as chief justice, a position which Chase held until his death in New York city on May 7, 1873.

Chase assumed the chief justiceship at a time when the prestige of the court was at its lowest ebb. Although he was not a distinguished legal scholar and cannot be ranked among the foremost U.S. jurists, his political wisdom in handling the constitutional problems created by civil war and reconstruction preserved the court and did much to restore its prestige. In *Mississippi* v. *Johnson* (4 Wallace 475) (1867), and *Georgia* v. *Stanton* (6 Wallace 50) (1867), Chase led the court in refusing to enjoin the president or a member of his cabinet from enforcing the Reconstruction acts. In the important case of *Texas* v. *White* (7 Wallace 700) (1869), Chase declared secession a nullity and the federal union indissoluble. Courageous stands against the military trial of civilians (*Ex parte Milligan*, [4 Wallace 2] [1866]) and against test oaths designed to penalize former Confederates (*Cummings* v. *Missouri*, [4 Wallace 277] [1867]; *Ex parte Garland*, [4 Wallace 333] [1867]) indicated that the Chase court would uphold traditional freedoms. Chase's best-known judicial opinions are those dealing with the constitutionality of the legal tender legislation enacted when he was secretary of the treasury. In *Hepburn* v. *Griswold* (8 Wallace 603) (1870), he wrote the opinion of the court declaring these acts unconstitutional, and in the *Legal Tender Cases* (12 Wallace 457) (1871), he vigorously dissented when a differently constituted court overruled its prior decision and upheld the legislation. The dignity and fairness with which Chase presided over the U.S. senate during the impeachment trial of Pres. Andrew Johnson, in spite of popular attack, redound to his credit, just as his continued attempts in 1868 and 1872 to attain the presidency reduced his influence.

A serious, dignified man of strong religious principles, Chase was respected for his ability and determination. He lacked magnetism, warmth and humour and often appeared self-righteous and opinionated. Nevertheless, he was one of the ablest leaders of the American Civil War period and deserves to be placed in the front rank of U.S. statesmen.

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CHASE, SAMUEL (1741–1811), U.S. legislator and U.S. supreme court justice, was a signer of the Declaration of Independence, and while serving on the United States supreme court was the object of an unsuccessful impeachment trial inspired by Pres. Thomas Jefferson.

Born in Somerset county, Md., on April 17, 1741, Chase was admitted to the bar at Annapolis in 1761, and for more than 20 years was a member of the Maryland legislature. He took an active part in the resistance to the Stamp act, and from 1774 to 1778 and 1784 to 1785 was a member of the continental congress. He did much to persuade Maryland to advocate a formal separation of the 13 colonies from Great Britain, and signed the Declaration of Independence on Aug. 2, 1776. In 1791 he became chief judge of the Maryland general court.

Pres. George Washington, in Jan. 1796, appointed Chase an associate justice on the federal supreme court where he was soon speaking his mind in a series of important opinions. Thus, in *Calder* v. *Bull* (3 Dallas 386) (1798), he contributed to later interpretations of the due process clauses by asserting that legislative powers over liberty and property were limited by "certain vital principles in our free Republican governments." When John Marshall became chief justice in 1801, Chase's influence declined sharply.

At the height of the struggle between the Federalist and Jeffersonian-Republican parties, Justice Chase, a Federalist sympathizer, conducted his circuit court in so partisan a fashion as to cause his impeachment. With President Jefferson's blessing, the house of representatives in 1804 voted to press charges. Six of the eight articles on which Chase was tried before the senate in Feb. 1805 charged him with improper and arbitrary actions at the treason and sedition trials of John Fries and James G. Callender in 1800, and two, with intemperate or political addresses to grand juries. The senate, on March 1, gave a verdict of not guilty on all counts. Chase remained in office until his death, June 19, 1811.

Many writers have conjectured that if Chase had been convicted, the Jefferson administration would have proceeded next against Marshall and other Federalist judges. Whatever may have been his initial plan, Jefferson later concluded that as a means of holding judges accountable, impeachment had proved a "bugbear" and a "mere scare-crow." Clearly, the acquittal, by creating the impression that justices were removable only for criminal conduct, reinforced the independence of the judiciary.

Bibliography.—For a more detailed account and bibliography, *see* article by Edward S. Corwin, in *Dictionary of American Biography*, vol. iv, pp. 34–37. On the Calder decision, *see* Corwin, *Liberty Against Government*, pp. 60 ff. (1948). For accounts of the impeachment trial, *see* Charles Warren, *Supreme Court in United States History*, rev. ed., vol. 1, pp. 271–297 (1926), and Albert J. Beveridge, *Life of John Marshall*, vol. iii, pp. 169–222 (1919). (D. G. Mn.)

CHASE, WILLIAM MERRITT (1849–1916), U.S. painter, perhaps the most important influence in establishing the fresh, spontaneous colour and technique that characterized much of American painting in the early 20th century. He was born at Franklin, Ind., on Nov. 1, 1849, and studied under B. F. Hayes in Indianapolis and J. O. Eaton in New York city. In 1872 he went to Munich, where he studied with Karl von Piloty and met Frank Duveneck and J. H. Twachtman. He abandoned the dark palette of the Munich school in the 1880s.

From his return to the U.S. in 1878 until his death on Oct. 25, 1916, he taught continually. In New York city he established a school of his own, after having taught for several years at the Art Students' league. A worker in all mediums—oils, water colour, pastel and etching—he painted with distinction the figure, landscape and still life. He is probably best known by his portraits and his studies of studio subjects and dead fish.

Chase won many honours at home and abroad, became a member of the National Academy of Design, New York, and for ten years was president of the Society of American Artists. In 1912 he was awarded the Proctor prize by the National Academy of Design for his "Portrait of Mrs. H." At the Panama Pacific exposition (1915) a special room was assigned to his works. Among his most important canvases are "Ready for the Ride," "The Apprentice," "Court Jester," and portraits of his friends, the painters Whistler and Duveneck.

See W. D. Peat, *Chase Centennial Exhibition* (1949).

CHASING: *see* Metalwork, Decorative: *Techniques of Metalworking.*

CHASLES, MICHEL (1793–1880), French mathematician, who specialized in geometry, was born on Nov. 15, 1793, at Épernon. He was educated at Paris, and engaged in business, which he later gave up for the study of mathematics. Chasles was made professor of geodesy and mechanics at the Polytechnic school and later professor of higher geometry at the Sorbonne. He and Jakob Steiner independently elaborated modern projective geometry. Chasles used his "method of characteristics" and his "principle of correspondence" to solve many problems; the solutions were published in a series of papers in *Comptes Rendus*. The problem of the attraction of an ellipsoid on an external point was solved by him in 1846. Many of his original memoirs were later published in the *Journal de l'École Polytechnique*. Chasles wrote two textbooks, *Higher Geometry* (1852) and *Conic Sections* (1865). His *Aperçu historique sur l'origine et la développement des méthodes en géometrie* (1837) is a standard work, the subject being continued in *Rapport sur le progrès de la géometrie* (1870). Chasles was the victim of a celebrated fraud; an impostor, Vain-Lucas, induced him to purchase various collections of faked letters from famous men of science, for a total of nearly 200,000 fr. He died in Paris on Dec. 18, 1880. (O. Oe.)

CHASLES, (VICTOR) PHILARÈTE (EUPHÉMON) (1798–1873), French scholar and writer who was a pioneer in comparative European literary history and criticism. Born at Mainvilliers (Eure-et-Loir) on Oct. 8, 1798, he was brought up in Paris, where his father became a member of the Convention. Apprenticed at the age of 15 to a printer, Philarète was imprisoned under the restored Bourbons for his Jacobin opinions, after which he went to England for five years. Returning to France in 1823, he soon afterward began writing for various periodicals, including the *Journal des débats* and the *Revue des deux mondes*. His connection with the latter came to a stormy end, resulting in a lawsuit in 1854. In 1837 he became curator of the Bibliothèque Mazarine and in 1841 he was elected to the chair of comparative literature at the Collège de France. He died at Venice on July 18, 1873.

Chasles is best known for his essays collected under the title *Études de la littérature comparée* (1846–75), of which *Études sur le XVIII^e^ siècle en Angleterre* (1846) is the most famous.

See E. M. Phillips, *Philarète Chasles, critique et historien de la littérature anglaise* (1933).

CHASSÉRIAU, THÉODORE (1819–1856), French painter, who sought to combine the classicism of Ingres with the romanticism of Delacroix, was born on Sept. 20, 1819, at Samana in the Dominican Republic, where his father was French consul. As a boy of 11, Chassériau entered the studio of J. A. D. Ingres where he remained until Ingres left Paris for Rome in 1834. His first pictures shown at the Paris salon in 1836 won immediate success, confirmed three years later by the "Vénus Marine" and the "Suzanne" (both now in the Louvre, Paris). Late in 1840 Chassériau visited Rome to see Ingres but began to feel dissatisfied with the work of his former master. His portraits of this period, "Lacordaire" (Salon, 1841) and "Les Deux Soeurs" (Salon, 1843), both in the Louvre, were, however, still in the Ingres tradition. After about 1843 the influence of Ingres's rival, Eugène Delacroix, made itself felt, both in style and in choice of subject matter. Chassériau was deliberately attempting to combine the rhythmical linear qualities of Ingres with the colouristic methods of Delacroix. The 15 Othello etchings (published 1844) and the paintings of Moorish and Jewish life that followed Chassériau's visit to north Africa in 1846 were reminiscent of Delacroix, though Chassériau was able to add an exotic quality of his own.

Chassériau was an important figure in the revival of monumental painting in France. He decorated (1841–43) the chapel of St. Mary of Egypt in the Church of St. Merri, Paris, and the main staircase of the Cour des Comptes in the Palais d'Orsay with allegorical scenes of war and peace, etc. (1844–48). This was followed by commissions for two frescoes at St. Roch, Paris (1853–54), and for the choir vault of St. Philippe-du-Roule (a "Descent From the Cross," 1854–56). Apart from the last-named, none of these paintings has survived intact, though fragments of the Palais d'Orsay decorations are preserved in the Louvre. Chassériau died in Paris on Oct. 8, 1856. He was a prolific draftsman, and most of his sketchbooks are now in the Louvre. After his early death his influence continued in the work of his friends and pupils, Gustave Moreau and Puvis de Chavannes.

See monographs by V. Chevillard (1893), H. Marcel (1911) and L. Bénédite (1932). (A. Bs.)

CHASSEURS, originally a term used in the French army to designate light-infantry or cavalry regiments. After World War I the term also was applied to armoured units.

Light-infantry units known as *chasseurs à pied* have been in continual existence since 1743, except for the period 1840–70. By the outbreak of World War I there were 30 battalions of *chasseurs*, of which 12 were known as *chasseurs alpins*. These latter were specially trained and equipped for mountain warfare. After World War II *chasseurs* were formed as independent battalions for administrative purposes, but were grouped into demibrigades of three battalions for war. They were distinguished from line infantry by their dark blue uniforms. Just prior to World War II a few battalions were integrated into armoured divisions as motorized infantry and called *chasseurs porté*.

The light cavalry (*chasseurs à cheval*) regiments were first instituted in 1779. They performed notable service in the European campaigns of the second empire. At the close of World War I they were represented by five regiments of *chasseurs d'Afrique*, originally recruited in 1831 for service in Algeria.

The number of such cavalry units was increased following World War I, and they were progressively reorganized into light armoured battalions. In the process, the term *chasseurs de chars* was added to distinguish units specifically designed as tank-destroyer units. The original connotation of *chasseurs* to designate lightly equipped units has been lost in the armoured branch of the French army. After the early 1950s this traditional term was used to designate light-, medium- and heavy-tank as well as armoured reconnaissance units. (B. H. T.)

CHASTELARD, PIERRE DE BOSCOSEL DE (1540–1563), French courtier whose name is inseparably connected with Mary Stuart. Born in Dauphiné in 1540, he first met her at the court of Francis II and was later a member of the retinue which accompanied her to Scotland in 1561. He revisited Edinburgh the next year, spent the winter at court and fell in love with Mary, who is said to have encouraged his passion. The young man hid himself under her bed, where he was discovered by her maids of honour. Mary pardoned the offense, but Chastelard was so rash as again to violate her privacy. He was discovered a second time, seized, sentenced and hanged the next morning. His story is the subject of Algernon Charles Swinburne's verse drama *Chastelard* (1865).

CHASTELLAIN, GEORGES (1415?–1475), Burgundian chronicler and one of the leading court poets, had many literary admirers and followers, among them Jean Molinet, Pierre Michault, Jean Meschinot and Guillaume Flameng. Born in Alost, Flanders, he served Philip the Good, duke of Burgundy, until in 1435, after the peace of Arras, he abandoned soldiering. He spent the next years in France, mainly as secretary to Pierre de Brézé, seneschal of Poitou. During this period his services were used to try to improve relations between Philip the Good and Charles VII of France. His affection for France remained even when, in 1446, he entered Philip's household. There too he was used on secret and diplomatic missions, and in 1455 he was also appointed Burgundian historiographer. About 1463 his disciple and successor, Jean Molinet, became his secretary. Chastellain died at Valenciennes in 1475, on March 20 according to his epitaph, on Feb. 13 according to the treasury accounts of the town. Only about one-third of his *Chronique des Ducs de Bourgogne* has survived: a complete copy, presented to the queen of Hungary in 1524 by his natural son, Gautier, has never been traced. The most complete (though faulty) edition of his extant works is that of Kervyn de Lettenhove (*Oeuvres de Georges Chastellain*, 1863–66), consisting of five volumes of the chronicle and three of other works.

The chronicle extends, with lacunae, from 1419 to 1474. Its interest lies in the descriptive and factual information it contains and in its shrewd assessment of contemporary figures and motives. Though paid by Burgundy, and not impartial, Chastellain does not hesitate at times to lay blame upon his patrons. The growth of middle-class political self-consciousness, however, meets with scant sympathy in his chronicle.

Chastellain's other work consists of formal poems of little interest; works addressed to fellow writers, *e.g.*, *L'Epistre à Jean Castel* and *Les Douze Dames de Rhétorique;* political pieces, *e.g.*, *Le Thrône Azuré*, addressed to Charles VII after the defeat of the English in Normandy; *Les Paroles de trois puissants princes* on the political motives of Philip the Good, Charles VII of France and Henry VI of England; *Le Dit de Vérité* on the discord between France and Burgundy; *Le Lyon Rampant* on the struggle between Louis XI of France and the duchy of Burgundy; *Le Temple de Boccace*, dedicated to Margaret of Anjou; and the *Déprécation* for Pierre de Brézé imprisoned by Louis XI; and didactic works and plays, often allegorical in form, and, like all Chastellain's writing, somewhat Latinized in style.

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(K. U.)

CHASUBLE, a liturgical vestment, the outermost garment worn by bishops and priests when celebrating the Eucharist. *See* VESTMENTS, ECCLESIASTICAL.

CHÂTEAU, the French word for "castle" (*q.v.*). The development of the castle in the 15th and 16th centuries into houses arranged rather for residence than defenses led to a corresponding widening of the meaning of the term château, which came to be applied to any seigniorial residence and so generally to all country houses of any pretensions (*cf.* the Ger. *Schloss*).

The French distinguish the fortified from the residential type by describing the former as the *château fort*, the latter as the *château de plaisance*. The development of the one into the other is admirably illustrated by the châteaux scattered along the Loire. Of these, Langeais, still in perfect preservation, is a fine type of the *château fort*, with its 10th-century keep and 13th-century walls. Amboise (1490), Blois (1500–40), Chambord (begun 1526), Chenonceaux (1515–60) and Azay-le-Rideau (1521) (*qq.v.*) may be taken as typical examples of the *château de plaisance* of the transition period, all retaining some of the architectural characteristics of the medieval castle. *See* also RENAISSANCE ARCHITECTURE: *France*. (T. F. H.)

CHATEAUBRIAND, FRANÇOIS RENÉ DE CHATEAUBRIAND, VICOMTE DE (1768–1848), French author and politician, was one of the first romantic writers in France, a distinguished if rather erratic politician and an outstanding figure in the early part of the 19th century. He was born at St. Malo, Brittany, on Sept. 4, 1768. His father was an eccentric and impecunious Breton noble, who, to maintain his just claim to noble birth, invested the family fortune in the estate of Combourg, near Dol, which carried with it the title of count. When Chateaubriand was nine, the whole family moved there, and the half-derelict medieval castle, with the ancient oak woods and wild heaths that surrounded it, became the familiar background of his youth. He was the youngest of the family; the elder brother and the three elder sisters soon made their way out into the world, but he shared a remote life with his youngest sister, Lucile, a plain and delicate girl of a strange intensity of feeling. Chateaubriand went away to school, first at Dol and then at Rennes and Dinan, but the holidays were long, and the romantic solitudes of Combourg were more congenial than the dusty classrooms of clerical schools. By the time he was 17, he succeeded in escaping from their walls and settling at Combourg.

He had no purpose in life but an idle melancholy, in which Lucile shared. Her natural piety had become obsessive; her father turned it into a useful channel by getting her accepted as an associate of the noble canonesses of Argentière, where in time, when she was a full canoness, she might hope for a little house and a modest income of her own. Meanwhile, the brother and sister spent their days wandering round the Breton countryside, in an atmosphere compounded of boredom and sensitivity that fostered little but imaginative dreams. Very gradually these began to find expression in verse. (Lucile's *Oeuvres* were edited, with a memoir, by Anatole France in 1879). After Chateaubriand had been at home nearly three years, it was suddenly decided by his father that Chateaubriand must take the commission his brother offered him in the regiment of Navarre.

His sojourn with his regiment did little but mend his manners; his father's death did nothing to mend his fortunes. He led a much more normal life, however, in the homes and among the friends of his married sisters, in Brittany and Paris; a life that was suddenly ended by the French Revolution. By the autumn of 1790 his regiment was in insurrection. He refused to join the royalists at Coblenz but sailed in April 1791 from St. Malo for Baltimore, Md., to discover the United States.

He did not get very far: Baltimore, Philadelphia, New York, Albany and Niagara falls. He found the towns provincial and ordinary enough and much of the country flat and uninteresting; but he rode to Niagara falls with a party of fur traders, through virgin forest; he met Cayuga Indians (they were taking dancing lessons from a wandering Frenchman) and spent some days in their company, went on to visit the Onondagas and met other less sophisticated redskins in the romantically unspoilt country near Niagara. Finally, he visited the falls. It is not surprising that Chateaubriand began to write a prose poem that was to be an epic of the savages.

He reached the shores of Lake Erie and there learned of the flight of Louis XVI to Varennes. For the first time he was conscious that he owed obligations to the monarchy, as well as to the "ideas of 1781"; he decided to return to France.

He found western France ravaged by the revolutionaries and his family sheltering in St. Malo. He was penniless; they solved the problem by marrying him to an heiress of 17, Céleste Buisson de la Vigne. She was pretty in a pink and white way, but had neither features, grace nor flexibility of mind. They went to Paris but soon realized that the Paris of the Revolution was too unsettled and, above all, too expensive for them. In June 1792 Chateaubriand and his elder brother left Paris under false passports and succeeded in joining the royalist armies at Coblenz. He took part in the siege of Thionville, where he was wounded. Discharged from the army and growing more and more ill from his infected wound, he made his way slowly and with infinite hardship to Brussels. There he fell ill with smallpox, but his brother found him and got him to Jersey. There, in the charge of some of his Breton kin, he recovered a measure of health; and thence he sailed in May 1793 for England.

London was full of French refugees trying to keep alive on the shilling a day that the government allowed the *émigrés*. Chateaubriand was too proud to take it and paid for his half share in a cousin's garret in Holborn by translations. At the same time he began to write an essay on revolutions, which his Breton friends assured him might well find a publisher. Holborn proved too expensive, and he moved to Marylebone; finally another Breton found him a small teaching post at Bungay, Suffolk, which he took up in the autumn of 1793.

Suffolk gave him back a measure of health and just enough to live on but bored him profoundly. He polished the essay on revolutions; he translated some Ossianic imitations and even had them published; and he had flirtations first with the wife of a neighbouring parson and then with the daughter. It all ended dramatically when he had to admit he was already married; he wisely decided to return to London.

The news from France was tragic. His brother and his sister-in-law had died on the scaffold with her grandfather Chrétien de Malesherbes, who had dared to defend Louis XVI; his own wife and his sisters were imprisoned at Rennes, his mother in Paris.

Back in London Chateaubriand worked steadily at the Indian epic he had first envisaged in America. *Les Natchez* (of which no more than half was ever written) is a hotchpotch of a book, sometimes tiresome, sometimes silly and often beautiful, alike in its descriptions of scenery and in its depiction of human passion. Chateaubriand was a natural colourist and had learned from English poetry that colour could be admitted even to *le style noble;* and though he had seen very little of America he had ridden through virgin forest and had slept in the tents of the Indians, at a time when he saw and felt everything with the acute sensibility of youth.

By the end of 1796 he learned that his mother and sisters had been released and that Lucile had married a man much older than herself. Early the next year the first volume of his "Essay on Revolutions" was published in London, to shock his *émigré* friends by its rejection of Christianity. It brought him, however, into a more intellectual and more fashionable circle of London French, and there he made one true and real friend in the journalist Louis Fontanes (*q.v.;* later marquis de Fontanes).

Fontanes returned to France in July 1798, and Chateaubriand began to write a romantic account of Christianity—ultimately famous as the *Génie du christianisme* (1802)—which gave him the entrée to the pious royalist circles of London. Fontanes, meanwhile, was making himself acceptable to Napoleonic society in Paris and was soon in a position to invite Chateaubriand to join him. They met in Paris in May 1800 and were soon joined by Céleste, who had earlier been released from prison.

Chateaubriand found that his London reputation had not preceded him and that his writings were unknown in his own country. He set to work on free-lance journalism, on the *Génie* and on the revision of his Indian epic. A fragment of it appeared as *Atala* in April 1801 and had an instantaneous success. It combined the apparent simplicity of a classical idyll with the more troubled beauties of romanticism. He was able to live under his own name, with his own passport, and to move among the noble and impoverished society that maintained pre-Revolutionary standards of taste, even in Napoleonic Paris. In the *salon* of Pauline de Beaumont he found not only society but a woman to love and to cherish him. With her encouragement he finished the *Génie,* of which the most finished and most admired section was the episode called *René,* which told the story of a sister's passion for her brother, set in an ancient castle in the depths of the woods—a clear reminiscence of his youth at Combourg. The whole book was finally published a week after Napoleon had signed a concordat with the pope; it has remained the symbol of an epoch.

The book secured a measure of recognition even from Napoleon, though he and Chateaubriand had a natural antipathy for each other. In 1803 Chateaubriand was appointed first secretary to the embassy at Rome, under Napoleon's uncle, Joseph Fesch. He loved Rome and hated the ambassador; and when Pauline de Beaumont joined him, it was only to die. Finally at the end of 1803 he was made chargé d'affaires in the tiny republic of the Valais; but when he reached Paris, it was in time for the execution of the duc d'Enghien, and he at once resigned from the service of the emperor.

Chateaubriand spent the next years in domestic life and literary work, consoling himself with many love affairs. He and his wife lived economically in and near Paris, until in July 1806 he decided to make a journey to Jerusalem in search of literary material. He succeeded in leaving his wife at Venice and went on through many adventures to Corfu, the Peloponnese, Athens, Smyrna, Constantinople, Jerusalem, Alexandria, Carthage and Spain. The *Itinéraire de Paris à Jérusalem,* three volumes (1811), which was the literary fruit of the tour, was unduly stuffed with secondhand scholarship; but the firsthand part of it is fresh and delightful. Secondary books were *Les Martyrs* (1809)—which even contemporaries found dull—and the more acceptable *Aventures du dernier Abencérage.* On the strength of the three books Chateaubriand stood for the French Academy and was elected.

The return of Louis XVIII in 1814 revived Chateaubriand's hopes of a political career. In 1815 he was created a viscount and a member of the house of peers, but he had none of the antennae of a politician and remained primarily a writer, and a writer more interested in his own view of history than in political fact. It was a time of financial difficulties. The only sunshine came from the beginning of a liaison with Madame Récamier, which was to illumine the rest of his life, and the chief occupation in starting the *Mémoires d'outre-tombe,* which are, perhaps, his most lasting monument. He and his wife settled, too, in a house in the rue du Bac that was to be his home until his death.

In 1820 he was nominated ambassador to Berlin. He did not take up the post until Jan. 1821 and hated it. By July political changes imposed his resignation; by Jan. 1822 a further change made him ambassador to London. It was for him the crown of his political career; that he, who had almost starved in London as a refugee, should now represent his country there could not but be the sweetest of time's revenges. From 49 Portland place he did his work well, at least from the point of view of prestige; but the drearier and more political side of diplomacy he despised. His *Mémoires,* however, progressed apace.

He was appointed as a French representative to the congress of Verona (1822); and at the end of its unfruitful negotiations found himself offered the ministry of foreign affairs under the comte de Villèle. It was delightful to return to Paris, and to Mme Récamier, with a position and an income, and 1823 brought the final satisfaction of a successful war against Spain. The bill for it brought him political disgrace.

The rest of his life was passed as a private individual and a spectator, but for a year in Rome as ambassador under Charles X in 1828–29. He remained loyal to his king at the revolution of 1830. He lived mainly in France, with occasional sojourns in Switzerland and a visit to London, where he was very kindly received by the comte de Chambord. He died on July 4, 1848, as the revolution was imminent, and was buried on the island of Grand Bé, near St. Malo.

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CHÂTEAU-GAILLARD, on the Seine river near Les Andelys in the *département* of Eure, is one of the most imposing ruins of medieval architecture in France. For a description of it *see* Castle. It was built on the order of Richard I Coeur-de-Lion of England to defend the dukedom of Normandy against the king of France, Philip II, after a truce in Dec. 1195. Work was begun in 1196 and the castle completed in 1198. It formed part of the fortified line between Norman and French Vexin, including the castles of Gisors and La Roche-Guyon. Its site, on a high spur of rock overlooking the river, afforded great advantage to the defender, who merely had to guard the southern end. Château-Gaillard defied medieval artillery, and it was only after a long siege (Sept. 1203–March 1204) that Philip II succeeded in taking it. After this, the French easily conquered Normandy.

The castle was later used as a prison for Philip IV's adulterous daughter-in-law Margaret of Burgundy; for David II, king of Scotland, who took refuge in France (1334); and for Charles II the Bad, king of Navarre (1356). It was taken and retaken by the English during the Hundred Years' War (1419, 1429, 1449). Château-Gaillard ended its usefulness during the civil wars of the 16th century. Henry IV took it in 1591 and ordered the outer works to be pulled down, and finally the cardinal de Richelieu had the donjon dismantled.

CHÂTEAU-RENAULT, FRANÇOIS LOUIS ROUSSELET, Marquis de (1637–1716), French admiral who served with distinction in Louis XIV's wars, was born on Sept. 22, 1637, probably at Château-Renault in Touraine. He served in the army under the vicomte de Turenne in Flanders in 1658 but transferred to the navy in 1661, his first experience in fighting at sea being against the Barbary pirates. Captain in 1672 and squadron commander in 1673, he took part in various campaigns in the Dutch war (1672–78), fighting against M. A. de Ruyter and other Dutch admirals in the North sea and the Mediterranean. Promoted lieutenant general in 1688, Château-Renault conveyed an expedition to Ireland in 1689 to help James II in his plan for the reconquest of England. He landed the troops at Bantry bay and engaged the English fleet under Adm. Arthur Herbert (later earl of Torrington; *q.v.*) on May 10–11 but could not follow up an initial success. Next year he commanded the vanguard of the comte de Tourville's fleet in the battle of Beachy Head (*q.v.*), in which he was chiefly responsible for the defeat of the Dutch ships. In 1696 he was entrusted with bringing a squadron from the Mediterranean to Brest to join the Brest squadron for an attack on England, but the weather delayed him on the way and the enterprise came to nothing. From 1697 to 1700 he was in command at Brest. In 1701 he was created vice-admiral.

Early in the War of the Spanish Succession, Château-Renault had the important task of escorting the Spanish treasure fleet from America to Europe. As the Spaniards would not let him take it to a French port and as the English were attacking Cadiz, he brought it into Vigo bay, where Adm. Sir George Rooke surprised him (Oct. 1702). Unable to save his ships, he had to set them on fire, losing part of the treasure. Louis XIV, not holding him responsible for this disaster, made him a marshal of France in 1703 and governor of Brittany in 1704. Château-Renault died in Paris on Nov. 15, 1716.

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CHÂTEAUROUX, MARIE ANNE DE MAILLY-NESLE, Duchesse de (1717–1744), mistress of Louis XV of France, was born in Paris on Oct. 5, 1717, the fifth daughter of Louis de Mailly, marquis de Nesle. She was married in 1734 to the marquis de La Tournelle, who died in 1740. Her eldest sister, Louise Julie, comtesse de Mailly (1710–51), had been succeeded as the king's mistress by the next eldest, Pauline Félicité, marquise de Vintimille (1712–41). After the latter's death, Madame de La Tournelle, backed by the duc de Richelieu, was installed at Versailles as the king's acknowledged mistress (Dec. 1742), despite Cardinal Fleury and the comte de Maurepas: her price included the dismissal of Madame de Mailly from court and the title of duchesse de Châteauroux for herself (1743). She incited Louis to look for military glory and received a letter of thanks from Frederick II of Prussia for her part in negotiating the alliance of 1744. Louis allowed her to join him with the army in Flanders in June 1744, dismissed her under pressure from the church during his illness at Metz in August but recalled her to court on his recovery. She died, suddenly, in Paris, on Dec. 8, 1744.

See E. and J. de Goncourt, *La Duchesse de Châteauroux et ses soeurs*, new ed. (1889); also the *Histoire de Madame de Châteauroux tirée des mémoires de la duchesse de Brancas* (1919).

CHÂTEAUROUX, a town of central France, capital of the *département* of Indre (*q.v.*), situated on the left bank of the Indre river, 88 mi. S. of Orléans on the main line of the Paris-Toulouse railway. Pop. (1954) 36,016. The old town, close to the river, forms a nucleus around which a newer and more extensive quarter, bordered by boulevards, has grown up; the suburbs of St. Christophe and Déols lie on the right bank of the river. Châteauroux owes its name and origin to the castle founded between 935 and 950 by Raoul, prince of Déols, which later passed to Henry II of England, falling eventually to the Condé family (1612). The present Château-Raoul dates from the 14th and 15th centuries. The old Église des Cordeliers (13th century) and St. Martial are the finest monuments. The library contains a manuscript (about 1270) of the *Chanson de Roland* and the 15th-century "Bréviaire Parisien" manuscript, and the Bertrand museum houses Napoleonic collections. Châteauroux has tribunals of first instance and of commerce, a board of trade arbitrators and a chamber of commerce. Textiles and machinery are manufactured, and there is a state tobacco factory. (Y. E.)

CHÂTEAU-THIERRY, a town of north-central France, *département* of Aisne (*q.v.*), 90 km. (55.9 mi.) E.N.E. from Paris by road, on the right bank of the Marne. Pop. (1954) 7,939. On the top of a hill are the ruins of a castle, said to have been built by Charles Martel for the Frankish king Thierry IV; the chief relic is a gateway flanked by massive round towers. Also interesting are a 15th-century belfry, the church of St. Crépin and the late-16th-century mansion in which fabulist Jean de La Fontaine was born. Château-Thierry is on the main railway line from Paris to Châlons-sur-Marne, Nancy and Strasbourg. The main industries are the manufacture of mathematical and musical instruments, biscuits and other foodstuffs. White wine and other local agricultural products are traded. Gypsum, millstone and paving stone are quarried in the vicinity.

Formerly the capital of the district of Brie Pouilleuse, Château-Thierry received the title of duchy from Charles IX in 1566. It was captured by the English in 1421 and by Charles V in 1544 and was sacked by the Spanish in 1591, in the Fronde wars in 1652 and by Blücher's Prussians in 1814. The Russo-Prussian forces were defeated by Napoleon in the neighbourhood. In World War I it was the farthest point reached by the German offensive of May–

July 1918. The 2nd and 3rd divisions of the American Expeditionary force were sent to assist the hard-pressed French forces; at Château-Thierry a U.S. machine-gun battalion took part in the successful defense of the river crossing, while to the west of the town the 2nd division fought the fiercely contested engagement of Belleau Wood. (*See* BELLEAU WOOD, BATTLE OF; MARNE, BATTLES OF THE). In World War II the town was under German occupation from June 1940 to Aug. 1944. (C. PR.)

CHATELAIN (Fr. *châtelain*, from *château*), in France, originally an officer with functions equivalent to those of the English castellan or the German *Burggraf* ("burgrave"); *i.e.*, the commander of a castle. With the growth of the feudal system, however, the title gained in France a special significance as implying the jurisdiction of which the castle became the centre. The chatelain in Carolingian France was an official of the count; with the development of feudalism the office became a fief and so, ultimately, hereditary. The chatelain was thus largely the equivalent of the viscount (*q.v.*); sometimes the two titles were combined, but more usually in those provinces where there were chatelains there were no viscounts, and vice versa. The title, however, continued also to be applied to the inferior officer, or concierge chatelain, who was merely a castellan in the English sense.

The power and status of chatelains necessarily varied greatly at different periods and places; occasionally they were great nobles with an extensive jurisdiction.

The *châtellenie (castellania)*, or jurisdiction of the chatelain, as a territorial division for certain judicial and administrative purposes, survived the disappearance of the title and office of the chatelain and continued till the French Revolution.

In Germany the *Burggrafen* were at first royal castellans; later they were appointed by lesser princes. In some towns, moreover, there was a *Burggraf* with police functions over the market who judged commercial disputes.

CHÂTELET, GABRIELLE ÉMILIE LE TONNELIER DE BRETEUIL, MARQUISE DU (1706–1749), French mathematician, physicist and philosopher who did much to free French thought from subservience to Cartesianism, was born in Paris on Dec. 17, 1706, the daughter of Louis Nicholas le Tonnelier, baron de Breteuil. An accomplished linguist and musician, she became prominent in the social life of the time. She was married at 19 to the marquis Florent du Châtelet, and they had three children; but before and after her marriage she had alliances with other men, the most important being that with Voltaire, dating from 1733.

Influenced by Samuel Koenig, she wrote *Institutions de physique* (1740), a work pervaded by the views of Leibniz; but her most important contribution to thought was the first French translation of the *Principia Mathematica* of Sir Isaac Newton. The long sojourns at the chateau of the Du Châtelets in Champagne provided a haven for writing, as well as refuge from the Paris police whenever it became necessary for her to extricate the intemperate Voltaire from personal and political difficulties.

Mme du Châtelet and Voltaire in 1738 competed independently for a prize offered by the Académie des Sciences for an essay on the nature of fire; and although the prize was won by Leonhard Euler, her *Dissertation sur la nature et la propagation du feu* was published in 1744 at the expense of the Académie. She also wrote *Réponse à la lettre de Mairan sur la question des forces vives* (1741) and a number of posthumously published treatises on philosophy and religion.

Voltaire and Mme du Châtelet (or du Châtelet-Lomont) continued to live together even after she had transferred her affections to the poet Jean François de Saint-Lambert; and when, on Sept. 10, 1749, she died in childbirth at the court of Stanislas of Poland in Lunéville, these men and her husband were with her. She had worked until the end on the translation of the *Principia*, and this was published, with a preface by Voltaire and under the direction of A. C. Clairaut, in 1756. The many hundreds of letters that passed between Mme du Châtelet and Voltaire are assumed to have been destroyed; but others were included in Voltaire's *Correspondence* (ed. by Theodore Besterman, 24 vol., 1953–57).

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CHÂTELET, in Paris, the principal seat of common-law jurisdiction under the French monarchy from the middle ages to the French Revolution. The building itself (demolished between 1802 and 1810) was originally a little fort (Lat., *castellum;* French, *châtelet*, diminutive of *château*), on the right bank of the Seine, guarding the northern approach to the Île de la Cité. First mentioned in the 9th century, it was rebuilt by Louis VI and considerably adapted under Charles V. It was generally known as the Grand Châtelet to distinguish it from the Petit Châtelet, on the left bank of the Seine, at the end of the Petit Pont. Rebuilt by Philip II and later by Charles V, the Petit Châtelet was demolished in 1782.

In the 12th century the Grand Châtelet became the seat of the royal *prévôt* ("provost") of Paris, who was the successor of the *châtelains-vicomtes* of Paris (*see* CHATELAIN). The *prévôt* had jurisdiction over the whole "*vicomté* and *prévôté* of Paris," which was a bailliage in all but name and, as such, the most important in the kingdom. This jurisdiction was over matters of common law, both civil and criminal, and the *prévôt*, as *bailli royal*, judged appeals from all royal and seigniorial courts within the area of jurisdiction. The legal terms and the procedure are recorded in the *Grand Coutumier de France*, compiled late in the 14th century by Jacques d'Ableiges, an advocate at the Châtelet. The Châtelet also heard uncontested cases, and notaries attached to it could deal with proceedings anywhere in the kingdom. In addition, the *prévôt* had administrative and financial functions, and the *procureur du roi* ("king's procurator") had not only judicial duties but also the control of the trade corporations of Paris.

Originally there were two *prévôts*, chosen from the bourgeoisie of Paris and acting together, but from 1261 a single *prévôt* was appointed. This officer, commonly called the *grand prévôt*, was thenceforth a figure of considerable importance. From the beginning of the 15th century he had three immediate subordinates, the *lieutenant particulier*, the *lieutenant civil* and the *lieutenant criminel*, whose jurisdiction was considerably expanded after 1674, when Louis XIV bought up all the surviving seigniorial rights of legal jurisdiction in Paris and amalgamated them. The Nouveau Châtelet, which was then set up as a presidial court and a *prévôté* like the original one, ceased to function separately in 1684.

Cases were then handled by about 60 counselors, divided among the various chambers. Judgment was passed on behalf of the *prévôt* by the *lieutenant civil*, whose appointment was worth more than that of a counselor of the *parlement*. In 1667 Louis XIV created a lieutenant general of police, commonly called "Monsieur de Paris." This officer was often to work with the king on the most confidential matters. He was given authority over the *commissaires-examinateurs* of the Châtelet, a permanent staff, in existence since 1327, who from 1419 were spread over the various quarters of Paris and, from an original 12, rose in number to 48 in the 16th century. They were responsible for security and public order, for the supervision of the prisons, including the Bastille (*q.v.*), and also for the regulation of the food supply of Paris.

The jurisdiction of the Châtelet was abolished by the law of Aug. 24, 1790. Its archives are now in the Archives Nationales in Paris.

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CHÂTELLERAULT, a town of west-central France, in the *département* of Vienne (*q.v.*), 34 km. (21.1 mi.) N.N.E. of Poitiers by road. Pop. (1954) 20,764. The old town has many 15th–17th-century houses, among them the Maison des Sybilles, the house where René Descartes spent his childhood (now a museum); there is also a 15th-century château. In the south is the 17th-century Hôtel Sully and the church of St. James. In the new part of the town are found the *hôtel de ville*, the church of St. John the Baptist, the *hôtel des postes* and the Collège René Descartes. Châtellerault is on the main line from Paris and Tours to Bordeaux and Spain. The main industry is armaments manufacture: cutlery, camping equipment, plywood and clothing manufactures are significant.

Châtellerault (or Châtelhérault: Castellum Airaldi) derives its name from a 10th-century fortress built by Airaud, viscount of the territory. In World War II the town was occupied by the Germans from June 1940 to Aug. 1944. (B. Pe.)

CHATHAM, WILLIAM PITT, 1st Earl of (1708–1778), one of England's greatest and most famous statesmen, whose combined vision and practical ability led to a remarkable increase in English possessions and influence, was born at Golden square, Westminster, on Nov. 15, 1708. His father was Robert, son of the famous Gov. Thomas "Diamond" Pitt of Madras; his mother, Harriet Villiers, daughter of Viscountess Grandison. He was the fourth child of a family of seven, most of whom showed signs of mental instability. He was educated in the classics at Eton and Trinity college, Oxford. At Eton he made friends with many who later became his political associates, and especially with George Lyttelton, Henry Fielding, Charles Pratt and Charles Hanbury Williams. He left Oxford after only one year, partly because of the persistent gout from which he already suffered, and spent several months studying law at the University of Utrecht. A large number of deaths among the influential members of his family when he was still only 20 left his career uncertain, but his steps were guided toward politics by the marriage, in 1728, of his brother to Christian Lyttelton, sister of his school friend George Lyttelton. Through the Lytteltons the Pitts became connected with the widely ramified clan of the Temples and Grenvilles, one of the most powerful groups in the landowning oligarchy, which, under the Hanoverian monarchs, virtually governed Britain. The leader of the group, Viscount Cobham, wielded great wealth and patronage, and it was through his gift that William, in 1731, was appointed a cornet in the king's own regiment of horse, which later became the 1st dragoon guards. This commission brought him an income of £150 a year and an introduction to court and public life.

Early Parliamentary Career.—In 1735 he entered the house of commons as member for Old Sarum, one of his brother's pocket boroughs, which later became the most notorious example of all rotten boroughs. He belonged inevitably to the group of "Cobham's cubs," the connection of family friends and place hunters whom Cobham was mobilizing to oppose the ministry of Sir Robert Walpole. Calling themselves "patriots," they joined with discontented Whigs like Lord Carteret and William Pulteney and Hanoverian Tories like Sir William Wyndham to rally the opposition forces behind the prince of Wales, Frederick Louis. At a time when a regular standing opposition in parliament was generally regarded as factious and even traitorous, since ministers were the king's ministers, it became common for political groups opposed to the government to seek respectability by alliance with the heir to the throne. Since it was normal for Hanoverian monarchs to be in a state of violent hostility with their eldest sons, royal power was habitually divided against itself. Politicians excluded from office looked to "the rising sun," and the prince of Wales used both his own patronage and the hopes of future office to unite them against his father and his father's ministers. At this time Viscount Bolingbroke was especially active in his efforts to form in this way a solid opposition to Walpole. So Pitt entered parliament at a crucial stage of party development. His maiden speech provoked reprisals from Walpole, who deprived him of his military commission in an effort to "muzzle this terrible cornet of horse."

In 1737 the prince of Wales made him a groom of the bedchamber with a salary of £400 a year. Despite his status as a relatively poor dependent of a powerful Whig clan and as a pensioner of the prince of Wales, Pitt already showed that independence of mind and appeal to popular support which were to gain him unique personal prestige in English political life. His talents as an orator had become clear. His exploitation of the position of patriotic martyr, by driving around the southern counties after his dismissal by Walpole, showed a readiness to appeal to public opinion outside parliament, as well as his lively sense of the histrionic. He repeatedly referred to the "voice of England," which had to be sought outside parliament because parliament was so packed with place men and sinecurists. He claimed to speak for the commercial interests and even the colonists overseas, both scarcely represented in the commons. Although the member for Old Sarum could hardly claim to represent such interests directly, he more and more put forward arguments that would logically deny the whole system of oligarchical control over the electorate and over parliament. If he was a Whig he was, par excellence, a wayward Whig, using, in the cause of opposition, arguments that carried far beyond the close oligarchy enjoyed by the Whig families.

When Walpole at last fell from power in 1742, he was replaced by a ministry which included his old colleagues the duke of Newcastle and Lord Hardwicke, with Carteret as secretary of state. Pulteney was silenced by a peerage. The "boy patriots," of whom Pitt was by now the acknowledged parliamentary leader, were still excluded from power. They were left with no option but to oppose Carteret even more vehemently than they had Walpole.

From 1741 to 1748 Great Britain was engaged in the complex diplomacy and strategy of the War of the Austrian Succession. The chief menace to British security was Bourbon power in Europe, and the aim of British policy was therefore to diminish French power in every way possible. Pitt differed from Carteret more about means than about ends. George II and Carteret saw the issue as primarily a continental one and aimed at a coalition of German states, led by Britain and Hanover, to support Maria Theresa of Austria in her struggle against France. Pitt insisted that Great Britain should concentrate on attacking France where it was most vulnerable and where British naval power would bring the greatest advantage—that is, in France's colonial possessions, which obstructed British enterprise and expansion in America and India. He accordingly attacked, in a series of great speeches, the government's policy of continental alliances and subsidies and exploited the unpopularity of the royal connection with Hanover. Carteret was condemned as "a Hanover troop minister" and as "an infamous minister who seems to have renounced the name of an Englishman." It was possible to be a "patriot" in a new and additional sense and to appeal to every sort of national and popular prejudice. When Carteret was forced to resign in 1744, Newcastle and his brother Henry Pelham took office. They wanted to include Pitt, but George II had been so offended by Pitt's attacks on Hanover that he refused to accept him. During the Jacobite rising of 1745 Pitt gained new stature as the one statesman of effectiveness and vigour, and the rising was itself a further argument against the continental policy of the king. In Feb. 1746 the king agreed to appoint Pitt joint vice-treasurer of Ireland at £3,000 a year, and two months later he became paymaster general of the forces.

Paymaster General.—Pitt's first ten years in parliament had been spent in opposition, and he had earned a formidable reputation as a malcontent. His acceptance of the paymastership, which was notoriously the richest plum of place hunters, at first caused bewilderment and recriminations, even from his friends. It seemed that the "patriot" had been bought by the government. But it gave Pitt a further opportunity to earn a unique reputation for honesty and disinterestedness. He renounced for himself all the rich perquisites of the office except its official salary of more than £4,000. He also introduced many useful reforms in the administration of the office and dramatically regained his reputation for both scrupulous honesty and efficiency. He held the office for nine years and left it still a poor man.

But a legacy of £10,000 from the old duchess of Marlborough enabled him to indulge in more lavish expenditure and generosity. He spent a good deal on landscape gardening and bought South lodge at Enfield. In 1754 he married Hester Grenville and thereafter found, in a supremely happy home life, a new source of strength and escape from his somewhat solitary existence. In policy he supported the Pelhams' alliance with Hanover but tried to strengthen British naval power as the chief weapon of both offense and defense. When Henry Pelham died, in 1754, Pitt hoped to become leader of the house of commons. The duke of Newcastle, jealous of Pitt's abilities and distrustful of his only serious rival. Henry Fox, maneuvered into office a colourless nonentity, Sir Thomas Robinson. Pitt and Fox joined in baiting and ridiculing Robinson, but when he was driven to resign, it was Fox whom Newcastle took in as secretary of state. Pitt transferred his attacks to the Newcastle-Fox combination, likening it to "the conflux at Lyons of the Rhône and the Saône: this a feeble, languid stream, and, though languid, of no depth—the other a boisterous and overbearing torrent—but they meet at last." The jibe cost him the pay office, from which he was dismissed in 1755.

War Minister.—The outbreak of the Seven Years' War gave Pitt his supreme opportunity for statesmanship. It began with heavy losses and considerable confusion of policy. The popular demand for Pitt became irresistible, and he declared, "I know that I can save this country and that no one else can." In Nov. 1756 he formed a ministry which excluded Newcastle, with the duke of Devonshire as its nominal head. In June 1757 Newcastle returned to office on the understanding that he should control all the patronage and leave Pitt to conduct the war. It proved to be an admirable division of labour.

Pitt determined that it should be in every sense a national war and a war at sea. He got rid of the German mercenaries who had been sent over to resist invasion and revived the militia, which he made into a serviceable defense force. He re-equipped and reorganized the navy. He sought to unite all parties and public opinion behind a coherent and intelligible war policy. He seized upon America and India as the main objects of British strategy. He sent his main expeditions to America, to ensure the conquest of Canada, and supported the East India company and its "heaven-born general," Robert Clive, in their struggle against the French East India company. He also subsidized and reinforced the armies of Frederick II the Great of Prussia, so as to engage the main French armies on the continent, while he used naval power to harrass the French on their own coasts, in the West Indies and in Africa. He chose good generals and admirals—James Wolfe and Jeffrey Amherst, and Edward Boscawen, Edward Hawke, Charles Saunders, George Pocock and Charles Watson—and he inspired them with a new spirit of dash and enterprise. Against so resolute and concerted a policy the Bourbon powers even in alliance could not prevail. At the treaty of Paris in 1763 Great Britain remained supreme in North America and India, held Minorca as a Mediterranean base and gained territory in Africa and the West Indies. Pitt had given Britain a new empire as well as preserving and consolidating the old.

But before the war ended Pitt had been forced to resign. In 1760 George III came to the throne resolved, as was his chief adviser, the earl of Bute, to end the war as speedily as possible. When Pitt failed to persuade his colleagues to forestall Spain's entry into hostilities by an immediate declaration of war he resigned, in Oct. 1761. He had tended to concentrate the whole conduct of government into his own hands and had worked with a furious energy. His haughty and aloof manner, which alienated so many of his colleagues, and his highhanded treatment of affairs, rendered tolerable only so long as he was proved right, had earned him respect and admiration but little friendship. When his resignation was accompanied by the grant of a peerage to Hester and an annuity of £3,000 a year for himself, there was again an outburst of abuse and scurrility. Just as when he had accepted the pay office, this acceptance of a peerage and a pension seemed to be the result of a political bargain and a sordid anticlimax to a brilliant career. As rewards for his immense services they were meagre enough, but it is some measure of the unique repute for high-minded disinterestedness which he had won that his acceptance of them should provoke so much bitter disillusionment. His effigy was burned in the City, and Hester was reviled as Lady Cheat'em.

He attacked the terms of the treaty of Paris as an inadequate recognition of Great Britain's world-wide successes. The intense unpopularity of Bute and Pitt's role as champion of national rights soon restored his popular appeal. But his career as a war minister was now over. He had delivered 115 speeches since he had entered parliament and more than half of them had been concerned with war or preparations for war. As a supremely successful secretary of state during the Seven Years' War he had combined colonial and naval operations with containing operations in Europe, and had shown that they were not alternative theories of strategy but were complementary. The rest of his political career was devoted to attempting a similar reconciliation of principles: of imperial power with constitutional liberty.

Later Years.—When Bute resigned in April 1763, he was succeeded by George Grenville. Pitt's attacks on his administration completed the breach between the two brothers-in-law. He condemned the action taken by the ministry against John Wilkes for his attack on the king's speech in no. 45 of the *North Briton*, and opposed Grenville's Stamp act. He took no active part in politics between 1764 and 1766, and was now becoming subject to the recurrent fits of manic-depressive insanity which were to cloud the rest of his life. In 1765 he was left, by Sir William Pynsent, the estate of Burton Pynsent in Somerset, worth more than £3,000 a year. In Jan. 1766 he re-entered the stage with a passionate appeal for imperial liberty. Of the American colonists, who had resisted the Stamp act, he proclaimed, "as subjects they are entitled to the common right of representation, and cannot be bound to pay taxes without their consent." He supported and defended their resistance and demanded the complete repeal of the Stamp act. This was done, but it was replaced by a Declaratory act maintaining the right of taxation. Grenville's successors, the Rockinghams, found their position equally untenable, and in July 1766 the king asked Pitt to form a ministry drawn from all sections of the house.

The idea of an all-party ministry had long haunted English politics. Parties were regarded as factions and the unit of parliamentary politics was not party but aristocratic group connection. Every ministry was a combination of several such groups and the groups excluded tended to form an opposition until some of them, at least, were offered places. While the notion of a regularly formed opposition was viewed with much distrust, it was natural to seek strength for government in a "broad-bottomed" or all-party administration. Pitt had propounded the view that a ministry should be formed on the principle of "measures and not men"; that is, that ministers should be appointed for their abilities and policies, and not because of their group connections. This has often been assumed to mean agreement with the aims of George III, who in his efforts to recover for the crown the use of royal patronage, which the first two Georges had allowed to fall into the hands of the Whig oligarchy, was seeking a ministry similarly united on principles rather than on group affiliations. But Pitt's interests were different. He was not concerned with attacking the system of group connections; rather, he wanted to insert himself, alongside the oligarchic leaders, as an individual who would be indispensable to any effective administration. He played, by instinct and temperament, something of a lone hand in politics. His main principle was that the king's government must be carried on, and what he wanted was strong, coherent and efficient administration. In 1763 he told the king that "it cannot be carried on without the great families who have supported the Revolution Government, and other great persons of whose abilities and integrity the public have had experience, and who have weight and credit in the nation." He repeatedly showed that he had no wish to destroy the oligarchic groups, but was perfectly willing to collaborate with them as long as they would acknowledge his own unique position and influence. Accordingly, his ministry of 1766 included Henry Conway and Lord Northington from the previous ministry, Lord Camden, Lord Grafton and Lord Shelburne, who were his own followers, and Lord North and Charles Townshend. It could have worked well only if Pitt himself had remained in active control over it. But he accepted an earldom and took the almost sinecure post of lord privy seal. The "great commoner" retired to the lords and fell ill for another two years. The luckless duke of Grafton was left in nominal control of the government just when the disturbances in America and in Middlesex, over the Wilkes elections case, were reaching their climax.

The new ministry was probably doomed to failure from the start. Its members held contrary views about America, and had little harmony of temperament or purpose. It is doubtful if even Chatham could have made them into a team; certainly the indolent Grafton could not. Engulfed in a black fit of insanity, Chatham withdrew completely and, in 1768, resigned office. His own chancellor of the exchequer, Townshend, imposed a series of duties on the American colonists which brought in little revenue but caused widespread discontent. Chatham appeared in the lords in 1770 to launch a savage attack on the ministry and on the house of commons for its surrender to the wishes of the king in the Middlesex elections, when it not only expelled Wilkes but also illegally declared the defeated candidate, H. L. Luttrell, elected. He supported the City in its protests against the government and demanded a dissolution to get rid of a subservient commons. He even proposed a measure of parliamentary reform to strengthen the county representation as against the boroughs, the "rotten parts" of the constitution. In the following year he pressed for triennial, instead of septennial, elections as a method of bringing the commons more closely into touch with public opinion in the country. His early "radical" propensities came more into the open.

During the last ten years of his life, 1768–78, he acquired a group of followers of his own, including Grafton, Shelburne, Camden and Isaac Barré. In parliamentary action he was driven to rely more upon this group and less upon his own eloquence and popularity. Instead of being able, in Burke's words, "to keep hovering in air, over all parties, and to souse down where the prey may prove best," he was driven into active alliance with the Rockingham group. He was forced into the normal Whig procedure of negotiating group alliances and in his deliberate disruption of the Grafton ministry in 1770 he acted little differently from the ordinary party man in opposition. The end of his career showed that there was little permanent place, in 18th-century politics, for one who claimed to depend primarily upon a personal reputation for ability and disinterestedness. In the end he, like the king himself, found that he had to come down into the arena and deal with politicians and group connections on their own ground.

His last years were clouded by illness, and only on rare occasions did he emerge from seclusion to appeal for a more generous and understanding treatment of America. Yet he broke with the Whig groups when they were prepared to recognize the independence of the 13 colonies and when the Americans had allied with Britain's traditional enemy, France. His last speech in the lords was a protest against any diminution of an empire based on freedom. In 1775 he hurriedly introduced a bill designed to suspend repressive measures in Boston, maintain the legislative authority of parliament over the colonies and yet use the continental congress established at Philadelphia as a body for assessing the monetary contributions of each colony. The bill was summarily rejected, but it is the best indication of how Chatham would have handled the American problem.

After 1771 it was his practice to emerge only occasionally, as the elder statesman, to promote or attack individual measures, but not to attempt, as in 1770, to overthrow the ministry as a whole. He spent most of these years enjoying the life of a country gentleman or in gloomy seclusion as an invalid. He died at Hayes, Middlesex, on May 11, 1778, and was buried in Westminster abbey.

Character and Influence.—Chatham remains a brilliant and dominant yet enigmatic figure in 18th-century history. Even the fragmentary reports of his speeches which survive endorse his contemporary reputation as one of the greatest orators that England has ever known. As a war minister he combined immense breadth of vision with brilliant executive ability. As a statesman he raised British power and prestige to great heights and added large territories to Britain's overseas possessions. As a man he was a model of devotion to his family as well as of unstinted public service. But his genius was erratic, his political behaviour at times factious and at variance with his professed principles. The penalty of his eminence was a certain isolation. He had the defects of spiritual pride and haughtiness, which were perhaps the natural counterparts to his great talents.

His role in the development of the English party system is ambiguous. He did not seek to destroy the system of aristocratic patronage and group connection in politics, yet in effect he did much to undermine their power and to introduce into parliamentary life the force of public opinion. By his sustained and vigorous opposition to such ministers as Walpole, Carteret, Fox, Bute, Grenville and Grafton, he established a powerful tradition of the merits and rights of an organized opposition in parliament; yet this development seemed to be denied by his support for the idea of an all-party administration based on "measures and not men." He had a less profound insight than his contemporary, Edmund Burke, into the basic implications of a constitutional parliamentary system. He remains, nonetheless, one of the greatest geniuses of statecraft in British history.

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CHATHAM, the county seat of Kent county, Ont., Can., is 15 mi. up the Thames river from Lake St. Clair, 64 mi. S.W. of London and 40 mi. E. of Detroit. Chatham is served by Canadian Pacific and Canadian National main lines and a Pere Marquette branch line. Small lake freighters along the river connect the city with the Great Lakes. Situated on an extinct lake plain, Chatham is a processing centre for farm products. It has a beet-sugar refinery, canneries, tobacco curing plants, a meat-packing plant and several light metal-fabricating industries. Named after Chatham, Eng., it was first settled about 1800. An outlet of the Underground Railroad for fugitive slaves, it was the scene of the "convention" held by John Brown preceding his raid on Harpers Ferry in 1859. Pop. (1961) 27,447. (G. Fn.)

CHATHAM, a port and municipal borough in the parliamentary division of Rochester and Chatham, Kent, Eng., on the right bank of the river Medway 10 mi. above its confluence with the Thames, and about 30 mi. E.S.E. of London by road. Pop. (1961) 48,989. Area 6.8 sq.mi. Though a distinct borough, it is coterminous with Rochester (*q.v.*) on the west and forms, with it and Gillingham (*q.v.*) on the east, one large conurbation, of which Chatham is the principal shopping, commercial and entertainment centre. Industries include flour mills, timberworks, etc., but by far the biggest employer is the royal naval dockyard.

Chatham (*Ceteham, Chetham*) belonged at the time of Domesday to Odo, bishop of Bayeux. It later formed a suburb of Rochester, but Henry VIII and Elizabeth I established a dockyard and an arsenal. The dockyard was altered and improved by Charles I and Charles II and became the chief naval station of England. In 1708 an act was passed for extending the fortifications of Chatham, and the town grew around the dockyard.

The royal naval dockyard is situated to the north of the town, on a point, partly of reclaimed marsh, beyond which the sharply curving river widens from about 400 yd. to its broad tidal estuary. The dockyard covers more than 500 ac. and has a river frontage of more than 3 mi. It is equipped both for building and repairing naval vessels of all kinds. There is a church in the dockyard, and near at hand are the royal naval, royal marine and royal engineers' barracks. Chatham has a number of memorials to members of the services in various campaigns. A series of open spaces on the hill east of the town are known as the "Chatham lines." On this hill a number of forts were erected to defend the port during the Napoleonic Wars; conspicuous on the heights is the Royal Naval War memorial. Just below Fort Amherst is the town hall. Fort Pitt was adapted to house a girls' technical school. High street is formed by part of ancient Watling street connecting Canterbury and London.

St. Mary's church occupies a site in similar use since Saxon times. Norman and Early English features from the old church, which was destroyed by fire, are incorporated in the present 18th-century building (thoroughly restored in 1903). The church contains a memorial to Stephen Borough (d. 1584), who in 1553 pioneered an Arctic sea route to Archangel. Near the railway station is a monument to Thomas Waghorn (d. 1850), a Chatham man who founded the overland route to India. St. Bartholomew's chapel, originally attached to the hospital for lepers founded by Gundulph, bishop of Rochester in 1078, is partly Norman. The hospital still has connections with Rochester cathedral. The Hospital of Sir John Hawkins, knight, in Chatham, for ex-seamen and ex-shipwrights of Chatham and Sheerness dockyards, was founded in 1592 by Sir John Hawkins and rebuilt in the middle of the 18th century. The fund called the Chatham Chest, originated by Hawkins and Drake in 1590, was incorporated with Greenwich hospital in the early 19th century.

Charles Dickens and his family lived from 1817 to 1821 in a house at Ordnance terrace, where his father worked in the navy pay office, and Chatham people were the originals of certain characters in *Sketches by Boz* and *David Copperfield*.

Chatham was constituted a parliamentary borough by the Reform bill of 1832. In 1918 the municipal boroughs of Chatham, Gillingham and Rochester combined to return two members to parliament. The town, with the suburb of Luton, was incorporated in 1890.

CHATHAM ISLANDS, a small group of islands in the Pacific ocean, forming part of New Zealand since 1842. They lie 467 nautical mi. E. of Lyttelton in South Island. The three main islands are Chatham (the largest), Pitt and Rangatira. Chatham (344 sq.mi.) rises to 938 ft. in the south and has a large number of small lakes and Te Whanga a shallow lagoon of 72 sq.mi. It is about 38 mi. long and 25 mi. in maximum breadth. Pitt (24 sq.mi.), 13 mi. from Chatham, has the highest point in the group (971 ft.). There are several small, rocky islets. The geological structure is mainly volcanic rocks with schists, and the presence of Tertiary limestone suggests that the islands were once part of New Zealand.

There are no indigenous mammals, and the reptiles belong to New Zealand species. The birds have been heavily reduced. The original forest vegetation (containing many New Zealand species) has been greatly modified since the arrival of Europeans. Large areas are now under English grasses though there are still extensive areas of swamp, bog, heath and dune. The climate is mild, with mean temperatures ranging from 45.4° F. in July to 57.6° F. in January. Rainfall averages 33.4 in. annually and is recorded on half the days of the year. Prevailing winds are southwesterly.

The islands were discovered in 1791 by Lieut. W. R. Broughton in H.M.S. "Chatham." He called the natives Moriori or Maioriori. Their language was akin to the Maori of New Zealand, but they differed physically. In 1835 they were overwhelmed by 800 Maori landed from a European vessel. The last pure Moriori died in 1933.

Europeans have lived in the group since 1840. After 1860 pastoral farming became increasingly important, and many large sheep stations were established. Chatham Island exports annually about 3,000 bales of wool, 20,000 head of sheep and 250 head of cattle. Breeding ewes and rams (mostly Romneys) are in constant demand in New Zealand, but shipping is expensive and, except in summer, irregular. Occasionally airplanes are chartered to carry passengers to New Zealand, with which there is a radio-telephone link.

Population at the 1961 census was 487 (316 Europeans). Most Maori have some Moriori or European ancestry. There is a cottage hospital and primary school at Waitangi (pop. 140), the main settlement and port of entry, which is on Petre bay on the southwestern side of the island. The islands are administered by a resident commissioner (who is also a magistrate) appointed by the New Zealand department of island territories. (R. M. Fr.)

CHATSWORTH, the principal seat of the dukes of Devonshire, in the parish of Edensor, Derbyshire. Chatsworth house stands close to the left bank of the Derwent river, 2¾ mi. E.N.E. of Bakewell. The park is more than 11 mi. in circumference. The house is built around a large open courtyard, which has a fountain in the centre. The gardens are adorned with sculptures by Caius Gabriel Cibber, and its fountains, designed by Sir Joseph Paxton (*q.v.*), are said to be surpassed only by those at Versailles. The house contains a library and art collection, which includes works by Sir Joshua Reynolds, Hans Holbein, Albrecht Dürer, Hans Memling, Bartolome Murillo, Carlo Dolci, Paolo Veronese, Titian, Michelangelo, Leonardo da Vinci and Correggio, and sculptures by Antonio Canova, Bertel Thorvaldsen, Sir Francis Chantrey and R. J. Wyatt. Beyond the river, and immediately opposite the house, is the model village of Edensor: of Saxon origin, it was almost entirely rebuilt by the 6th duke. The parish church, built by Sir Gilbert Scott to replace a much older building, contains a brass in memory of John Beaton, confidential servant to Mary Stuart.

Chatsworth (Chetesworde, Chattesworth, "Ceatt's homestead") took its name from Ceatt, one of its Saxon owners. It was entrusted by William I to the custody of William Peverel. It afterward belonged for many generations to the Leech family and was purchased in the reign of Elizabeth I by Sir William Cavendish, husband of the famous Bess of Hardwick. In 1553 he began to build Chatsworth house, which was completed, after his death, by his widow, later countess of Shrewsbury. Mary Stuart spent several years of her imprisonment there under the care of the earl of Shrewsbury. During the Civil War, Chatsworth was occupied as a fortress by both parties and subsequently pulled down. The present house was designed by William Talman and Thomas Archer for the 4th earl (created 1st duke in 1694). Although a marble slab in the Great hall states that it was begun in 1688, work was already in progress in 1687. The long north wing was added (1820–27) by Sir Jeffry Wyatville for the 6th duke, who also extended the east side (1827–34) and rebuilt the interior of the south wing.

CHATTAHOOCHEE, the river which inspired Sidney Lanier's poem "The Song of the Chattahoochee," is formed in the Blue Ridge mountains in northeastern Georgia by the confluence of several headstreams. It flows southwestward across northern Georgia to West Point, south of which its course forms the Georgia-Alabama and Georgia-Florida boundaries until it joins the Flint river at Chattahoochee, Fla., where the combined waters of the two streams form the Apalachicola river. Northeast of Atlanta, Buford dam forms Lake Lanier, a popular recreational centre which serves as a storage reservoir and regulator of Atlanta's water supply. West Point, 235 mi. from the Chattahoochee's source, is the northernmost of a group of five large textile towns in the central Chattahoochee valley; the others are the Alabama towns of Lanett, Shawmut, Langdale and Fairfax. North of Columbus, Ga., are two hydroelectric dams: Bartlett's Ferry dam (145 ft. high, 1,975 ft. long) and the smaller Goat Rock dam. The Chattahoochee is navigable from Columbus to its mouth. Southeast of Columbus lies the Providence canyon area, created by severe dissection in unconsolidated sandy soils which has produced gullies as deep as 300 ft. and as wide as 200 ft. South of Fort Gaines, Ga., stands the Kolomoki mound (57 ft. high and 56 to 66 ft. wide at the top), thought to be a prehistoric Indian burial ground. The Jim Woodruff dam spans the river 201 mi. from West Point, where the Chattahoochee joins the Flint.

(M. C. P.)

CHATTANOOGA, a city of Tennessee, U.S., on the Tennessee river at the southern boundary of the state adjoining Georgia, is the seat of Hamilton county and is in the geographic centre of the Tennessee Valley authority's (TVA) development area. Pop. (1960) city 130,009; standard metropolitan statistical area (Hamilton county in Tennessee and Walker county in Georgia) 283,169. (For comparative population figures *see* table in TENNESSEE: *Population.*)

Chattanooga is known for its scenic and historic sites. Within the city limits is Missionary ridge, which affords an impressive vantage point. Nearby Lookout and Signal mountains offer unusual views including Moccasin bend and the canyon of the Tennessee river. Detached sections of the Chickamauga and Chattanooga

National Military park on Orchard knob. Missionary ridge and Lookout mountain are in the city's environs although the main part is nearby in northern Georgia. Ascending Lookout mountain is a steep-incline railway. Inside the mountain is a cave with a 145-ft. waterfall and atop are the gardens and odd rock formations of Rock City.

Approximately 7 mi. by river above Chattanooga is the TVA dam which impounds the water of 59-mi.-long Lake Chickamauga, a centre for boating, swimming, fishing and other outdoor sports.

History.—During the American Revolution and the years following, the Chickamauga Indians, a splinter tribe of the Cherokee, roamed from their strongholds on the river to bring war to the southeastern frontier. After their destruction in 1794 the Cherokee, who rapidly became highly civilized, dominated the region. About 1815 John Ross (*q.v.*), later a Cherokee chief, established a landing on the river in what is now downtown Chattanooga, which became known as Ross' Landing. Brainerd mission, located about five miles from the landing, was opened in 1817 by the American Board of Commissioners for Foreign Missions and continued service to the Cherokee until the removal of the latter to Indian territory (now Oklahoma) in 1838.

Even before removal was effected settlers began moving into the area of Ross' Landing, which they renamed Chattanooga, the aboriginal name for Lookout mountain; it means "rock rising to a point." In 1839 Chattanooga was incorporated as a town; in 1851 the state legislature granted a new charter and complimented the community by designating it a city. The settlement benefited from its location on the river but the construction of railroads in the 1850s was more important in its development. In 1860 the population numbered 2,545, but because of its junction position the community was more important than this size might indicate. The following year the city voted with Tennessee to secede although the county, like most of eastern Tennessee, favoured remaining in the union.

In 1863 the town and environs became the site of the battle of Chickamauga (*q.v.*) and the campaign for Chattanooga (*see* CHATTANOOGA, BATTLE OF). A national cemetery was dedicated that year and four years later, a Confederate burial ground. At the end of hostilities many veterans of both armies settled in Chattanooga and helped foster an early spirit of reunion. In 1877 David M. Key of Chattanooga was appointed postmaster general by Pres. Rutherford B. Hayes and thus became the first southerner and former Confederate officer to hold a cabinet post in the federal government. Adolph S. Ochs (*q.v.*), through the columns of his paper, strongly encouraged a balanced economy for the new south and helped to eliminate the past bitterness. The Chickamauga and Chattanooga National Military park, created in 1890, was dedicated in 1895 and during the Spanish-American War was used as a training centre. In 1904 a permanent post, Ft. Oglethorpe, was established just north of the park. It was an active installation until 1946 and was a training centre for both World Wars I and II.

For a number of years after the American Civil War the city placed its economic hopes in the iron industry but by 1900 it was evident that development in this field was not feasible and industry began to diversify. The growth of the textile industry, the insurance business and the bottling of Coca-Cola, a process which originated in the city, gave momentum to that trend.

The creation of the Tennessee Valley authority on May 18, 1933, was of major significance to the city. Authorized by referendum in 1935, the municipally owned Electric Power Board of Chattanooga was established to distribute energy in the area and purchased the facilities of the privately operated company. After that date the use of electrical power multiplied many times and electrical heating and cooling of homes became general. TVA flood-control measures protected the city from major inundations; barge traffic supplemented other carrying facilities; and new recreational opportunities based on the lakes were provided. A major urban-renewal project and a system of freeways were further developments.

Transportation and Industry.—The site of Chattanooga, always an important transportation centre, is at the intersection of several highways. It has good rail and air service and the 9-ft. channel of the Tennessee river is navigable all year for barge traffic. Travel facilities combine with the scenic and historic attractions in a multimillion-dollar tourist business. Three large insurance companies have home offices in the city. Principal industries are the manufacture of textiles, steam boilers, nuclear reactors, gas, coal, electric stoves, plumbing supplies, farm implements, machinery, bathtubs, soil pipe, structural steel, furniture, chemicals, paper, glass bottles, ceramic products, cement, beverages, medicines and candy.

Education and Cultural Activities.—Interest in cultural affairs is manifest in the opera association, the symphony, the little theatre and the Hunter Art gallery. In addition to public schools the educational institutions include three private schools, Baylor and McCallie for boys, and Girls' Preparatory, as well as parochial schools. There are two church-related colleges, Southern Missionary college at nearby Collegedale, founded in 1916 and controlled by the Seventh Day Adventists, and Tennessee Temple college, begun in 1946 and supported by the Highland Park Baptist church of the city. The University of Chattanooga, established in 1886, is a private coeducational institution; Cadek Conservatory of Music and Chattanooga college (an evening college) are two of its divisions.

See G. E. Govan and J. W. Livingood, *The Chattanooga Country, 1540–1951: From Tomahawks to TVA* (1952). (J. W. Li.)

CHATTANOOGA, BATTLE OF, a decisive engagement of the American Civil War fought in late Nov. 1863. The city of Chattanooga, on the Tennessee river, had strategic importance because it was the junction point of railroads to Atlanta, Ga., and Memphis, Nashville and Knoxville, Tenn., all vital connections for the Confederacy. In Sept. 1863 Gen. William S. Rosecrans, commanding the Federal army of the Cumberland, had maneuvered Gen. *Braxton Bragg* and his army of Tennessee out of the city without a fight. But *Bragg*, reinforced by troops of Gen. *Joseph Johnston* and Gen. *James Longstreet*, had turned on him at Chickamauga, Ga., on Sept. 19–20 and swept him and his staff back into Chattanooga. Only the firm stand of Gen. George H. Thomas (the "rock of Chickamauga") had prevented a rout of the Federal army.

Bragg failed to follow this victory with an assault on Chattanooga which, his critics argue, would most certainly have been successful. Instead he took up positions on Missionary ridge and Lookout mountain with outposts on Raccoon mountain, from which he controlled the river, the main roads and the railroads into the city. There he waited for Rosecrans to be starved into withdrawal or surrender. To bring supplies from Bridgeport, Ala., less than 30 mi. away, Rosecrans relied upon a 60-mi. route through the Sequatchie valley, parts of it steep and mountainous, much of it wet and muddy and exposed to frequent Confederate cavalry raids. But the Union had no intention of surrendering Chattanooga without a fight. On Oct. 16, Ulysses S. Grant became commander of the newly created division of the Mississippi. A week later he was in the city, where Thomas had succeeded Rosecrans. He directed the campaign to relieve the besieged army, reinforce it and seize the offensive. On the night of Oct. 26, on pontoon boats built in Chattanooga, 1,500 troops floated down the river, slipped past the Confederate positions and gained a foothold on the southern bank of the river at Brown's Ferry, 3 mi. below Lookout mountain. They enlarged the bridgehead the next day and drove the Confederate sharpshooters from positions on nearby Raccoon mountain. The "cracker line" to the city was now open.

Gen. Joseph Hooker, who had brought Northern reinforcements by rail from the army of the Potomac, marched to the base of Lookout mountain. Meanwhile Gen. William T. Sherman was making his slow way from Memphis, rebuilding railroad as he came. *Bragg*, apparently feeling secure in his position overlooking the city, sent *Longstreet* with 20,000 troops, a third of his army, in a futile effort to drive Gen. Ambrose E. Burnside from Knoxville. By Nov. 23 Grant was ready to make his move. Sherman crossed the river at Brown's Ferry, marched east of Chattanooga, moved his troops across the river again, near Chickamauga creek, and assaulted the Confederate right at the northern end of Missionary ridge, but without notable success. Hooker then struck at the left flank of the Confederates on Lookout mountain. He fought his way up through fog and mist and in the "battle above the clouds" drove an inferior force from the position.

At 3:30 P.M. on Nov. 25 occurred perhaps the most dramatic and inexplicable event of the entire war. Two of Thomas' divisions moved out from the centre for what was intended to be a demonstration to assist Sherman. Ordered to take the Confederate rifle pits at the base of Missionary ridge, the men without further orders stormed up to the top and captured the crest. Possibly *Bragg's* men were demoralized by watching the build-up of Union strength in the valley below and by realizing that they could not depress their artillery sufficiently to sweep the bluecoats from the mountainside. Whatever the reason, the Confederate centre was broken and soon *Bragg* was in retreat into Georgia. Losses of men were less than at Chickamauga—5,824 Union and 6,667 Confederate—but the result was completely decisive, ranking in importance with Vicksburg and Gettysburg in the same year. The way was open for Sherman's march to Atlanta and on to Savannah in the following year. *See* also AMERICAN CIVIL WAR. (C. W. TE.)

CHATTEL, a term synonymous in English law with personal property (*q.v.*).

CHATTEL MORTGAGE, a transaction by which an owner of personal property transfers the property to a creditor for the purpose of securing payment of the debt (*see* MORTGAGE). A chattel mortgage should be distinguished from a pawn or pledge (*see* PAWNBROKING). In the former, only title is transferred, while in the latter there is a transfer of possession. It may be distinguished from a conditional sale on the same grounds (*see* SALE OF GOODS; INSTALLMENT CREDIT; BILL OF SALE). Because of the danger of misleading other creditors and the opportunity for fraud, all states of the United States require that a chattel mortgage be recorded in some public office. (E. G. S.)

CHATTERER, the general name applied to the members of the family Cotingidae, South American woodland birds, feeding mainly on fruit; the best known are the brightly coloured cocks of the rock, umbrella birds and bellbirds (*qq.v.*). One of the most exotic of the cotingas is the pompadour chatterer, *Xipholena pompadora,* having brilliant raspberry-coloured hairlike plumage and white wings. Chatterer was once inappropriately applied to the waxwing (*q.v.*).

CHATTERJI, BANKIM CHANDRA (BANKIM-CANDRA CATTOPADHYAY) (1838–1894), Indian author, whose novels firmly established prose as a literary vehicle for the Bengali language and helped create in India a school of fiction on the European model, was born near Naihati in Bengal on June 27, 1838, of an orthodox Brahman family. He was educated at Hooghly college, at Presidency college, Calcutta, and at the University of Calcutta, of which he was one of the first graduates. From 1858, until his retirement in 1891, he served as a deputy magistrate in the Indian civil service.

Some of Bankim Chandra's youthful compositions appeared in the newspaper *Sambad Prabhakar*, and in 1858 he published a volume of poems entitled *Lalita O Manas*. For a while he wrote in English, and his novel *Rajmohan's Wife* appeared serially in *Indian Field* in 1864. His first notable Bengali work was the novel *Durgesnandini*, which features a Rajput hero and a Bengali heroine. In itself it is of indifferent quality, but, in Tagore's words, it took "the Bengali heart by storm," and with it the Bengali novel was full born. *Kapalkundala,* a love story against a gruesome background of Tantric rites, was published in 1866; and *Mrinalini,* which was set at the time of the first Muslim invasion of Bengal, in 1869. *Banga Darshan*, Bankim Chandra's epoch-making newspaper, commenced publication in 1872, and in it some of his later novels were serialized. *Bishabriksa,* which poses the problem of widow remarriage, and *Indira* were published in 1873; *Yugalanguriya* in 1874; *Radharani* and *Candrasekhar* in 1875; *Rajani* in 1877; *Krishnakanter Uil*, which the author considered his greatest novel, in 1878; *Rajsimha,* a story of Rajput heroism and Muslim oppression, in 1881; *Anandamath*, a patriotic tale of the revolt of the sannyasis against the Muslim forces of the East India company, in 1882; *Debi Caudhurani*, a domestic novel with a background of dacoity, in 1884; and finally, in 1866, *Sitaram,* a marital tangle and a struggle of Hindus against Muslim tyranny. To *Banga Darshan* Bankim Chandra also contributed articles on religious, historical, scientific and other subjects. His later writings include *Kamalakanter Daptar* (1885), a collection of serious and humorous sketches by a drug addict; and *Krishnacarit* (1882) and *Dharmatattva* (1888), essays on religion and political science.

Bankim Chandra's novels are exciting to read, but structurally they are faulty. Serial publication was partly responsible for imperfect integration of the various episodes. Evolution of plot depends too frequently on chance or supernatural intervention, and characterization is often subordinated to an overriding didactic purpose. His achievements, however, outweigh these technical imperfections. To his contemporaries his voice was that of a prophet; his valiant Hindu heroes aroused their patriotism and pride of race. He taught that orthodox Hinduism, cleansed of excesses, was undeniably the religion of India, well able to prevail against the doctrines of Christianity and the Brahmo Samaj. In him nationalism and Hinduism merged as one; and his creed was epitomized in the song Bande Mataram ("Hail to thee, Mother") —from his novel *Anandamath*—which later became the *mantra* ("hymn") and slogan of Hindu India in its struggle for independence. He died on April 8, 1894. *See* also BENGALI LITERATURE.

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CHATTERTON, THOMAS (1752–1770), England's chief poet of the Gothic revival and youngest writer of mature verse, was born posthumously at Bristol on Nov. 20, 1752. His father had been schoolmaster of Redcliffe and subchanter in the cathedral—a man proud and dissipated, toying with magic and collecting books and Roman coins; his widowed mother, who opened a little sewing school, was a nonentity, and his sister's mind was periodically deranged. He had a tearful childhood, choosing the solitude of an attic and making no progress with his letters; yet his playmates accepted his illusion of being their chief, and when five he asked a potter to paint on a promised cup an angel with a trumpet "to blow his name about." Over the street was the incomparable church of St. Mary Redcliffe, where his uncle was sexton; Chatterton moved in the old aisles with solemn self-deception, aloof from his family and an anachronism in a bustling city. Suddenly, he could read and write far in advance of his years; the means were all old—music folios, a black-letter Bible, and Redcliffe muniments filched by his father. There began his voracious scribbling; dying at 17, he yet left over 600 printed pages of verses, besides prose pamphlets and letters. At seven, he was entered at Colston's school, on the site of the Whitefriars and with every boy tonsured like a little monk, yet a spartan place turning out tradesmen, craftsmen and mariners, with nothing in its curriculum save writing, accounts and formal religion; he acquired no language but English, and all his humane studies were pursued independently. Yet his first known poem, "On the last Epiphany," published in the local newspaper when he was ten, is a scholarly little piece, with Miltonic echoes tempering the trite hymnody; "A Hymn for Christmas Day" (a little later) uses the same vocabulary, in skilful stanzas, for a clear yet paradoxical statement.

In 1763 he produced his first individual poem, satirizing a Redcliffe churchwarden for destroying a medieval cross; slight as it is, it puts a boy of 11 in the van of the Gothic return, along with "Ossian" (1762–63), *The Castle of Otranto* (1764) and Percy's *Reliques of Ancient English Poetry* (1765). He was drawing too, concocting rough but enthusiastic architecture and heraldry, and salvaging from his mother's dressmaking patterns any Redcliffe archives with writing on them. This was the next stage of the mischief. He was perhaps no more than 11 years old when he showed a Colston's usher an old parchment inscribed with the pastoral eclogue "Elinoure and Juga," supposedly of the 15th century; it was, indeed, in rhyme royal, but with help from Spenser in the final Alexandrines, and from Gray and Milton in the doleful music, which shines through its spate of added *-e* endings, its vowels changed at whim, and its words culled or coined haphazardly. Fatally, it deceived its readers, and thereafter a merely puerile deception, to mystify and impress, became a separate poetic current, so that Chatterton's output is best treated in two parts, the antiquated and the acknowledged.

Out of his loneliness and his dreams, he erected a past that was an allegory of his present, set near Our Lady on the Red Cliff in the 15th century; its hero and interpreter was the fictitious Thomas Rowley, a gentle, dreamy priest, with a patron such as Chatterton never found. Just when Thomas Rowley was invented is uncertain; the idea must have been long germinating, and the name is from a civilian's brass at St. John's, Bristol, but he comes to full life as confessor and secretary of the authentic William Canynges, with the additional duty of collecting antiquarian documents and pictures. Further, a pleasant coterie gathered round Canynges, writing one another verses and taking parts in Rowley's plays. Too much has already been said, in sheer mockery of the bogus Middle English, in Skeat's 1871 edition, which insensitively modernized the spelling and replaced fine ghost words (*i.e.*, pseudoarchaisms of Chatterton's own coining) by Victorian rationalizations, thereby effacing the music. It is admittedly true that Rowley's calligraphy lacks contractions and has too many capitals; metrically he anticipates Spenser, Surrey, and (in "Battle of Hastings") the unlikely Pope; his rhymes are often correct only to modern ears or made correct by wrenchings of spelling, grammar and vocabulary; his syllable counting is too modern for his century; and "so haveth I" was the idiom of no age or dialect. Rowley's diction is likewise full of glaring revelations of his method: he adopted the blunders of recent glossaries; and ten Anglo-Saxon words from William Somner's 1659 dictionary, all suspiciously beginning with *a*, occur in "The Ryse of Peyncteynge yn Englande," sent to Horace Walpole. Yet Somner, peeps at Chaucer and odd excerpts from *The Faerie Queene* proved too slow a vehicle, so the indifferent dictionaries of John Kersey and Nathan Bailey were recruited, with any alteration that poetry demanded. The Rowleian canon is full of happy plagiarisms, such as a song in *Ælla* remembering one in *Hamlet*, and fragments from as far apart as *Chevy Chase* and Nicholas Rowe.

All this is mentioned because, marvelously, the young poetry bursts through these musty tricks without further inhibition. Into the Rowley poems Chatterton threw all his genius, and they, not his cross-grained satires, mark him as an early romantic, a pioneer in metrics and sentiment. Were they merely contemporary poems in period dress, they would still have their music, pathos, nostalgia and warmth, and the racked pride of their heroes. But, more, they catch the authentic spirit of Rowley's age; unlike the Gothic mutterings of the early revival, Chatterton speaks out here with understanding, using his antique jargon for a whole and fastidious vision of the landscape of poetry. The best of balladry sits with Syr Charles Bawdin on his sledge in the "Bristowe Tragedie," where "syx mynstrelles . . . tun'd the strunge bataunt," that noble but unknown instrument. In the play *Ælla*, one can almost believe that Chatterton was no longer composing in English and translating into Rowleian; the language is as consistent and credible as the thesis that Bristol was the headquarters of resistance to the Danes. The characters, too, develop organically in a mere 1,250 lines: Ælla with his tragic flaw of impetuosity, Celmonde destroyed by lust yet dying brave and repentant (so that his "O! I forslagen be!" is silly only to the pedant), Hurra the chivalrous foe, Birtha all womanly. Varied riches of revelry, victory, abduction, suicide are conveyed in many metres, including lyrics where Rowley almost reaches his heights. One shows the metrical dexterity of alliteration and internal rhyme in the line "Comme, wythe acorne-coppe & thorne"; in another, a boy of 15, of no poetic "school," declares that "Wommen bee made, notte for hemselves, botte manne, Bone of hys bone, and chyld of hys desire." And Ælla's address to his troops, beginning importantly in the cleared air of a new scene, "Now havynge done oure mattynes & oure vowes," continues for nearly 100 lines of sustained pride and passion that illuminate the twofold mystery and tragedy of Chatterton's anonymity and suicide. *Ælla* ranks Chatterton among poets; the other Rowleiana have the same gusto put to less purpose, and though one can still share the poet's delight in Redcliffe church, "The pride of Brystowe and the Western lande," he apparently made little systematic study of medieval antiquities, getting half-digested material from such things as Weever's *Ancient Funerall Monuments* and Verstegan's *A Restitution of Decayed Intelligence.* He appears earliest as a metrical innovator in "The Unknown Knight," where he rediscovers the principle of equivalent substitution of feet in couplets of four-stress lines, known in the middle ages, alive in Spenser, but tidied away by 18th-century pens until its supposed "new" appearance in Coleridge's *Christabel* at the close of the century. All these skills were certainly Chatterton's own; there was no tutor, friend or talented parent to help with his effusions, and it is clear that the music of his poetry was a rhythm natural to him and easily acquired from others, so much so that even in a factual letter of 1768 "a very good Mistress of Nature to discover a *demon* in the habit of a parson" has a Shakespearean cadence that may come from a speech of Edmund's in the second scene of *King Lear.*

Meanwhile, on July 1, 1767, he was apprenticed to John Lambert, a Bristol attorney. It was a menial and empty job, tying him to a lonely office for 12 hours daily with no duties save copying legal precedents. He ate with servants and slept with the footboy. His two hours' evening freedom and what he was allowed of Sunday were spent at home, or roaming the scenic spots and antiquities near Bristol, or with a little circle of young bucks and scribblers; he also mentions actors at the Theatre Royal and may sometimes have escaped early enough to attend. But his working day passed mainly in his own creative writing, which could be turned to a little profit in the pages of *Felix Farley's Bristol Journal* and to rather more from three Bristol gentlemen who credited and welcomed the works of Rowley; their motives were variously antiquarian research (for which "A description of the Mayor's first Passing over the Old Bridge" was obligingly discovered), crude curiosity and a desire for family trees, and their influence led to forgery and mystification rather than to inspiration. *Felix Farley*, of course, and *The Town and Country Magazine* wanted up-to-date contributions in verse or prose, and the acknowledged works now began to oust Rowley. Chatterton's amatory verses, sometimes written for other youths, are addressed to girls with cacophonous names, and a pretense of love struggles through acrostics, the Pantheon and the Muses; Sally Clarke would have charmed Saul on the harpsichord, but the latest poems contain some impudent and sinister stuff.

In his elegiac poems he is at his worst, and even a friend sincerely mourned, the usher Thomas Phillips, is given a fulsome treatment of the "deathy tomb," and the "pitchy vapour," the pathetic fallacy and an affectation of utter despair; changes between drafts of the poem suggest falseness—"cheerful" becomes "frugal," and "friendship's potent spells" become "necromantic spells." Even his poem on a suicide, which perhaps suggested the form of his own, contains the deplorable line, "The blood-stained tomb where Smith and comfort lie." Yet the elegies not of mourning have a Gothic quality; one even parodies the Gothic mode with adders, meteors, cataracts, blasted oaks and the snap ending "lady Betty's tabby cat is dead." Nearer to his taste are the African landscapes (in his "African Eclogues"), where his imagination brims to wild, hectic scenes and, far ahead of his time, to the horrors of the slave system; the juvenile ferocities are deserved, and Gaira, whose beloved has been stolen by the whites, can cry, "O could I throw my javelin from my eyes!" The landscape, often conventional, is still sharply defined at moments, such as when the hero "gained a mountain glaring with the dawn."

As for his satires, his bulkiest work and the main occupation of his last days, they may now seem brilliantly precocious exercises in unmeant fury, their rolling oratory derived from Charles Churchill, their quips tedious, their political sentiments ephemeral, their asterisked names unintelligible. Yet now and then the poet brushes aside the hack, and even in the filthy *Exhibition* there is a wistful glance (from his final sojourn in London) at a Bristol evening "Flying on silken wings of dusty grey." There is admirable wit in "Kew Gardens," when he hints at Ossian: "Alas! I was not born beyond the Tweed!"; realism in "February," when, after some zodiacal stuff, "the spruce mercer trembles in his shop"; and always the gift of phrase—"the drilling rain," the enraged dowager who "dined upon her nails."

In his now irksome life, other dangers began to jostle: free thought, Wilkesism, contempt for Bristol and his dowdy family, a philandering attitude to local girls, and the "death" of Rowley. Dodsley the publisher did not rise to a bait, apparently never answering Chatterton's letter offering some of Rowley's manuscripts; Horace Walpole did and was the more severe when he was advised by friends that the manuscripts were modern. Chatterton rewarded him with bitter yet noble lines. By a mock suicide threat (the "Last Will and Testament—of me, Thomas Chatterton of the City of Bristol"), he forced Lambert to release him from his indentures, and set out for London with a few guineas, to storm the city by satires and pamphlets. A naughty, swinging burletta, *The Revenge,* was decently paid for, but the ruin of his chosen party and the death of a prospective patron quenched his hopes. Only one friend came to comfort him—his own creation Rowley, with that most pathetic of his poems, "An Excelente Balade of Charitie"; and with little left but his pride Chatterton took arsenic in his garret in Brooke street, Holborn, on the night of Aug. 24, 1770.

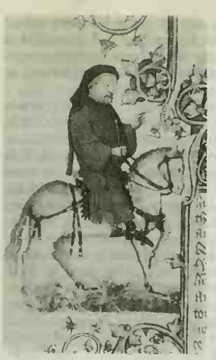
The aftermath was fame. After controversy between the "Rowleians" and those who rightly saw Chatterton as the sole author, came the just tributes of many poets: Coleridge wrote him a "Monody," Wordsworth saw him as "the marvellous Boy," Shelley gave him a tearful stanza in "Adonais," Keats dedicated "Endymion" to him and was greatly influenced by him; Crabbe, Byron, Scott, Rossetti and various poetic endeavourers added their praise. In France the romantics hailed his example, and Alfred de Vigny's absurdly inaccurate play *Chatterton* was the model for an opera by Ruggiero Leoncavallo.

BIBLIOGRAPHY.—E. H. W. Meyerstein, *A Life of Thomas Chatterton* (1930), a brilliant 600-page account of the poet and his poetry, superseding all previous studies. *The Works* were first properly edited by R. Southey and J. Cottle (1803); the editions normally used are by W. W. Skeat (1871) and Sidney Lee (1906). *The Exhibition* is printed only in Esther P. Ellinger, *Thomas Chotterton, the Marvelous Boy* (1930). An important body of cuttings and plates is in British museum library C. 39. h. 20 (1). (A. B. Co.)

CHATTI, a powerful German tribe who in the 1st century B.C. lived near the upper Visurgis (Weser) river, from whom the modern German *land* of Hesse derives its name (*Hessi* or *Hassi* being identified with Chatti). They soon expanded across the Taunus mountains to the Moenus (Main) river valley. The Chatti defeated the Cherusci (*q.v.*) and became the most dangerous German opponents of the Romans during the 1st century A.D.; in 83, however, the emperor Domitian drove them back from the Taunus and constructed his *limes* (defensive frontier line) up the Lagona (Lahn) river and across to the Main. They were allies of the rebel governor of Upper Germany, L. Antonius Saturninus, in 89 and raided Roman territory in 162, 170 and 213. They were perhaps incorporated in the coalition of the Franks in the 3rd century A.D.

See Tacitus, *Germania.* (G. E. F. C.)

CHAUCER, GEOFFREY (*c.* 1340–1400), the great English poet, was born *c.* 1340, probably in London. His father and grandfather were prosperous vintners, who at times held offices connected with the king's court. The family derived from Ipswich, Suffolk, but Chaucer's father moved to London, became a prominent citizen and at one time lived in Thames street, where Chaucer may have been born. The first record of Chaucer himself, however, is in the account book of Elizabeth, countess of Ulster, for 1357, which shows him as a page in her service. Nothing is known of his education, but he may have attended a grammar school. Either formally or informally he learned Latin and French, and as a page he would be instructed in courtly behaviour and in bearing arms. In 1359 he served on a military expedition in France and was taken prisoner near Reims, being ransomed soon after. It is possible, as J. M. Manly has suggested (see *Bibliography,* below), that he then spent some time studying at one of the Inns of Court in London, where a good though expensive general and legal education suitable as a preparation for a career at court was given to the sons of nobles and rich men.



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EQUESTRIAN PORTRAIT OF CHAUCER. MINIATURE ILLUSTRATION FROM THE ELLESMERE MANUSCRIPT. IN THE HUNTINGTON LIBRARY, SAN MARINO, CALIF.

By Sept. 12, 1366, he had married Philippa, to whom at that date a payment was made as one of the queen's ladies in waiting. She was probably the daughter of one of the queen's knights from Hainaut, Sir Payne Roet. Philippa, on the death of the queen in 1369, became for a time lady in waiting to John of Gaunt's second wife, Constance, queen of Castile, and probably died late in 1387. Her sister Catherine, after the death of her husband Sir Hugh Swynford in 1372, became governess to John of Gaunt's children, then his mistress and finally, in 1396, his third wife.

This close family connection with Gaunt, who was the third surviving son of Edward III and uncle of Richard II, no doubt benefited Chaucer beyond the gifts occasionally recorded to him and his wife, but in his middle years at least Chaucer in political matters seems to have belonged to the "king's faction" or "court party" (led by Sir Simon Burley, tutor to Richard II) rather than to Gaunt's Lancastrian faction. On June 20, 1367, Chaucer was granted an annual salary of 20 marks (£13 6s. 8d.) as one of the four *valecti* ("yeomen of the chamber") of the king's household, and in the following year he was appointed one of the king's 40 esquires, a position he retained till 1378 or later. Among the varied political and social duties attached to this position was that of entertaining the court with stories, songs and music. In 1369 John of Gaunt's wife, Blanche, duchess of Lancaster, died and Chaucer composed an elegy of 1,334 lines in octosyllabic couplets in her honour. In 1368, 1369 and 1370 he made trips abroad on the king's business, to France and possibly to Italy. On Dec. 1, 1372, he left on a longer journey as one of three commissioners to negotiate a trade agreement with Genoa and also, on his own, to perform a secret mission to Florence. It was presumably on this journey that he acquired that knowledge, perhaps unique in England at that time, of the Italian works of Dante and Boccaccio that was to become so important for his poetry. He returned in May 1373. In April 1374 he was granted a pitcher of wine daily, and on May 10 he obtained the lease of the dwelling house above the city gate of Aldgate, both probably made along with a new appointment, as comptroller of the customs and subsidy of wools, made on June 8, 1374, at £10 a year, with annual gratuity of £6 13*s.* 4*d.* (multiply at least 60 times to get the rough modern equivalent; the modern equivalent in U.S. dollars of the £10 being thus roughly $1,680). Five days later he received an annuity of £10 for life from Gaunt. His prosperity was increased by other fees and rewards, which testify to his competence and the favour he enjoyed. He retained this appointment till 1386, and in these 12 years, during which he was responsible for personally performing such duties as keeping the accounts, he went abroad several times to France and once to Italy on ambassadorial missions and royal marriage negotiations. In the same period he probably composed *The House of Fame, The Parliament of Fowls, Troilus and Criseyde* and minor works, besides translating Boethius' *De consolatione philosophiae.* Two sons (all that is known of his family) were probably also born to him during this time. A reference to his daily accounts and his evening reading in the earlier part of this period is found in *The House of Fame,* II, 641–660. In 1382 he was made in addition comptroller of the petty customs; he was allowed to appoint a permanent deputy, a privilege he also applied for in 1385 for his main comptrollership. He was appointed justice of the peace for Kent in Oct. 1386 and in Aug. 1386 knight of the shire to attend the parliament held in October.

Probably in 1385 he went to live in Kent. The house over Aldgate was leased to another man in Oct. 1386, and in December he lost his two comptrollerships, probably as a result of the shift of power from the friends of the king to the so-called lords appellant (*see* RICHARD II) who later were responsible for the death of several of Chaucer's friends and associates. Chaucer lived quietly for the next two or three years, possibly going to Calais for a time in 1387, and apparently short of money, for he began to be sued for debt in April 1388, and he sold his crown pension for a lump sum at about the same time. In May 1389 Richard II reasserted himself against the appellants and on July 12 Chaucer was appointed clerk of the king's works, responsible for maintaining the Tower, Westminster palace and other buildings. In 1390 he was responsible for erecting the scaffolding for the famous jousts at Smithfield and in the same year served on a commission to survey the banks of the Thames between Woolwich and Greenwich. In September he was robbed on journeys near London two or three times in four days, losing £20 of the king's money. Some time before June 22, 1391, he was appointed deputy-forester of the royal forest of North Petherton, Somerset; he relinquished his clerkship on June 17, 1391. In the last decade of the century Chaucer received among other gifts an annuity of £20 in Feb. 1394 from the king and Christmas gifts from Henry, earl of Derby (son of John of Gaunt and the future Henry IV), so that he was probably not poor, though small borrowings from the exchequer suggest that he may have been short of ready money. A suit against him for debt in 1398 seems to have arisen out of transactions during his clerkship and he obtained letters of protection for two years. When Richard II was deposed and Henry IV was received as king on Sept. 30, 1399, Chaucer, like nearly everyone else, acquiesced in the change and he addressed the new king in a graceful, witty poem entitled *The Complaint of Chaucer to his Purse*. He was rewarded in October by a new annuity of 40 marks (more than £16), and by the confirmation of his former grants from Richard. In Dec. 1399 he took a lease of a house in the garden of Westminster abbey, and probably in Oct. 1400 he died. He was buried in the abbey, a signal honour for a commoner, and his tomb, still to be seen, became the nucleus of the later Poet's corner.

These details of a successful career as courtier, diplomat and, to use a modern term, "senior civil servant" are supplemented by a very few autobiographical remarks in Chaucer's own poetry. The passage in *The House of Fame* already referred to is the fullest. The confession of unsuccessful love at the beginning of *The Book of the Duchess* is mere literary convention. Chaucer introduces himself into several other poems, notably *The Prologue to the Legend of Good Women* and *The Prologue to Sir Thopas* in *The Canterbury Tales*. The first passage tells of his devotion to books, except in the springtime; the second presents him half-jokingly as fat, silent, downlooking, strange. His opinions, to judge from the poems, were, like Shakespeare's, those of his time: orthodox, respectable and devout; it is his genius which is unique. There are no contemporary comments on his personality, unless we except John Lydgate's remark that he had heard that Chaucer was no carping critic of other poets (C. Spurgeon (ed.), *Five Hundred Years of Chaucer Criticism and Allusion*, vol. 1, p. 25; 1925). There are a few miniature portraits in manuscripts, all made after his death. The most authentic is the likeness his friend and literary disciple Thomas Hoccleve caused to be made in what is now the British museum manuscript Harley 4866. It shows Chaucer a little plump, with gray hair and two-pointed beard, in black hood and gown, holding beads, and with a calm, serious expression. The most interesting portrait occurs in the frontispiece to the manuscript of *Troilus and Criseyde* in Corpus Christi college, Cambridge, which shows a younger Chaucer with brown beard reading a poem from a wooden pulpit to a brilliant company, centred on the young Richard and his queen.

WORKS

The *Troilus* frontispiece shows the essential nature of Chaucer's audience and mode of publication. He wrote primarily for a relatively small group (of which he was himself a respected member) of the most important and cultured people in the land, and his poems were in the first instance read aloud to this highly sophisticated courtly audience. They were also disseminated in manuscript for a somewhat wider audience in court and city, and among country gentry. None of these contemporary manuscripts survives. In the 15th century the poems were copied and recopied, and it is from copies of copies that Chaucer's original must be reconstructed. *The Canterbury Tales* was always the most popular of his works and there are 84 full manuscripts or fragments, of which the Ellesmere manuscript (in the Huntington library, California) is the best; there are 20 manuscripts of *Troilus*, 14 of *The Parliament* and 3 each of *The Book of the Duchess* and *The House of Fame*. Chaucer gives lists of his works in *The Prologue to the Legend of Good Women*, the *Introduction to the Man of Law's Tale* and in the *Retractation* at the end of *The Canterbury Tales*. With the aid of these and internal evidence, such as astronomical references and the use of sources, the canon and chronology of his works can be stated with fair but not complete certainty.

The Book of the Duchess is one of the few poems with a certain date, since it commemorates the death of the duchess Blanche in 1369. The indirect narrative mode establishes a delicate tone of feeling, in which sorrow and praise unite with tenderness, and yet there is no intrusion on Gaunt's personal grief. The blend of gladness for what the lady was and sorrow for her loss is characteristic. The poem is somewhat too discursive, but even this fault (shared with *The House of Fame*) has its compensation in providing a kind of personal richness which is absent in the later, more disciplined works.

The House of Fame, 2,158 lines long but unfinished, is written in the same rather rough octosyllabic metre as *The Book of the Duchess*, and although it shows a knowledge of Dante and Boccaccio it is still, like the earlier poem, close in type to the French love vision. It is remarkable for the autobiographical passage already mentioned, and for the delightful comedy of book ii, when an eagle carries the alarmed poet high into the sky and delivers a lively lecture on the physical properties of sound. Chaucer describes himself here for the first time, as he always did later, as an outsider in the affairs of love, yet interested in love above all things. The combination of many subjects, the mingling of light and serious moods, make the poem strikingly unusual, for all its dependence on tradition. It was probably written between 1374 and 1382.

The Parliament of Fowls, 699 lines long, was probably written toward the end of the same period. The summary of Cicero's *Somnium Scipionis* at the beginning gives the story of the love vision and love debate a ground note of philosophical inquiry. Chaucer's new Italian reading, especially the *Teseida* of Boccaccio and the *Inferno* and *Purgatorio* of Dante, has here been much more fully assimilated. *The Parliament* is the most successful of the poems of Chaucer's early maturity, rich in bright description and in implication. The tone is light and vigorous; it includes without loss of unity touches of self-mocking description, Scipio's vision among the stars, a luscious description (from the *Teseida*) of Venus and the speeches of the birds' debate, variously noble, courtly, downright, racy, cynical. All the narrative and dramatic variety centres on the problem of love, that universal medieval theme.

The House of Fame and *The Parliament of Fowls* have often been taken as poems written in connection with events at court (as *The Book of the Duchess* certainly was), or as veiled petitions for reward. The most popular of such theories associates *The Parliament* (of which the pivot is a refusal to marry) with the marriage of Richard II and Anne of Bohemia in 1383, though a number of other occasions have also been suggested. Chaucer does make occasional undisputed references to contemporary persons, such as that to the duchess Blanche, or to the queen (in *Troilus* i, 171), or as a special case in *The General Prologue* to *The Canterbury Tales*; but no conclusive evidence has ever been produced to prove that *The House of Fame* and *The Parliament* are allegories of events at court, or that they are petitions for reward. That they may be so remains always a possibility, but in the present state of knowledge such possibilities add little to appreciation of the art and value of the poetry.

The depth of Chaucer's art was increased by his intimate knowledge of Boethius' *De consolatione philosophiae* which he translated from the Latin, probably in the early 1380s. This noble work, one of the most famous in Europe from the 6th to at least the 16th century, deeply affected Chaucer's thought on those problems of God's foreknowledge and man's free will, of fortune, suffering and destiny, which so constantly interested him. *The Consolation* is one of several long pieces of prose translation from Latin or French sources that bear witness to Chaucer's serious interests. Another is *The Astrolabe*, an unfinished elementary treatise on astronomy written in 1391 for his little son Lewis. *The Equatorie of the Planetis*, a more advanced astronomical treatise (ed. by D. J. Price, 1955), may also be by Chaucer and the manuscript may even be in his own hand. The somewhat tedious *Melibeus* in *The Canterbury Tales* is a serious treatise on social and personal justice, on the need to love God, to obey the law, etc. *The Parson's Tale*, which concludes *The Canterbury Tales*, is an immense sermon on penance, containing, among much else, a treatise on the seven deadly sins. These translations remind us of the serious, orthodox bases of Chaucer's attitude to life.

Troilus and Criseyde.—*Troilus and Criseyde* probably followed closely after, or was contemporary with, the translation of the *De consolatione*, whose influence pervades the poem. The *Troilus*, which seems to have been completed by 1385, is 8,239 lines long, written in the same "rhyme royal" stanza form as *The Parliament*, and divided into five books. It is a work of full maturity and arguably Chaucer's greatest; rich in vivid realistic touches and convincing dialogue, yet learned and magnificent; noble, tender and sympathetic, yet humorous, even with a touch of cynicism. Everywhere it is penetrated by Chaucer's compassionate and keen observation of the contradictions of earthly life that give rise both to humour and tragedy. Before Chaucer, Troilus had been long famous in medieval times as a lover whose love was betrayed and whose fate was part of the fate of Troy, of whose warriors he was supposed to be among the best. Boccaccio had taken the various episodes of his story scattered through the long medieval accounts of the Trojan War and retold it, with some changes, in a single swift passionate plot in his poem *Il Filostrato*. Here Criseida is a rich and amorous young widow, and Troilo a full-blooded young man whose passionate affair with Criseida is helped on by Criseida's cousin Pandaro. Chaucer's adaptation of this vivid sensual poem has been much studied, for though he followed Boccaccio's story in outline, translating much of the actual Italian text, he added many details, either invented or taken from earlier accounts of Troilus' story, and he entirely altered the spirit of Boccaccio's poem. (It has been suggested by R. A. Pratt that he may have taken many hints from the French translation of *Il Filostrato* by Pierre de Beauvoir.) The first two books of *Troilus and Criseyde* describe in fascinating detail how Troilus falls in love with the reluctant Criseyde and how Pandarus, by somewhat shady dealing, brings her to love Troilus. The second book is especially delightful for its comedy of social intrigue. The third book, in which the love affair is consummated, continues the intrigue, but develops also a deeper tenderness and culminates in a noble philosophical song in praise of love. The fourth and fifth books tell how Criseyde is sent to join her father who has deserted to the enemy, and how "with wommen fewe, among the Grekis stronge," Criseyde is quickly wooed and won by "sudden Diomede," and breaks her faith to Troilus. After a period of misery Troilus is killed in the fighting; at the end his soul is carried into the heavens, from where he sees and laughs at the misery of this world. The poem's final stanzas are a condemnation of worldly vanity and a call to "yonge, fresshe folkes" to set their hearts on God.

Chaucer makes his Troilus more innocent, more courtly, than Boccaccio's Troilo. He makes Criseyde, on whom he lavishes all his art and tenderness, more delicate, timid, loving and vulnerable than Boccaccio's heroine, and without her ready wantonness. Chaucer turns Pandarus into a far more complex figure than Pandaro. He makes him into Criseyde's uncle, of uncertain age; still the most intimate companion of Troilus (who must be imagined to be about 20), and yet much more experienced than he. Chaucer further enriches his poem with innumerable touches and occasionally whole episodes (such as Pandarus' visit to Criseyde in book ii) of lively social detail, by which he elaborates character, feeling and event. He transports the reader into a peculiarly intimate vision of 14th-century courtly life. Even more, Chaucer deepens the scope of the poem with philosophical reflections, sometimes putting them into the mouths of the characters, sometimes expressing them in the course of the narrative or in the magnificent preludes to each of the five books. The result is a poem very different from Boccaccio's. Boccaccio uses his hero to convey his own feelings; Chaucer, on the other hand, is detached from, though deeply compassionate toward, his lovers as, for proper appreciation of the poem, the modern reader must be. Chaucer's poem is contemplative in spirit, and hence necessarily, in its richness, slow moving. If it has a fault, it is that we are made to dwell too long on Troilus' misery in the fifth book; but this is a defect of its virtue—the maturity of outlook which appeals to the reader who wishes to see life whole and steadily, rather than to one who wishes only to identify himself with the hero of an energetic story. The ending has been held to be, not without some reason, strange, inconsistent and artistically at fault; but it is better regarded as an extreme example of Chaucer's ambivalent view of the world as good in essence, because it was made by God, but also bad, in that it has been spoiled by man's sin. And although worldly pleasures are great, they are inextricably linked with misery, and cannot compare with the pleasures promised in heaven. This complex attitude is the key to the quality of much of Chaucer's greatness, for it enables him to respond keenly to the mixture of good and bad in the world, to be at the same time satirical and tolerant, to be compassionate without sentimentality, cheerful without insensibility, idealistic without absurdity and to contemplate with serenity whatever life offers.

The Legend of Good Women.—His next major poem, *The Legend of Good Women*, is something of a decline after the *Troilus*, though the prologue has great charm and several points of interest. After the famous passage about the poet's love of books and greater love of the spring, it tells of his devotion to the daisy—a charming example of the refined, literary and indeed rather precious 14th-century courtly sensibility. Then in a dream the god of love reproaches the poet for treating women badly in some of his writings, so the poet promises to write a series of stories about women who were faithful in love, "Cupid's saints." Chaucer may have projected as many as 25 of these stories, but only nine survive, the last unfinished. In one version of the prologue it is stated that they are to be presented to the queen. Most critics feel that they are at best patchy, and Chaucer himself may have tired of them. The prologue, with the poet's characteristically self-mocking presentation of himself, is unquestionably the most delightful part, and has also the interest of being an almost unique example of the poet's revision, for it exists in two versions. The first version (and probably the individual *Legends* as well) seems on internal evidence to have been written *c.* 1386, and exists in 11 manuscripts; the second, revised version was probably written *c.* 1395, and exists in only one manuscript. (The view presented here, though generally accepted, is opposed by some scholars who, like W. W. Skeat, reverse the order of composition.)

The Canterbury Tales.—By 1387 Chaucer had a few tales, like the early *Life of St. Cecilia* (which became *The Second Nun's Tale*) and the story of Palamon and Arcite (*The Knight's Tale*), which he must have wished to use in some larger scheme. Men in the 14th century liked collections of varied short stories. Chaucer's friend and contemporary, the poet John Gower, made one in English, the *Confessio amantis*, which Chaucer knew; and the most famous of a number of Italian collections is of course Boccaccio's *Decameron*, although there is no evidence that Chaucer knew it. Chaucer's own collection of short stories, *The Cant-*

erbury Tales, is unique in the variety of the tellers of the tales, in the vividness with which the tellers are described and in the developing dramatic relationships between tales and tellers. Chaucer planned a huge scheme. There were to be roughly 30 pilgrims (including the poet himself) described on a pilgrimage from the Tabard inn in Southwark, a suburb of London, to the famous shrine of St. Thomas Becket in Canterbury cathedral, and back again. Each pilgrim was to tell two stories going and two returning. But only 22 stories were in fact completed, including those that had been written earlier. The scheme obviously changed under Chaucer's hands, and Chaucer did not live long enough to revise completely even those sections he had more or less finished, though some of these sections had been circulated even before his death. It is impossible to date the individual tales precisely, save that with the exceptions already noted they mostly belong to the period after 1387.

The Canterbury Tales begin with the general *Prologue* of 858 lines of five stresses each, in rhyming couplets. After the deservedly famous opening lines describing the spring, in which the extremely conventional theme is treated with great freshness, he describes the group of pilgrims one by one in a series of brilliant brief portraits. The medieval ideal of the threefold structure of society—knighthood, clergy and plowmen—is represented by the noble portraits of knight and squire, parson and clerk, yeoman and plowman. Most of the other pilgrims are drawn from the miscellaneous variety of 14th-century society, both ecclesiastical and secular, which consciously or unconsciously evaded the ideal classification. There is a group of clerics and officials connected with the church, each of whom in some way breaks rules that should be obeyed, ranging from the charming prioress, too keen to be thought a lady, to the gross and oppressive summoner and the contemptible, fraudulent pardoner. The remainder of the pilgrims come from what would now be called the middle class, and range from the rich and slippery lawyer, who was probably connected with the court, to the cheating miller and beery cook. None of these persons is poor, and almost all are in some degree the objects of Chaucer's comic satire. The satire is occasionally no more than a mere touch, as with the franklin, a rich and respectable country gentleman; or a gentle irony, as with the prioress; or an amused revelation of roguery of different kinds, as with the miller, reeve and manciple. In other cases the satire is sharper, if more veiled, and may well be personal, as with the physician, lawyer and merchant. Sometimes the satire is openly and strongly hostile, as with the friar and summoner, while the portrait of the pardoner is almost savage. The variety and complexity of the poet's attitudes is great, and the subtle shades of feeling in many of the portraits, especially those of the monk and the wife of Bath, defy brief analysis. Chaucer rejoices in his characters at the same time that he mocks them. The characters are types, but they are also individuals, and some at least of the descriptions are unquestionably portraits of people known to Chaucer's own circle. Harry Bailly, host of the Tabard, was certainly a real person, records of whose activities exist; and J. M. Manly showed good grounds for suspecting that the lawyer, for example, was one Thomas Pinchbeck, sergeant-at-law, whom Chaucer had no reason to love. Plausible originals have also been suggested for the shady merchant, the piratical shipman, the tricky, touchy reeve and others. In other poems Chaucer shows a range of feeling and description which far surpasses the general *Prologue*, but in its vivid sense of living people and in the subtlety and richness that underlie its apparent simplicity, the general *Prologue* is the most remarkable poem that Chaucer ever wrote: of its age, yet astonishingly original, and always making an instant appeal, for all its subtlety.

The static characters of the general *Prologue* are set in motion in the short links between the tales, and these snatches of realistic comedy, the most original things Chaucer ever wrote, make a delightful framework to the tales. The tales themselves are as varied as the tellers and in many cases represent the summit of Chaucer's art, though a few, like *The Physician's Tale* and *The Manciple's Tale*, are relative failures, and the prose treatises do not aim at an artistic effect. Many of the tales are written in the five-stress line, rhyming in couplets, which Chaucer first introduced into English in *The Legend of Good Women*.

Courtly romance in *The Canterbury Tales* is represented in differing ways by *The Knight's Tale* and *The Squire's Tale*. *The Knight's Tale* is of a splendour comparable with the *Troilus*, and like it is translated from a poem of Boccaccio's, *La Teseida*. Chaucer improves on his source by drastically reducing the length, but he also makes additions, especially from Boethius, and like the *Troilus*, *The Knight's Tale* is philosophical and contemplative at heart, for all its colourful description and action. *The Squire's Tale*, which is unfinished, has a fine courtly festival, and describes magical wonders. In contrast to the nobility, the courtly idealism and fine sentiment of these tales (with which might be bracketed the pleasant *Franklin's Tale*) are a number of fabliaux, comic anecdotes somewhat outspoken but not offensive. Four of them are part of the quarrels between miller and reeve, friar and summoner.

These stories, based on anecdotes common to 14th-century Europe, far transcend their sources; *The Miller's Tale* and *The Reeve's Tale* particularly are perfect in poetic artistry and perhaps the funniest tales in English. Again in piquant contrast are the serious and devout tales of miracles of the Virgin, told by the lawyer and the prioress. The prioress' brief tale of a murdered child, beautifully told in seven-line stanzas with deep devout tenderness, is not less perfect, nor less typical of Chaucer, than the tales of the miller or the reeve. Two tales are particularly the product of the characters' own interests, and are more purely though ironically dramatic than many of the others. These are the tale of the wife of Bath, which has a delicate charm, an unusual touch of mystery and a vein of strongly felt morality; and the powerful tale of the pardoner, who tells how three thieves sought out death. Each of these tales is preceded by a prologue of self-revelation, rightly famous for satirical and sympathetic insight; the wife of Bath's prologue is probably the greatest example of "high comedy" in English. Comedy of other types, brilliantly various mixtures of satire, realism, farce, learning, burlesque and parody, is found in Chaucer's *Tale of Sir Thopas*, in *The Nun's Priest's Tale* of the cock and the fox and in *The Canon's Yeoman's Tale* about fraud in alchemy. An unusual variation of Chaucer's typical mixture of the serious and the comic is found in *The Clerk's Tale*. Here the story of the heroine Griselda's exemplary patience, beautifully and seriously told, is mockingly turned against women in a final satirical *envoi* of great technical brilliance.

Besides the tales mentioned, and one or two others, there are the serious prose treatises, one of which, *The Parson's Tale*, brings the fragments of the great scheme to a conclusion. It is followed by the *Retractation*, in which the aging Chaucer, in a spirit somewhat resembling that of the end of *Troilus and Criseyde*, condemns all his secular works and commends his "moralities" and "homilies."

Other Works.—Apart from the works already noticed there are several which Chaucer mentions as his but which are lost. Chaucer also says he translated *Le Roman de la Rose*. An incomplete Middle English translation of the *Roman*, over 7,000 lines long, in octosyllabic metre, survives in one manuscript, and it is usually agreed by scholars that Chaucer probably wrote the first 1,705 lines of this in youth. The original *Roman* is the most important single literary influence on Chaucer's writings, for in it he found not only the vision of idealized love (*fine amour*) to which he was constant from youth to age, but also the suggestion and poetic example for much of the philosophizing, the scientific interest, the satire and even the comic bawdry of his maturest work.

He wrote also a number of shorter poems, including several rather frigid love poems, some pleasant addresses to friends, a brief, biting curse on Adam, his scribe, for making so many mistakes, and several short personal pieces based largely on Boethius, expressing resignation and contempt for the world. The third stanza of *Truth* is a particularly clear expression of what may be taken as Chaucer's considered attitude to life—optimistic, resolute, devout, unillusioned, unworried.

> That thee is sent, receyve in buxumnesse[1],
> The wrastling for this world axeth[2] a fal.
> Her is non hoom[3], her nis[4] but wildernesse:
> Forth, pilgrim, forth! Forth, beste[5], out of thy stal!
> Know thy contree, look up, thank God of al;
> Hold the heye[6] weye, and lat thy gost[7] thee lede;
> And trouthe thee shal delivere, it is no drede[8].

[1]obedience [2]asks for [3]home [4]is not [5]beast [6]high [7]soul [8]doubt

Versification and Language.—Chaucer's metre is extremely skilful and varied; his verse is notably musical, especially if read with the pure vowel sounds of his time, though it is rarely lyrical. He began by imitating the fashionable French octosyllabic verse, but since English is a more heavily stressed language than French, and has a strong tradition of accentual verse in which the number of syllables is easily varied, his "octosyllabic" verse has often more or fewer than eight syllables, and seems rougher than that of his French masters. But Chaucer gives an indication of how deliberate his handling of the metre is when he comments in 1, 1098 of *The House of Fame* on his practice of occasionally omitting the first unstressed syllable of the line. French also gave him precedent for a longer line, but it was almost certainly the example of Dante and Boccaccio which led him to introduce into English the regular use of the five-stress, basically ten-syllable line of which he became one of the great masters. He never aimed, however, at the regularity which Dryden and Pope later attained. Often one of the five stresses is lighter than the others, and there is very often an extra syllable at the end of the line. Lines of 9 or 12 syllables are not uncommon, and the pause in the line was probably longer than a modern reader is accustomed to. Much of the variety of the verse is due to his masterly skill in varying the position of the pause.

Chaucer's language, which is the chief but by no means an insuperable bar to enjoyment of his poetry by a modern reader, was the dialect of the court and the City of London. This dialect was predominantly that of the southeast midlands, but it had a number of forms from nearby dialect areas, such as Kentish. It is the chief ancestor of modern standard English—not because Chaucer used it but for more complex reasons—and it is thus easier for the modern reader to understand than other medieval dialects in which great poetry was written. Its chief difficulty is perhaps its vocabulary, for it has many words now obsolete, or used in a different sense. Nevertheless it has more familiar than unfamiliar words, and the patient use of a glossary is soon rewarded. Chaucer did not invent many words, but he is often the earliest writer, or among the earliest, in English whose use of a word is recorded, and to his contemporaries his language seemed notably fresh, modern and rich. The other well-known difficulty for the modern reader is the presence in many words of a decayed form of an earlier full inflection, represented by a final *-e* or *-es*, which must be lightly pronounced even when occurring at the end of a line, thus:

A$\overset{x}{\text{n}}$d smal$\overset{x}{\text{e}}$ fówel$\overset{x}{\text{e}}$s mák$\overset{x}{\text{e}}$n mél$\overset{x}{\text{o}}$dýe$^{(x)}$.

Chaucer took some licence in pronouncing or not pronouncing the final *-e*, because the use of this inflection was rapidly dying out in his time. Furthermore, his usage was often obscured because even 15th-century scribes were often unfamiliar with the pronunciation of the inflection, and so sometimes either left it out, although it was needed for the metre, or added an unnecessary final *-e*. But the pronunciation of the inflections given in modern edited texts soon becomes familiar, and if the vowels are pronounced as in modern French, and all the consonants given their full value, a very tolerable rough approximation to Chaucer's pronunciation may soon be achieved even by the reader who lacks knowledge of philology. Philologists have of course constructed an almost complete idea of Chaucer's pronunciation.

Reputation.—Chaucer in his own time and ever since has been recognized as one of the greatest English poets. His contemporaries and immediate successors praised him for his art, for the splendour of his verse, for his learning and for being "the first finder of our language." He was so fashionable in the middle of the 16th century that it was said that "the fine Courtier wil talke nothyng but Chaucer." Scholars and poets praised him. Shakespeare does not mention him, but echoes him several times. In the 17th and 18th centuries his obsolete language and the change of taste lessened his popularity, except for enthusiasts and poets, of whom Dryden, who wrote the first literary criticism of Chaucer of a modern kind, was the chief. Only in the 18th century begins that praise of his humour which, justified in itself, has sometimes tended to obscure those other qualities of nobility, learning and art which earlier centuries more easily recognized. Modern scholarship begins with T. Tyrwhitt's edition of *The Canterbury Tales* (1775–78), but did not much develop beyond this until F. J. Furnivall founded the Chaucer society in 1868. Since then Chaucer has been extensively studied, especially in the 20th century by U.S. scholars.

In summary, the impression left by the whole body of Chaucer's work is one of great variety. His settings vary from palaces to humble homes, from the realistic to the fantastic; his style ranges from a simple and earthy directness to elaborate splendour. His stories vary from mildly bawdy tales to saints' lives told with a pure and sweet devotion, from philosophical romance to courtly elegy. His humour, occasionally broadly farcical, often of the subtlest delicacy, is all-pervading; yet the feeling most frequently expressed by him is a tender pity. Many of his tales reveal a remarkable range of knowledge of books, yet he has the full measure of everyday life from court to village street. Only an intimate presentation of the lives of the labouring poor is lacking. With all this variety his works yet convey a feeling of a strong, unified personality and of a sincere, orthodox, Christian philosophy and morality. Perhaps the secret of his greatness lies in this capacity to behold and harmonize the contradictory nature of life's experiences; to maintain in equilibrium a set of ambivalent responses to the whole of life; to remember that after woe comes joy, and after joy comes woe:

> Swich is this world, whoso it may beholde.

He is both sophisticated and simple, humorously detached and worldly, yet compassionate and convinced that this world is not all.

See also references under "Chaucer, Geoffrey" in the Index volume.

BIBLIOGRAPHY.—The fundamental bibliographical works are: E. P. Hammond, *Chaucer, a Bibliographical Manual* (1908); D. D. Griffith, *Bibliography of Chaucer, 1908–1953* (1955).

Life: The earlier lives of Chaucer are useless. The foundation of accurate knowledge is *The Life-Records*, published in parts by the Chaucer Society (1871–1900). Details discovered later are listed in the bibliographies, but J. M. Manly, *Some New Light on Chaucer* (1926), should be specially noted. On the facts thus recorded are based the sketches in modern editions and biographies.

Editions: The multiplication of manuscripts in the 15th century was succeeded by many printed editions in the late 15th and 16th centuries, by William Caxton and others. The first collected edition, *The Workes of Geffray Chaucer*, was ed. by W. Thynne (1532). This and subsequent editions by Thynne, and the editions by J. Stow (1561) and T. Speght (1598), also printed and sometimes wrongly attributed to Chaucer a mass of inferior 15th-century poems—a process of accretion which continued as late as the 18th-century editions. The prints of manuscripts and the studies published by the Chaucer Society made posssible the first satisfactory edition of Chaucer by W. W. Skeat, 6 vol. (1894), with a 7th vol. (1897) containing the spurious poems. Though out of date, this edition contains much of value, especially in the notes and glossary. It is the basis of many minor editions. The best modern edition is in 1 vol. by F. N. Robinson (1933; rev. ed., 1957) with excellent introductions, text and compressed notes, and a useful but somewhat inadequate glossary. There is an important edition by J. M. Manly and E. Rickert of *The Text of the Canterbury Tales*, 8 vol. (1940), and by R. K. Root of *The Book of Troilus and Criseyde* (1926). There are many minor editions of the poems.

Modernizations and translations: These begin with Dryden in the late 17th century. There have been many attempts at modernization or translation from the 18th century onward, by Pope, Gay and Wordsworth among others. In the 20th century the translation into verse of *The Canterbury Tales* by N. Coghill (1951) is perhaps the most popular. There are many others. Parts of Chaucer's work have been translated into French, Italian, Spanish, German, Dutch, Swedish, Danish, Czech, Russian and Japanese.

Scholarship: The large number of specialist studies is listed in the bibliographies. Important literary background material is given in the *Sources and Analogues of Chaucer's Canterbury Tales*, ed. by W. F. Bryan and G. Dempster (1941). *See* also J. M. Manly, *Some New*

Light on Chaucer (1926); C. S. Lewis, *The Allegory of Love* (1936); T. A. Kirby, *Chaucer's Troilus: a Study in Courtly Love* (1940); W Clemen, *Der junge Chaucer* (1938); J. A W. Bennett, *The Parlement of Foules* (1957). The social background is described by G. G. Coulton, *Chaucer and His England* (1908), and by E. Rickert (comp.), *Chaucer's World*, ed. by C. C. Olson and M M Crow (1948). Most notable among studies of the scientific background is W. C. Curry, *Chaucer and the Mediaeval Sciences* (1926). Chaucer's language and versification have been studied by B ten Brink, *Chaucer's Sprache und Verskunst* (1884), Eng. trans. by M. B. Smith, *The Language and Versification of Chaucer* (1901); there is a 3rd German ed., rev. by E. Eckhardt (1920). H. Kökeritz, *A Guide to Chaucer's Pronunciation* (1954) is for the nonphilological student. Language and versification are also discussed in most modern editions.

Criticism: Among many critical studies may be mentioned H. S. Bennett, *Chaucer and the Fifteenth Century* (1947); G. K. Chesterton, *Chaucer* (1932); G L. Kittredge, *Chaucer and His Poetry* (1915); J. L. Lowes, *Geoffrey Chaucer* (1934); P. V. D. Shelly, *The Living Chaucer* (1940); J. Speirs, *Chaucer the Maker* (1951); C. Muscatine, *Chaucer and the French Tradition* (1957). For a brief survey of Chaucer's life and work and Chaucerian criticism, *see* D. S. Brewer, *Chaucer* (1953). (D. S. B.)

CHAUEN: *see* Xauen.

CHAULIAC, GUY DE (Guido de Cauliaco) (*c.* 1300–1368), French surgeon and one of the most learned men of his time, was born at Chauliac, Auvergne. He took holy orders and studied at Toulouse, Montpellier and Paris, and then went to Bologna to study anatomy under Nicolo Bertuccio. Chauliac's book *Chirurgia magna* (1363) passed through many translations and was for a long time the standard work on the subject, though it tended to retard progress in surgery by advocating meddlesome treatment of wounds. It was first printed in French at Lyons in 1478. In his *Capitulum singulare* he qualifies as an important medical historian. He operated for hernia and cataract, which had previously been treated mainly by charlatans, and left a description of the narcotic inhalation given to patients. He died on July 25, 1368, at Avignon, where he was physician to the pope.

See Fielding H. Garrison, *Introduction to the History of Medicine*, 4th ed., pp. 156–158 (1929); Arturo Castiglioni, *History of Medicine*, ed. by E. B. Krumbhaar, 2nd ed., pp. 345–347 (1947).

CHAUMETTE, PIERRE GASPARD (1763–1794), French revolutionary, distinguished as a popular leader, as a social reformer and as a promoter of the cult of Reason, was born at Nevers on May 24, 1763, a cobbler's son. After going to sea as a cabin boy, he returned home in 1783 to resume his interrupted studies, took up botany, moved about France and finally reached Paris as a medical student in 1789. In the course of the Revolution, he joined the Cordeliers club, subscribed to the petition of July 17, 1791, demanding the king's abdication and, after the rising of Aug. 10, 1792, represented the Théâtre Français section in the Paris commune. In Dec. 1792, he became *procureur général* of the commune. Concerned for the people's material and moral welfare, he improved conditions in hospitals, organized decent burial for the poor, forbade whipping in the schools and suppressed lotteries, prostitution and the display of obscene books and engravings. A relentless enemy of the Girondins, he contributed actively to their destruction. In the campaign against the Roman Catholics, he made the commune forbid priests to officiate outside churches (Oct. 1793) and organized the first ceremony of the worship of Reason, in Notre Dame, with an actress personifying the new goddess (Nov. 10). He next had the Paris churches closed (Nov. 23), and they remained so despite his conceding freedom of worship on Robespierre's intervention two days later. Though he did nothing to help the Hébertists in the crisis of March 1794, he was nevertheless arrested on their overthrow, brought before the Revolutionary tribunal and on April 13, 1794, executed. He had seemed dangerous to the committee of public safety not only as the sponsor of atheism but as a potential leader of the Parisian sans-culottes. Selections from his papers were edited by A. Aulard in *Mémoires de Chaumette sur la Révolution du 10 août 1792* (1893), by M. Tourneux in *Procès-verbaux de la Commune de Paris du 10 août 1792 au 1er juin 1793* (1895) and and by F. Braesch in *Papiers de Chaumette* (1908). (A. So.)

CHAUMONT (Chaumont-en-Bassigny), a town of eastern France, capital of the *département* of Haute-Marne (*q.v.*), is situated on high ground at the confluence of the Marne and Suize, 100 km. (62 mi.) N. of Dijon by road. Pop. (1954) 16,945. The church of St. John the Baptist dates from the 13th century, the choir and lateral chapels belonging to the 15th and 16th. The sculptured triforium (15th century), the spiral staircase in the transept and a Holy Sepulchre are of interest. An 11th-century keep is the principal relic of a château of the counts of Champagne; the rest of the site is occupied by the law courts. Chaumont is on the main railway from Paris to Basel, Switz. The main industries are glovemaking and leather dressing. The town has trade in grain, iron (mined in the vicinity) and leather.

Chaumont received a charter from the counts of Champagne in 1190. In 1814 Great Britain, Austria, Russia and Prussia concluded at Chaumont the treaty by which they bound themselves to prosecute the Napoleonic War to a successful issue. Chaumont was occupied by the Germans in 1870–71 and again from June 1940 to Sept. 1944.

CHAUNCEY, ISAAC (1772–1840), U.S. naval officer, was born at Black Rock, Conn., Feb. 20, 1772. He entered the navy from the merchant service as a lieutenant in 1798 and became a captain in 1806. During the War of 1812 he took command on Lake Ontario at Sackets Harbor, N.Y., in Oct. 1812; he prepared for action with skill and energy but failed in strategy. Commodore Sir James Yeo expected him to attack or blockade Kingston, Ont., across the lake from Sackets Harbor, a key point on vital lines of supply by water for all British operations to the westward. Instead, Chauncey sailed with his squadron on April 25, 1813, and captured York (now Toronto). Yeo countered by attempting to take Sackets Harbor. This attack on his base brought Chauncey back, and he then permitted the British to move supplies with almost complete freedom for nearly two months. Thereafter both commodores exercised great care to avoid decisive action, although Yeo was slightly more aggressive in 1814.

After the war Chauncey commanded in the Mediterranean from 1816 to 1818. During his later years he served as commissioner of the navy and was president of the board of naval commissioners from 1837 until his death at Washington, D.C., Jan. 27, 1840.

See Dudley W. Knox, *A History of the United States Navy* (1948). (J. B. Hn.)

CHAUNCY, CHARLES (1592–1672), American clergyman and second president of Harvard college, described by Cotton Mather as "a most incomparable scholar," was born at Yardley-Bury, Eng., in Nov. 1592, and attended Trinity college, Cambridge. He was in turn vicar at Ware and at Marston St. Lawrence, but twice incurred censure from the authorities for nonconformity. His formal recantation in Feb. 1637 caused him lasting self-reproach. In the same year he emigrated to America, where he was an associate pastor at Plymouth, then pastor at Scituate, Mass., and, from 1654 until his death, president of Harvard college. He died on Feb. 19, 1672. His writings include: *The Plain Doctrine of the Justification of a Sinner in the Sight of God* (1659) and *Antisynodalia scripta Americana* (1664).

Charles Chauncy (1705–87), American clergyman and great-grandson of the above, a leader of the liberals of his generation, was born in Boston, Mass., on Jan. 1, 1705, and graduated at Harvard in 1721. In 1727 he was chosen as the colleague of Thomas Foxcroft in the First Church of Boston, continuing as pastor until his death. He condemned the Great Awakening as an outbreak of emotional extravagance in his sermon "Enthusiasm" and in his *Seasonable Thoughts on the State of Religion in New England* (1743), written in answer to Jonathan Edwards' *Some Thoughts Concerning the Present Revival of Religion in New England* (1742). Before and during the Revolutionary War he ardently supported the patriot party. He died in Boston on Feb. 10, 1787. His publications include: *Salvation for All Men Illustrated and Vindicated as a Scripture Doctrine* (1782) and *Five Dissertations on the Fall and Its Consequences* (1785).

For the elder Chauncy *see* Cotton Mather, *Magnalia Christi Americana* (1702); W. C. Fowler, *Memorials of the Chaunceys* (1858). For the younger Chauncy *see* P. L. Ford, *Bibliotheca Chaunciana* (privately printed, 1884); Williston Walker, *Ten New England Leaders* (1901).

CHAUSSON, ERNEST AMADÉE (1855–1899), French composer who was one of the group of followers of César Franck. Born in Paris on Jan. 21, 1855, he studied under Massenet at the Paris Conservatoire and from 1880 to 1883 was a private pupil of Franck. His early works include songs on poems by Leconte de Lisle, notably "Le Colibri." Later he set poems by Paul Verlaine and cycles of poems by Maurice Bouchor (*Poème de l'amour et de la mer*), Jean Cros (*Chanson perpétuelle*) and Maurice Maeterlinck (*Serres chaudes*). His orchestral works include the Symphony in B flat (*c.* 1890) and the *Poème* for violin and orchestra (1896). His principal chamber works are the *Concert* for violin, piano and string quartet (1890–91) and the Piano Quartet (pub. 1917). Well-to-do and generous, Chausson was secretary of the Société Nationale de Musique and did much to encourage contemporary French music. He was killed in a bicycle accident at Limay, Seine-et-Oise, on June 10, 1899. His opera *Le Roi Arthus* was posthumously produced at Brussels (1903). His last work, a string quartet, was completed by Vincent d'Indy. Though it is harmonically indebted to Franck and Wagner, much of Chausson's music is nostalgic and melancholy in mood. The more powerful aspects of his work are displayed in his symphony and in the song cycle *Serres chaudes*.

See Charles Oulmont, *Ernest Chausson et la bande à Franck* (1935); *La Revue musicale,* special number on Chausson (Dec. 1925).

(E. Lr.)

CHAUTAUQUA, the westernmost county in New York, U.S., and the home of the adult education program of the same name. The county is known for agricultural products, grapes, vegetables, fruits and dairy products. Its northern extremity is bordered by Lake Erie and an excellent port is located at Dunkirk. Food and metal products are manufactured there. Chautauqua lake, 18 mi. long and 3 mi. wide, is popular for summer and winter sports. Chautauqua institution, located on the lake shore in the township of Chautauqua, presents summer programs in religion, education, music, art and drama; for the history of the institution and its influence *see* Lyceums and Chautauquas. A teachers' college at Fredonia (*q.v.*) and a community college at Jamestown (*q.v.*) offer collegiate instruction for the youth of the county.

See Helen G. McMahon, *Chautauqua County, a History* (1958).

(A. W. B.)

CHAUTAUQUAS: *see* Lyceums and Chautauquas.

CHAUVINISM, a term for excessive and unreasonable patriotism, of which the nearest English equivalent is "jingoism" (*see* Jingoism). The word derived from the name of Nicolas Chauvin, a French soldier born at Rochefort, who was wounded many times during the French Revolutionary and Napoleonic wars but who, satisfied with the reward of military honours and a small pension, retained a simple-minded devotion to Napoleon. He came to typify the cult of military glory that was popular after 1815, among the veterans of Napoleon's armies. During the 1830s this aggressive if brave militarism came to be ridiculed in vaudeville, caricature and lampoon, and *chauvinisme* came to mean any kind of ultranationalism, whether Bonapartist or not. When the third republic experienced conflicts between the civil and military authorities, it was applied to the militarist groups hostile to the republic which were accused of wanting to turn the whole state into a barracks. Meanwhile the word had spread outside France (*e.g.,* Italian *sciovinismo*). (D. Tn.)

CHAUX DE FONDS, LA, an industrial town in the Swiss canton of Neuchâtel, is about 25 km. (16 mi.) N.N.W. of Neuchâtel by road and 5 km. (3 mi.) from the French frontier. It stands at a height of about 3,250 ft. in a valley of the same name in the Jura. Pop. (1960) 38,906, chiefly Protestant and French speaking; of the Catholic faith, the majority are Old Catholics. The town is mainly modern and is laid out on a regular plan. It is the headquarters of the Swiss watch chamber of commerce and a centre of the watchmaking industry. There are schools of watchmaking and of industrial art. The museum contains interesting collections, especially the large section devoted to horology. The nearby forested Jura mountains are handy for day or week-end excursions. Railways run to Neuchâtel and Biel as well as to Besançon in France.

CHÁVEZ, CARLOS (1899–), foremost Mexican conductor and composer whose music skilfully combines elements of indigenous folk songs and advanced modern techniques, was born in Mexico City, June 13, 1899. He studied with Manuel Ponce, and at the age of 19 completed his first symphony. In 1921 he wrote his first significant work in a Mexican style, a ballet *El fuego nuevo*. After traveling in Europe and in the United States, he became conductor of the Orquesta Sinfónica de México (1928) and director of the national conservatory in Mexico (1928–34). He also appeared as guest conductor with major U.S. orchestras. An articulate writer and lecturer, Chávez published numerous essays on Mexican music and a book, *Toward a New Music* (1937); in 1958–59 he was Charles Eliot Norton lecturer at Harvard university. His lectures at Harvard were collected in a book *Musical Thought* (1961). The music of Chávez is unmistakably Mexican in its melodic patterns and rhythmic inflections, but he seldom makes use of actual native tunes, preferring the more sophisticated method of adumbrative stylization. His works include *Sinfonía de Antígona* (1933); *Sinfonía India* (1936); *Sinfonía Romántica* (1952); *Piano Concerto* (1938–40); *Violin Concerto* (1949). His *Toccata* for percussion instruments (1942) is an interesting experiment in modern sonorities. (N. Sy.)

CHAYOTE (*Sechium edule*), a slender scrambling perennial vine of tropical America, cultivated for its edible fruits and tubers. It belongs to the gourd family and is also known as christophine. The plant is suitable for growing near the Gulf of Mexico, along the Atlantic coast through South Carolina and in California. The fruit is generally pear shaped, furrowed, green or white, three to four inches long and fleshy; it encloses a single seed one to two inches long. (J. M. Bl.)

CHEADLE AND GATLEY, an urban district (1894) in the Cheadle parliamentary division of Cheshire, Eng., 7 mi. S.S.E. of Manchester and 3 mi. S.W. of Stockport. Pop. (1961) 45,599. It comprises the three ancient townships of Cheadle Moseley, Cheadle Bulkeley and Stockport Etchells (Gatley). Though the district has been occupied since Roman times, Cheadle is a modern suburban town and primarily a residential area. Its chief manufactures are chemicals, drugs, accumulators and bricks and there are large engineering works.

CHEB (Ger. Eger), an ancient city of the West Bohemian region, Czech., is situated in the Ohre valley on the spurs of the Fichtelgebirge which lie on the German border between Bavaria and Bohemia. Pop. (1961) 21,380. The grim, ruined castle, built of great lava blocks, was completed by Frederick Barbarossa. In it Wallenstein's officers were assassinated in 1634, shortly before the murder of the leader himself in the town hall. The market place survives as a relic of medieval German settlement, although the south part of the town was much damaged in World War II. The history of Cheb has been full of violence, for it guards the easiest approach to Bohemia from the northwest. It passed in the 13th century from Swabian rulers to Otakar of Bohemia, and was battered in the Hussite wars, in the Thirty Years' War and again in the War of the Austrian Succession. In the 19th century its importance as a military strong point, a railway junction and a textile and machine manufacturing town grew steadily. It was almost entirely a German city until the expulsion of the Germans after World War II. (H. G. S.)

CHEBICHEV, PAFNUTIY LVOVICH (1821–1894), one of the most distinguished of Russian mathematicians, was born at Borovsk on May 26, 1821. Educated at the University of Moscow in 1859, he became professor of mathematics in the University of St. Petersburg, a position from which he retired in 1880. He became a correspondent in 1860, and in 1874 *associé étranger* of the Institute of France. He was also a foreign member of the Royal Society of London. He wrote much on prime numbers; particularly the number of primes below a certain bound, and devoted much attention to the problem of obtaining rectilinear motion by linkage. The "Chebichev's parallel motion" is a three-bar linkage, which gives a very close approximation to exact rectilinear motion. His mathematical writings covered a wide range of subjects, including the theory of probabilities, quadratic forms, orthoganal functions, theory of integrals, gearings, the construction of geographical maps, formulas for the computation of volumes, etc. He also published a *Traité de la théorie des nombres.* He died at St. Petersburg on Dec. 8, 1894. His works were published in a French edition, *Oeuvres* (1899–1907); and in a five-volume Russian edition (1946–51). (O. Oe.)

CHEBOKSARY, a town and capital of the Chuvash Autonomous Soviet Socialist Republic of the Russian Soviet Federated Socialist Republic, U.S.S.R., stands on the right bank of the middle Volga opposite Sosnovka, between Gorki and Kazan. After the town was connected by railway to Kanash and thus to Moscow (360 mi. distant) and Kazan in 1939 it grew rapidly, from 31,000 inhabitants to 83,000 (1959). Manufactures include electrical apparatus, tractor spare parts, matches, sawed timber and a range of textiles and foodstuffs. Across the Volga a power station uses local peat. There are agricultural and pedagogical institutes and other educational and cultural foundations. (R. A. F.)

CHEBOYGAN, a city of Michigan, U.S., and the seat of Cheboygan county, is on Lake Huron at the northern tip of Michigan's "mitten." It commands a view of the historic Straits of Mackinac with its chain of islands. Settled in 1857, Cheboygan (at first called Duncan and later Inverness), was incorporated as a village in 1871 and as a city in 1889. It originated as a lumbering town on the Cheboygan river but later became a commercial fishing centre and the home of such varied manufactures as cement products, tools and dies, paper supplies, precision instruments and rustic furniture. The icebreaker "Mackinaw" of the U.S. coast guard is based there and the University of Michigan has a biological station nearby. Dairy farms and apple orchards border the city. Numerous inland lakes as well as proximity to lakes Huron and Michigan make Cheboygan a busy resort area in summer; skiing, ice skating and ice fishing attract winter sports enthusiasts. The name Cheboygan is an Indian word meaning "place of entrance," "portage" or "harbour" and probably refers to the river. For comparative population figures *see* table in Michigan: *Population.* (B. L. F.)

CHECHEN-INGUSH AUTONOMOUS SOVIET SOCIALIST REPUBLIC, in the Russian Soviet Federated Socialist Republic of the U.S.S.R., lies on the northern flank of the Greater Caucasus range. Pop. (1959) 710,424. Area 7,452 sq.mi. Physically it falls into three regions. In the south is the main Caucasus range, the crestline of which forms the republic's southern boundary. The highest points are Mt. Tebulos-Mta (14,744 ft.) and Mt. Shan (14,531 ft.). The chief rivers of this area are the Argun and Assa, tributaries of the Sunzha. The second region is the foreland, consisting of the broad valleys of the Terek (*q.v.*) and the Sunzha, which cross the republic from the west to the east, where they unite. These valleys are separated by the Sunzha and Terek ranges, which rise to 2,132 ft. and are themselves separated by the Alkhan-churt valley. Thirdly, in the north are the level, rolling plains of the Nogai steppe. The great variety of relief is reflected in the soil and vegetation cover. The Nogai steppe is largely semidesert with sagebrush vegetation and wide areas of sand dunes. This gives way toward the south and southwest, near the Terek, to feather-grass steppe on black earth and chestnut soils. Steppe also occupies the Terek and Sunzha valleys. Up to 6,500 ft. the mountain slopes are densely covered by forests of beech, hornbeam and oak, above which are coniferous forests, then alpine meadows and finally bare rock, snow and ice. The climate varies, but is in general continental. Summers in the north are hot and dry (July average temperature 77° F.) and winters moderately cold (January average 25°). Rainfall is 8–16 in. a year. In the mountains temperature conditions are less extreme and the rainfall rises to 16–20 in. a year.

The republic was formed in 1936, after the amalgamation of the Chechen and Ingush autonomous *oblasts,* but lost its status during World War II, when it became Grozny *oblast.* It was re-established as an autonomous republic in Jan. 1957 when various boundary changes took place. The republic lost the northern part of the Nogai steppe, but its southern boundary was extended to the Caucasus crest. It is not known in what proportions the inhabitants belong to the two national groups, the Chechen and the Ingush, but in the U.S.S.R. as a whole these peoples are said to number 419,000 and 106,000 respectively. At the time of the 1926 census Chechen formed 58% and Ingush 13% of the population. These nationalities are Muslims and are two of the many Caucasian mountain peoples speaking Japhetic languages. Traditionally independent, they made prolonged resistance to Russian conquest, in the 19th century especially, with other Caucasian tribes which, under the leadership of Shamil (*q.v.*), were temporarily successful while the Russians were occupied with the Crimean War. The Russians in later incursions, however, employed large forces; Shamil was captured in 1859 and many of his followers migrated to Armenia. The Terek river remained a Cossack defensive frontier until the 1860s. The constant skirmishes of Chechen and Russians along the Terek form the background to *The Cossacks* by Tolstoi, who, like M. Y. Lermontov, served in the frontier fortress of Grozny. Of the present population 41.2% (293,039) are urban dwellers, the bulk of whom live in the capital, Grozny (*q.v.*), which has 240,000 inhabitants. Population density varies greatly, being lowest in the dry steppe and highest in the valleys of the foreland region.

The backbone of the economy is petroleum. Drilling is mainly in the lower Sunzha valley between Grozny and Gudermes and in the Sunzha and Terek ranges, especially around Malgobek. There are also new wells in the Nogai steppe. Large-scale production of petroleum began in 1896. By the early 1930s the area was producing about one-third of Soviet oil, but this proportion has fallen greatly, because of exhaustion of older wells and the growth of new oil fields. Refining is concentrated in Grozny, one of the largest centres of this industry in the U.S.S.R., while pipelines run to the Caspian at Makhachkala, to the Black sea at Tuapse and to the Donets basin (Donbas). The great refining capacity of Grozny outstripped the slackening pace of local petroleum production and oil is now imported from the Volga-Urals area. Benzine is a major product, Grozny petroleum having the highest benzine content of the U.S.S.R. Natural gas is also found in the area and by the early 1960s production amounted to more than 7,000,000,000 cu.ft. annually. Gas pipelines run to the Donbas and Moscow.

Engineering, particularly the manufacture of machinery for the petroleum industry, is concentrated in Grozny, as is the chemical industry. Timber-cutting is important in the mountains, the timber, mostly beech, being made into furniture, parquet flooring and musical instruments at small centres on the railways in the valleys. Food processing is well developed, especially canning of fruit and vegetables.

Agriculture is largely concentrated in the Terek, Sunzha and Alkhan-churt valleys and, for the most part, requires artificial water supply. Nearly 200,000 ac. are irrigated, while other areas depend on artesian wells. Spring wheat, barley and millet and winter rye are dominant crops in the Terek valley, winter wheat, maize (corn), sunflowers, mustard, rape and flax in the Sunzha valley. Vineyards are common and a wide range of fruit and vegetables are grown. Livestock husbandry is rather poorly developed but is the major use of both the dry steppe (especially for sheep) and the mountain pastures. There is considerable transhumance between these areas.

The main axes of communication are the railways following the Terek and Sunzha valleys, forming links with Astrakhan and Baku on the Caspian and with Tuapse and Rostov on the Black and Azov seas. A motor road joins Grozny to Ordzhonikidze, and thus to the Georgian military highway across the Caucasus. (R. A. F.)

CHECK (Cheque), a bill of exchange drawn on a bank and payable on demand. It has proved in practice to be a most useful device and has become the chief currency of domestic commerce in the U.S. and Great Britain. (*See* Commercial Paper.)

As a negotiable instrument, a check is a written order to pay money and it may be transferred from one person to another by endorsement and delivery or, in certain cases, by delivery alone. Negotiability can be restricted by appropriate words such as those provided by restrictive endorsements, or by the check form itself. Most checks are "order" checks reading "Pay to the order of." This form requires that the person whose name is on the check, known as the payee, must endorse the check before it is paid or transferred. "Pay Bearer" checks do not require endorsement and may be negotiated by delivery only, but in practice drawees usually require endorsement. Endorsement is the signature of the payee or other holder of a negotiable instrument, usually written on the back of the check. As it appears on the face of a check, the word "pay" means payment in legal tender, the legal medium of exchange. Most checks, however, are not "paid" in currency but by the debiting and crediting of bank deposits. In fact, the major monetary functions of commercial banks are the creation of demand deposits and the transfer of deposit credits upon the orders (checks) of depositors.

The usual form of a U.S. bank check carries at the top the date of issuance, the name of the bank upon which it is drawn, space for a number for convenient identification and a printed number for use in bank clearing operations. Across the middle are the printed words, "Pay to the order of" and a space wherein the name of the payee may be written. There is also a space for writing the whole amount in figures. On the next line, the amount in dollars is written out and the cents are usually shown in figures. At the bottom appears the signature of the drawer. To collect or "cash" the check, the payee must endorse it on the back exactly as his name is written on the face of the check. When so endorsed, the check is good in the hands of anyone. Most business checks are printed on a safety paper that makes erasure and alteration of a check difficult. Business firms often take the further precaution of using a machine that perforates the figures as it prints them.

When a check is presented for payment to the bank on which it is drawn it is carefully examined by bank officials. They note the date, signature and endorsement; make sure that the writer of the check has sufficient funds in his account to "cover" the check; and determine that the writer of the check has not placed a stop-payment order on it. A bank is usually responsible to its customers for paying raised or altered checks or checks on which the customer has ordered that payment be stopped. It is generally held that the debt for which a check is given is not extinguished by the mere delivery of the check; a check is only a conditional payment until it is finally honoured.

"Check kiting" is a procedure whereby checks written on accounts in separate banks are used to generate short-term purchasing power through the use of the bank's credit. A depositor with accounts in two banks may build up his balance in Bank A by depositing a check drawn on Bank B, although his balance in Bank B (perhaps an out-of-town bank) is not sufficient to cover the check. He makes the check good before it is presented for collection but in the meantime has made use of the bank's credit. Many banks prevent this practice by refusing to credit any check for deposit until the collection has been made.

A cashier's check is issued by the bank against itself and is signed by the cashier or some other bank officer. It is the close equivalent of cash and has unquestioned acceptability as exchange. It is frequently used by persons who have no bank accounts.

A certified check is a depositor's check that has been guaranteed by the bank upon which it is drawn, and it is so stamped. By certifying a check the bank becomes responsible for its payment and sets aside for that purpose the amount that must be paid. Certified checks and cashier's checks are used in almost all large financial transactions because they are equivalent to cash, are easier to handle, prove good faith and establish definite ability to fulfill a contract.

Travelers' checks are cashier's checks sold to travelers that require two signatures by the payee. One signature is placed on the check in the presence of an issuing agent; the other signature is for purpose of identification and is placed on the check when it is cashed. Purchasers of travelers' checks are guaranteed reimbursement by the issuers of the checks if they are lost or stolen.

Fundamentally, there are two kinds of payment money in a modern economy, currency and checks. The effective real money supply is the total of demand deposits in banks (75%–80%) and currency (20%–25%). Although deposit money is not legal tender, checks are freely accepted in payment because they may readily be converted into currency and because the government assures the ultimate safety of bank deposits. Checks, used as money, have many advantages. They have a lower risk of loss by theft; they eliminate the need to make change; they are easily transported, accounted for and handled; and they act as payment receipts. The chief disadvantage of checks is their reduced acceptability.

Over 90% of all transactions are paid by check in the United States and the Commonwealth of Nations. More than 12,000,000,000 checks are written annually in the United States alone and the number is steadily increasing. The sorting and allocation of checks to the correct banks and depositors is known as check clearing. Clearings are accomplished either by direct presentation, by correspondent banks, through local clearinghouses such as those in New York and in Chicago or by the federal reserve banks in the United States. The task is so substantial that electronic equipment has been developed that can sort and scan checks at a rate of over 750 per minute. When magnetic ink characters are placed in a prearranged position on a check, the machines are able to "read" amounts of money and names of drawee banks, and thus to handle all sorting and accounting for many accounts. *See* BANKING; CURRENCY; MONEY; MONEY ORDER.

See also references under "Check" in the Index volume.

(O. R. G.)

CHECKERS. Checkers, known as draughts in Great Britain, is one of the world's oldest intellectual pastimes. The game is played by millions of persons and has virtually the same rules throughout the English-speaking world. Its rudiments are simple, yet its expert play is so profoundly intricate that no champion can truthfully state that he has nothing more to learn. According to its many devotees, the game's fascination increases in proportion to the player's insight into its strategies, and the skilled player finds in it an inexhaustible appeal and lifetime hobby.

GENERAL INSTRUCTIONS

The game is played by two persons who occupy positions opposite each other across a board of 64 light and dark squares, the same as a chessboard. The 24 playing pieces are disk shaped and of contrasting colours (whatever their colours, they are identified as Black and White). At the start of the game each contestant has 12 pieces arranged on the board as shown in fig. 1. The single corner is to the left and the double corner to the right. While the diagram establishes the setup of the pieces, the actual playing is always done on the dark squares; the board customarily is shown in reverse for clarity. A half turn of the actual checkerboard from the position shown will bring it into the proper placement for playing on the dark squares.

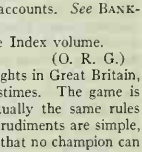


FIG. 1.—CHECKERBOARD OR DRAUGHTBOARD SET FOR PLAY

Mechanically, the play consists of advancing a man diagonally forward to an adjoining vacant square. If an opponent's piece is in such an adjoining vacant square, with a vacant space beyond, it must be captured and removed by jumping over it to the empty square. If this square presents the same situation, successive jumps in a straight or zigzag direction must be completed in the same play. When there is more than one way to jump the player has his choice. When a man first enters the king row (squares 29, 30, 31, 32 for Black and 1, 2, 3, 4 for White in fig. 2), it must be crowned by the opponent who places another piece of the same colour on it. A man reaching the king row has finished its move. As the king has the added privilege of moving and jumping backward, this rule has an effect on strategy. A win is scored when an opponent's men are all captured or blocked so that he cannot move. When neither side can force a victory and the trend of play becomes repetitious a draw game is declared.

Standard Tournament Rules.—The official board used in tournaments is of 2-in. squares; the checkers are round and of a diameter not less than $1\frac{1}{4}$ in. or more than $1\frac{1}{2}$ in.

At the beginning of a game, lots are cast for choice of colours. The first move is made by the player of the Black pieces. Thereafter, the colours alternate with each succeeding game.

Moving.—If a move is not made by the end of five minutes, time is called, and if it is not completed by the end of another minute the game shall be adjudged as lost through improper delay.

Capturing.—When there are two or more ways to jump, five minutes shall be allowed; but where there is only one way to jump, time is called at the end of one minute; and at the expiration of another minute, the game is forfeited by the delaying player.

Touched Pieces.—If a person whose turn it is to play touches one of his playable pieces, he must play it or forfeit the game. Once he has moved a playable piece toward another square, it must be moved in that direction.

The Huff.—The huff or blow (picking up a man for not jumping) has been abolished. All jumps must be completed, and all jumped pieces must be removed from the board.

Kings.—When a single piece reaches any of the squares on the opposite extreme side of the board, by reason of a move or jump, it becomes a king; and that completes the play. The piece then must be crowned by the opponent by placing a piece on top of it. A king, once crowned, can move forward or backward one move at a time but can jump one or more pieces in any direction.

Draw Game.—A draw is declared when neither player can force a win. When one side appears stronger, the player with the weaker side can request the referee for a count on moves, and from that point the player with the stronger side must show a decided advantage within 40 of his own moves, and failing in this must concede a draw.

Conduct.—During a game, neither player can leave the board without permission of the referee. If permission is granted, his opponent may accompany him. Anything that may tend to distract or annoy an opponent is forbidden, and any player so acting after being warned can be penalized with the loss of the game. Any spectator giving warning either by signs or remarks shall be ordered from the room. Similar rules are enforced for smoking or talking near the playing boards.

HISTORY

There is good evidence of the game's ancient origin, both factual and circumstantial. That checkers was played in the days of the earlier Pharaohs is well authenticated by Egyptian history and the British museum contains specimens of primitive boards quite similar to the modern ones. The roots of checkers are intertwined with those of chess, a sister game, and there is some conjecture over priority. Checkers being simpler in form, it is reasonable to presume it was devised first, and that chess followed as an elaboration. Plato and Homer mention checkers in their works and the Romans are believed to have imported it from Greece. Comparison of these games of antiquity with the modern pastime may be speculative; nevertheless, the earliest publications on record show the 12 men on each side and the conventional board.

Antonio Torquemada of Valencia, Spain, published the first book on checkers in 1547. Other Spanish issues followed and in 1650 Juan Garcia Canalejas published a notable volume containing games and traps that are still dependable. The Spaniards may have received their knowledge from older sources in Arabia through the Moors.

William Payne, a mathematician, was the pioneer of English draughts literature and his book, *Guide to the Game of Draughts*, appeared in 1756. A striking feature of Payne's book is the dedication by Samuel Johnson, who was exceedingly fond of the game. In 1800 Joshua Sturges brought out a treatise that served as a textbook for nearly half a century until the advent of Andrew Anderson's elaborate compilation in 1848. Thereafter the literature grew at a rapid pace and by 1900 the books counted up in the hundreds. In newspaper columns and periodicals a student could find games and problems, analyses by critics, reports on tournaments, matches and correspondence play, together with notices of simultaneous and blindfold entertainments by itinerant champions.

After 1900 the growth of scientific play was stepped up by the advancement of U.S. players, who made rapid progress, spurred on by their first team match with a representative British group in 1905. The contest was on the two-move restriction style of play, at which the U.S. aggregation was no match for the more seasoned Scots masters, the greatest of their day, and the U.S. was defeated by a score of 73 to 34 and 284 draws. A second international match in 1927, staged in New York city, found the U.S. team in front by 96 wins to 20 losses and 364 drawn games.

Opening Restrictions.—At first all expert play was unrestricted or go-as-you-please, the opening moves being left entirely to the discretion of the individual. But during one of the Wyllie-Martins matches in 1863 an episode occurred which crystallized the need for widening the game's scope. A variation of the Glasgow opening (since dubbed "Martins' rest") was repeated 21 times. This act was attributed to the fear each player had of the other and paved the way for gradually introducing the two-move restriction, where the first move on each side is determined by lot, compelling the handling of 43 openings and tremendously increasing the sweep of the game. Three-move or the American restriction was adopted in the United States in 1929, raising the playable openings to 137. Launched explicitly to forestall lengthy heats of drawn games in tourneys between overcautious experts whose forte was safety first, it was expected that the plurality of openings would nullify the advantages of "the book" (proven lines of published play) and produce pure cross-board checkers, long the ideal of many players. This assumption quickly proved erroneous for the newest restriction presented many unbalanced games, structurally feeble at the start, requiring still greater efforts of study and private research. Three-move restriction is handicap checkers and has trebled the professional's labour. Eleven-man ballot, removing one piece by lot from each side at the start, increases the openings into the thousands and is a generator of originality. But aside from a few proponents it failed to gain favour.

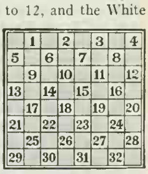
It is interesting to note that the original game of go-as-you-please remained the most popular mode of playing checkers, and likewise had its champions. One of its strongest adherents was Melvin Pomeroy, who not only proved his invincibility at this style of play, but redemonstrated its scope by defeating Alfred Jordan in a go-as-you-please match contested in 1914. Jordan, who won the two-move championship of England, was anxious to annex the free-style title. In a return match, in 1915, Pomeroy was again victorious, winning three games and leaving Jordan scoreless. He retained the title until his death in 1933. Later matches between Millard Hopper and Tom Wiswell for the go-as-you-please championship presented added proof that the original method of playing checkers was far from being exhausted.

In the United States matches are officially endorsed by the American Checker federation, which recognizes the international aspects of the game and works in harmony with the English and Scottish Draughts association.

PLAYING THE GAME

General Principles.—The notation used in describing the game is based on numbering the squares on the board as shown in fig. 2. The Black pieces always occupy squares 1 to 12, and the White pieces invariably rest on squares 21 to 32. The beginner should learn to play slowly and with care, studying every possible move at his command and evaluating it in relation to his opponent's possible countermove. When possible, he should play with better players, for each defeat will point out flaws in his game.

Centre Moves.—Checker men should be moved toward the centre of the board, producing a wedge-shaped formation. Each advanced piece should be backed up and supported so that the ranks are solidly massed. Such a phalanx is a powerful attacking force and can strike at any weak point in an opponent's game.



	1		2		3		4
5		6		7		8	
	9		10		11		12
13		14		15		16	
	17		18		19		20
21		22		23		24	
	25		26		27		28
29		30		31		32	

FIG. 2.—CHECKERBOARD NOTATION: BLACK OCCUPIES SQUARES 1 TO 12, AND WHITE 21 TO 32

Side Moves.—A move to the side of the board, especially at the start of a game, is tactically weak. Side moves hinder the mobility of the pieces, and the piece on the side is often referred to as one handed. It can attack in only one direction, while a checker in the centre can advance on both the right and left diagonals. This does not mean that side moves are invariably weak, for there are exceptions wherein such a play is proper and advantageous.

Key Squares.—Control of the centre of the board is also a prime objective and the player should try to occupy squares 14, 15, 18 and 19. These are known as key squares, and possession of more of them gives a commanding position from which a player can launch a powerful attack. If an adversary has control of one or more of these squares, it is generally wise to exchange men so that these pieces are removed while the capturing men take over these points of control.

King Row.—A player should never attempt to hold the king row intact. This is a fallacy with beginners predicated on the premise that by withholding four men in the king row, an opponent can be prevented from securing a king. Obviously, if a player follows this precept he will have only eight checkers left as fighting forces, and if his opponent attacks with ten men, his superiority in field forces will wield a winning advantage, enable him to crack the king row, secure a king and bring it out to mop up the retreating single men. The sound and orthodox king-row defense employs only two checkers which are retained on squares 1 and 3 or 30 and 32. If pieces are kept on these squares it will be discovered that an opponent can only enter the king row by forming a bridge, posting checkers on squares 10 and 12 or 21 and 23. Such bridge positions are extremely weak for the pieces on squares 10 and 23, and are subject to attack by an adversary's king. In the case of the men posted on squares 12 and 21, the bridge is not dangerous, but the piece that enters the single corner for a king generally finds itself locked in. The best way to pierce the two-man king-row defense is to line up three pieces and swap off the defending pieces.

First King.—The early acquisition of a king is a tactical advantage, especially when it can be put to the maximum of power. The first king decides many contests and when possible it is often a wise plan to sacrifice a checker in order to crown and attack from the rear.

Reducing Forces.—When a player is a checker ahead, it is wise to make judicious exchanges of men in order to reduce the forces. Some opponents may resent this swapping off as unsportsmanlike but experts all recognize it as a legitimate tactic for retaining the advantage and developing a final victory.

Strokes and Shots.—These trick plays are usually the chief resources with which the skilled player annihilates the beginner. It behooves the novice to learn the mechanics of these plays before attempting to handle his entire army of checker men. An insight into these clever maneuvers will often lead a player to delve deeper into the advanced features of the opening and mid-game formations.

The nemesis of the tyro is the simple two-for-one shot. Several examples follow: White on squares 21, 17 and 18; Black on squares 9, 10 and 11. White gains a man by moving 17 to 14, Black capturing 10–17 and White rejumping from 21 to 5. Another instance: White on 25, 22 and 18; Black on 7, 9 and 11. White gains a checker by the exchange of 18 to 14. Again, White on 25 and 30 and Black on 17 and 18. The winning move is 25–22. Still another form: White on 28 and 32, Black on 20 and 18. It will be seen that White's move 28 to 24 ends the game. These simple strokes arise in a variety of ways on either side of the board, and often during a game when the player's attention may be distracted by the number of checkers on the board.

The following two-for-one is a recurrent booby trap. White on 18, 22 and 25; Black on 11, 13 and 15; with Black to move and win by 13–17. A similar situation: White on 18, 20, 22, 25 and 29; Black on 6, 7, 11, 13 and 15. White wins by 20–16.

Another clever dodge is the slip shot. White on 18, 24, 27 and 32; Black on 5, 9, 11 and 20. To the uninitiated the position appears innocent, but it is White's move and he gains a surprising win by 27–23, 20–27, 18–15, 11–18, 23–14, 9–18, 32–14. Trick plays like this one will leave a novice flabbergasted.

Another brilliant combination that might salvage many a lost game is the in-and-out shot. White on 7, 26 and 30; Black on 4, 18, 21 and a Black king on 16. White is a man down and about ready to resign but it is Black's move and being anxious to start another checker for a king he moves from 4 to 8. This move leaves him open to the following situation: White proceeds to win the game by moving 30–26, forcing Black to jump into the king row by 21 to 30. Black must remain there to be crowned before jumping out and this delaying action gives White what is called a waiting move. Taking advantage of it, White pushes his checker from 7 to 3 and when the Black king jumps out (compulsory) 30–23, the newly crowned White king captures three Black checkers and lands in position to block the surviving Black piece. Experts win many a game on sacrifices, squeeze plays and compound strokes that include variations from minor to major tactics.

Although cross-board talent is an important weapon, it is outweighed by knowledge. Thus, the strongest natural player may be at a disadvantage if he is maneuvered into a cook (privately analyzed departure from established book lines) and has to search for the right reply across the board. However, cross-board ability is not guesswork, but a methodical process based on experience. The time limit of five minutes (with a minute's grace) per move governing official contests may seem like an eternity to the uninitiated, but it is often insufficient to cope with the ramifications of a new position which an opponent may have explored for many hours prior to the contest. In cases of this kind, it is generally wise to play safe and try to run for a draw game, as advocated by the English authority Alfred Jordan.

Opening Game.—In contesting a checker game the adept player relies materially on what is termed forcing. If he can steer the game into familiar channels he often has a distinct advantage over his opponent, and quite naturally both players vie for their favourite lines of play. An elementary example of the value of known lines is exemplified in the Canalejas stroke, one of the oldest opening losses and consequently a favourite line against a beginner.

If an uninformed player has the Black checkers and starts his game by moving from 11 to 16, an expert can assume that his intentions are to continue this checker to the side of the board. Having in mind the possibility of making a startling finish to the game, the experienced player moves 23 to 18 as White's reply. Black continues 16–20 and White baits the trap for the stroke by playing 24–19.

At this stage, 8–11 looks like a satisfactory reply but it loses by a remarkable combination thus: 19–15, 10–19, 18–14, 9–18, 22–8, 4–11, 27–24, 20–27, 31–8 and White demolishes the Black forces, gains a checker and is on his way for a king. Note the alternate ways of forming the same trap:

11–16, 24–19, 16–20, 23–18, 8–11
12–16, 23–18, 16–20, 24–19, 8–12
12–16, 24–19, 16–20, 23–18, 8–12

The expert player has many opening and mid-game losses and uses his knowledge to telling effect on the unlearned player. Assuming the checkerboard is set up for the start of a game, it will be found that the Black checkers have a choice of seven opening moves. While all are considered drawable, Black's side move of 9–13 forms what is known as the Edinburgh and is considered the weakest. On the other hand, 11–15, known as old faithful, is considered strongest as it permits Black to occupy the centre of the board. Because of its known advantage, 11–15 has been more extensively played and analyzed than any other opening. Many of Black's starting moves have quaint names which are of British origin: 12–16 forms the Dundee; 11–16, the Bristol; 10–15, Kelso; 10–14, Denny. Black's move of 9–14 is referred to as the double corner. The White replies to Black's starting moves also form many additional openings, for example: 11–15, 24–20 is Ayrshire lassie, 11–15, 24–19 is second double corner; 11–15, 23–18 forms the cross; and 11–15, 21–17, 9–13, the switcher. There are additional name formations stemming from other combinations of moves, but because of their profundity many devotees are content to specialize in just a few openings and try to force them upon an opponent. In this respect, 9–14 as Black's opening move became quite popular as it immediately forced the double corner opening and eliminated considerable study of the many formations arising from 11–15. Obviously, in playing restriction checkers, where the first two or three moves are determined by lot, it is impossible to narrow the scope of the game. Assuming the student first wishes to gain proficiency at checkers before delving into restricted play he would be interested in finding a safe reply to Black's opening move of 11–15. There is no better choice for the beginner than to reply 23–18, forming the cross opening. The name implies a crossing of the board, but it can also define a crossing up of an opponent. Exhibition checkerists use the 23–18 reply to 11–15, there being numerous ways to trap the Black pieces.

The following instructive game will illustrate some of the many pitfalls, and if learned should help win many checker games. The game is listed in columns as is customary in checker books, and the moves continue from the bottom of one column to the top of the next. The alphabetical annotations are also a standard format and should be referred to as the game is reviewed on a numbered checkerboard. As in all games, the opening move is Black.

Cross Opening

11–15	9–14–B	11–15–D	15–24	15–24	24–31
23–18	18– 9	17–13	22– 6	26–22–I	30–26
8–11	5–14	7–11–E	1–10	13–17–J	31–22
27–23	22–17	13– 9–F	28–19–G	22–13	25– 2
4– 8–A	15–18–C	6–13	11–15	2– 6	White has
23–19	26–22	24–20	31–26–H	32–27–K	an easy win.

(A) 10–14 is Black's strongest reply here and forces White to exchange by 23–19 or 22–17 to avoid a cramped game.

(B) Again 10–14, exchanging pieces is recommended. However, the tyro invariably plays 9–14.

(C) 11–16 loses by an explosive shot. White moves 31–27 and after Black jumps 16–23, captures three Black checkers.

(D) 11–16 again loses for Black at this stage, continue: 22–15, 16–23, 31–27 (star move), then 10–19, 17–10 (star move), and no matter which way Black jumps, White wins neatly. If 6–15, then 27 to 18 to 11 to 4. Again, if Black captures 7–14, White takes 27–18 to 9, 6–13, 24–15 and has a winning game.

(E) 8–11 loses immediately by 24–20, 15–24, 22–8.

(F) White starts a clever arrangement to lure Black into a thrilling finish.

(G) The White piece on 19 is a decoy inviting 11–15.

(H) An unexpected sacrifice with skullduggery involved.

(I) Black now realizes the strategy of White's sacrifice for the 22–17 move poses a threat of a two-for-one shot, which could give White access to the king row.

(J) Black, assuming he has found an escape, decides to give up a checker. Actually, he has fallen into the trap. His draw move was 14–17.

(K) The unexpected pulverizer, a powerful in-and-out shot that should be studied.

(Considerable play on the cross opening can be found in T. Wiswell and K. Grover, *Let's Play Checkers*, 1940.)

Having seen some of the opening and mid-game pyrotechnics, it might be interesting to learn how a dramatic situation can arise during the closing moves of a game. A fine example is the 14th game played in the 1951 world's championship go-as-you-please match. As the game neared its end, Tom Wiswell had a slight advantage but seemingly not enough to secure a win. It was at this point that one of the most remarkable problems in checkers arose on the board, enabling Wiswell to score a victory.

Black—Tom Wiswell White—Millard Hopper

10–15	29–25	15–24	22–18	10–17	6–10
22–18	8–11	18– 9	12–16	21–14	14–17
15–22	25–22	1– 5	18– 9	31–26	21–14
25–18	6–10	32–28	16–20	14– 9–B	22–17
11–15	23–18	5–14	9– 5	3– 7–C	9– 5
18–11	9–14	28–19	24–27	5– 1–D	2– 6
8–15	18– 9	7–11	31–24	7–10	10– 1
24–19	5–14	26–22	20–27	1– 6–E	17–10–F
15–24	27–23	11–15	23–18–A	10–14	Black
28–19	11–15	30–25	27–31	25–21	won
4– 8	22–18	15–24	18–14	26–22	

(A) White appears to be escaping.

(B) After this move, White relaxes under the impression that danger is past.

(C) Black discerns a combination 12 moves ahead and sets a trap.

(D) Into the trap from which there is no escape, 25–21 draws.

(E) White cannot pitch 9–6 and play 1–6 as Black threatens 26–30.

(F) Locked in the double corner. A brilliant finish that depicts the strategy of checkers.

Efficiency at checkers is based on mathematical exactness and timing, and offers the chance for creative ingenuity. The following game between Walter Hellman and Marion Tinsley on this style of play illustrates the perfection of the master's game.

Black—Walter Hellman White—Marion Tinsley

9–13	29–25–C	14–23	21–14	11–16	27–23
22–18	5– 9	27–18	13–17	19–15	19–26
11–15–A	23–18	3– 7	14– 9	16–19	30–23
18–11	16–20	22–17	7–11	23–16	22–26
8–15	24–19	9–13	9– 5	12–19	23–19–E
21–17–B	4– 8	17–14	17–22	31–27	eventually
13–22	25–21	6–10	18–14	6– 9	drawn
25–11	10–14	32–27	2– 6	14–10	
7–16	26–22–D	10–17	27–23	9–14	

(A) One of the weakest of the three-move openings.

(B) Strongest, but 24–20 is second best.

(C) 24–19 is equally powerful for White, also 24–20.

(D) An unexpected deviation. The usual continuation is 26–23.

(E) A well-played game on a dangerous opening.

End Game Finesse.—It takes two kings to oust and corral one sheltered in the double corner. Therefore, an advantage of one piece is usually enough to win. But two kings caught together in the single corner can be held there by one king. For example: Black kings on 29 and 25, White king on 26, Black playing cannot release himself. One piece can bottle up three in the single corner in a few situations.

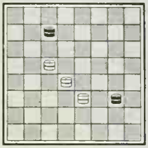


FIG 3.—WHITE TO PLAY AND WIN

In fig. 3, where White has three kings attempting to overcome a Black king lodged in each double corner, White must compel an exchange to win. Though puzzling to many the solution is easy. A sequence of correct moves is necessary and one wrong play retards the win by several moves. Play from the illustrated setting: 18–15, 24–28, 23–27, 6–1, 14–10, 28–32, 27–24, 1–5 (or 32–28, 24–19, 28–32, 10–6, White wins), 10–6, 5–1, 24–19, White wins. Every move executed by a skillful player is carefully planned with a definite objective; nothing is left to luck.

The Move.—An elemental force in checkers is the move or opposition. Simply stated, it means having the last move to pin down the rival pieces. As the move changes with almost every exchange, it is not significant until the end game when the trading of pieces can be controlled. The move itself is not always vital, although in most cases it is necessary to have the move to win or draw many of the standard positions. A classic example of the power of the move is first position. In fig. 4, White having the move, it is his turn to play and he proceeds to win as follows: 27–32, 28–24, 23–18 (avoiding the 24–19 swap which would change the move and allow Black to draw), 24–28 (A), 18–15, 28–24 (if 12–16, 15–11, 16–19, 32–27, 28–32, 27–31, 32–28, 11–16, White wins), 32–28, 24–27, 15–18, 12–16, 28–32, 27–24, 18–15, 24–28, 15–11, 16–19, 32–27, 28–32, 27–31, 19–23, 11–15, 32–28, 15–19, White wins. (A) 12–16, 18–15, 16–20 (if 16–19, 32–27, White wins—an example of an exchange that does not alter the move), 15–18, 24–19, 32–28, 19–16, 18–23, 16–11, 23–19, 11–8, 28–32, 8–11, 32–27, 11–8 (11–7, 19–15), 27–23, 8–11, 23–18, 11–8, 18–15, White wins. There are many variations to first positions.

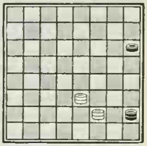


FIG. 4.—FIRST POSITION. WHITE TO PLAY AND WIN

Payne's draw has been the means of avoiding defeat in contests among players of various grades. It consists of Black kings on 14 and 15 and a Black single man on 13, and White kings on 22 and 26. White has the move and plays 26–23; continue, 14–17, 23–26, 15–10, 22–18, 17–21, 18–22, 10–14, 26–30, 21–17, 30–26, drawn.

VARIATIONS

Spanish Checkers.—(often called pool checkers). In this game the single checkers can jump backward as well as forward, and a king can move over any number of empty squares along the same diagonal, and jump any pieces along the way. If by switching to a crossing diagonal he can capture additional men, he is qualified to do so.

Turkish Checkers.—All 64 squares are used in this game, the men move to the sides or straight forward, but not backward.

There are 16 men to a side, 8 each on the second and third rows to commence. Captures are made either to the side or forward; the maximum take is enforced. Pieces are removed one by one when captured. The king has a sweep of any number of squares.

Losing Checkers.—As the name implies the object of this game (applicable to any game of checkers) is the reverse of the regular play. The first one succeeding in giving away his men or immobilizing them wins.

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(T. WL.)

CHEDDAR, a town in the Axbridge rural district of Somerset, Eng., 20 mi. S.W. of Bristol by road. Pop. (1961) 2,845. To the west lies the low Axe valley, to the east rise immediately the limestone Mendip (*q.v.*) cliffs (600–800 ft.) of the spectacular Cheddar gorge (National Trust), which is a narrow, winding pass, nearly 2 mi. long, with beautiful stalactitic caverns, of which Cox's and Gough's are best known. In Gough's cavern human remains have been found of the Stone Age period as well as tools, animal fossils and a flaked amber. Iron Age and Romano-British remains were also found there. Long hole, Soldier's hole and Chelm's Combe shelter have also yielded a wide variety of remains. Cheddar gorge is also known for the beauty of its precipitous white cliffs with their rare limestone flora. The only known British locality for the Cheddar pink (*Dianthus caesius*) is there and other rarities include blue gromwell, honewort and white rock rose. The manor of Cheddar was a royal demesne in Saxon times, and the witenagemot was held there in 966 and 968. It was granted by King John in 1204 to Hugh, archdeacon of Wells. The bishop of Bath and Wells granted it to the king in 1553. It is now owned by the marquess of Bath. The market and stock fairs have long been discontinued, the former in about 1690. The name of Cheddar is given to a well-known species of cheese (*q.v.*), the manufacture of which began about the 16th century; strawberries are plentiful in the neighbourhood.

CHEDUBA ISLAND lies in the Bay of Bengal, 10 mi. from the coast of Arakan, Burma. It forms part of the Kyaukpyu district of Arakan. The island extends about 20 mi. in length from north to south and 17 mi. from east to west, and its area of 220 sq.mi. supports a population of 46,723. The channel between the island and the mainland is navigable for boats. Cheduba was a stopping place on the historically important coastal trade route from Bengal, India, by way of Akyab and Pegu to lower Burma and Indonesia. It was along this route that civilization spread from India to Burma in the early years of the Christian era. Buddhism arrived later by the same way, as did also the earliest contacts with the East India company. Small craft still call at the island on their way from Chittagong, Pak., and Akyab to Rangoon. Slight volcanic activity is shown by the presence of mud cones emitting steam and sulfurous fumes. There are oil and gas seepages but extensive exploration has failed to locate a field of economic importance. (L. D. S.)

CHEERING, loud shouting or voicing of sounds, usually in large assemblies, to encourage or incite to action or show approval or exultation. Cheering may be peaceful, connected with games, athletic contests, and civic and social events, or warlike, connected with participation in battle. The two types are somewhat closely related. Loudness, an important feature of cheering, is often referred to in history and literature. When the foundation of the Temple at Jerusalem was laid, "all the people shouted with a great shout" (Ezra 3:11). Shakespeare, in the first scene of *Julius Caesar*, tells how the Romans, welcoming Pompey, made such "an universal shout, that Tiber trembled underneath her banks."

Words with little or no meaning are often used in cheering, as in "hip hip hip hurrah," where the three hips, sometimes timed by a cheerleader, serve as preparation for the hurrah with its prolonged and noisy second syllable.

Cheering sometimes takes on a dignified and solemn form, as when in a British coronation service the people loudly signify their allegiance to the new monarch "all with one voice." This is according to ancient custom, perhaps from the days when a tribe's fighting men chose their ruler by conclamation, the shouting of many voices in unison. Cheering is also a form of applause at theatrical exhibitions. Audiences in ancient Rome sometimes chanted their applause, presumably in unison.

The college yell is a form of cheering popular in the United States and Canada from the middle of the 19th century. It is used principally at athletic contests. Each college or school has its yells, rhythmic arrangements of words or syllables to be shouted by the students in chorus, usually directed by one or more cheerleaders.

A formula popular in the 1860s was "hiss-boom-ah!," known as a skyrocket. "Hiss" represented the sound when a rocket was ignited, "boom" the resultant bang, and "ah" the delight of the crowd when the rocket shed coloured stars. A variant is the better-known "sis-boom-rah." The syllable "rah," heard in many yells, is a shortened form of hurrah. There are hundreds of novelty yells, some introducing whistling, growling, handclapping, or imitations of sirens and other sound effects. Yells have been used as war cries. Gideon and his men routed the Midianites aided by a shouted slogan, "A sword for the Lord and for Gideon!" (Judg. 7:20). The word "hurrah," so often used in peaceful acclamation, served as a battle cry for Prussian soldiers in 1813. *Banzai* was used similarly by the Japanese in the Russo-Japanese War and in World War II.

Slogan, derived from a Gaelic term meaning battle yell, refers to war cries such as were formerly used by the Scottish clans. Some slogans repeated the clan surname, as "A Gordon! A Gordon!" Others named a rallying place; the Buchanans shouted "Clàr Innis!," an island in Loch Lomond. Still others named a plant or flower, as Clan Macqueen with its "Fraoch!" ("Heather!"). (A. McQ.)

CHEESE is the food made by coagulating milk, removing the whey, and preserving the curd. Milk is coagulated by the enzyme rennin or by an acid, or both, acting upon casein, the chief protein of milk. Coagulation of milk is the first essential step in converting milk into cheese. The rennin used for this purpose is obtained in a salt-brine extract from the fourth stomach of young, preferably milk-fed calves; this solution is called rennet extract or rennet. Rennin causes casein particles to coalesce in the presence of soluble calcium salts of milk and to form curd. The acid used to coagulate milk is developed by microorganisms that convert lactose (milk sugar) into lactic acid. When enough acid develops in the milk, a soft gel (the curd) is formed by the particles of casein made insoluble by the acid.

Milk at the moment of coagulation contains all of the milk constituents, including most of the fat, casein, and other water-insoluble substances. The curd is cut or broken to release the whey, or waterlike fraction, which contains the water-soluble constituents. The curd always retains a portion of the whey.

TECHNOLOGY OF CHEESE MANUFACTURE

Milk Sources.—Hundreds of varieties of cheese are made from the milk of the cow, ewe, or goat, and occasionally from water buffalo, mare, llama, or yak. This is accomplished by variations in the treatment of milk, curd, and cheese.

The milk itself is varied by choosing it from certain different animals, or by adjusting its fat content. Biological agents in the milk are controlled by heating or pasteurizing, and by adding enzymes or cultures of bacteria, molds, or yeasts. Milk is homogenized to make smaller fat globules for desired curd properties or to hasten actions of enzymes that produce flavour.

Handling the Curd.—Curd formation is varied by changing temperature, time, and acidity for coagulation and by altering amounts and proportions of rennet and acid.

Curd is manipulated differently for each variety to control the speed and extent of removal of the whey. This is done through cutting, stirring, heating, washing, removing free whey, pressing, and salting.

Ripening and Curing.—The series of biological and chemical processes that begin in the newly made curd and continue more or less rapidly until the cheese is eaten are known as ripening or curing. Before cheese is ripened it is said to be fresh or green; after ripening it is cured, aged, or ripened.

When cheese ripens it undergoes profound physical, biological, and chemical changes. These changes are affected by the composition of the cheese (*e.g.*, by its moisture content and acidity); by its texture, shape, and size; and by the number and types of microorganisms in it, as well as by the temperature and humidity of the storeroom and by handling of the surface of the cheese. The changes alter the consistency as well as the flavour of the product. The nature of the chemical changes can be classified broadly as the breakdown of fats to fatty acids, proteins to amino acids, and lactose to such products as lactic, acetic, and propionic acids, diacetyl, and carbon dioxide. The flavourful products of ripening include volatile fatty acids, ketones, esters, alcohols, peptides, amino acids, ammonia, hydrogen sulfide, and many others.

Food Values.—Cheesemaking reduces ten volumes of milk to about one volume of cheese. Whole-milk cheeses, such as Cheddar and other common hard varieties, contain approximately 36% moisture, 34% fat, 24% protein, 1.7% salt, and 4.3% other milk solids. Such cheese contains most of the fat, casein, calcium, vitamin A, and small amounts of solids from the residual whey. The food energy value of such cheese approximates 3,924 cal. per kg. (1,784 cal. per lb.). In converting 100 kg. of milk into cheese, approximately 90 kg. of whey is removed. This whey contains about 4.9% lactose, 0.9% protein, 0.45% fat and fatlike substances, 0.6% ash, and a small amount of lactic acid. After centrifuging to remove fat, the whey is concentrated or dried and used for human food in processed cheese products, baking, candymaking (confectionery), and other foods. Whey is used for animal feed as a liquid, concentrate, or dry powder.

Standards.—The Food and Agricultural Organization/World Health Organization code of principles for milk and milk products and their standards, which was set up on the initiative of the International Dairy Federation (IDF), contains a general standard for cheese. The IDF in the mid-1960s was preparing draft international standards for individual cheeses.

HISTORY

Ancient Origin.—Cheesemaking probably originated when man first took milk from wild or domesticated animals. Any milk, if not used promptly, sooner or later sours to form acid curd, which releases whey and leaves semisolid curd. This was probably the first form of cheese. Primitive peoples still use this procedure or mix milk with juices or extracts of certain plants or animal tissues that turn milk into curd and whey. The Old Testament contains several references to curd and cheese; "cheese of the herd" was given to King David (II Sam. 17:27–29), indicating that milk from cows, and presumably other animals, was being used for cheesemaking by about 1000 B.C. The Greeks and Romans also knew and valued cheese before the Christian era. Early peoples living in northern Europe and England made simple types of curd and cheese, which the Romans observed and used. When methods for cheesemaking improved, they were kept secret as long as possible; some are still secret today.

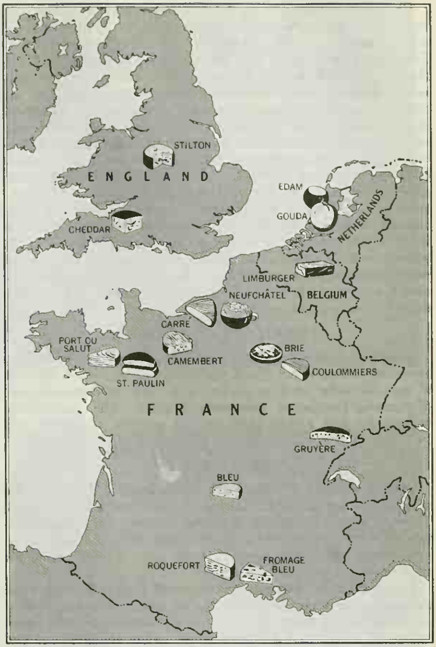


FIG. 1.—CHEESES OF BELGIUM, ENGLAND, FRANCE, AND THE NETHERLANDS AND THE AREAS IN WHICH THEY ARE PRODUCED

Cheesemaking can, of course, be regarded as a way of preserving milk (other ways being drying, condensing, buttermaking, and production of "fermented" milks). It has been of primary importance for hundreds of years in the Netherlands, France, Italy, and Switzerland. The French cheese industry is remarkable for its variety, between 70 and 300 kinds being distinguished.

Man through the ages has adapted his cheesemaking to take advantage of his environment. The heating and kneading of curd, as used in making Provolone cheese (see below), produces the keeping quality needed to preserve curd under the climatic conditions of Mediterranean countries, where this type of cheese originated. Similarly, good keeping properties characterize the so-called "white cheeses," *e.g.*, the Egyptian Domiati, which is made for preservation in salt brine. The loosely knit structure of French Roquefort develops blue mold only in a cool, wet atmosphere such as occurs naturally in the caves of Roquefort. These typical examples suggest why certain cheeses are historically associated with particular areas.

Beginning of Factory Methods.—Cheese was first made commercially on a small scale as a home or farm enterprise; some is still made that way. Gruyère is still made by the old system of collecting milk from a very small number of farms. The factory system came into use toward the end of the 19th century, but the first factories, too, received the milk of only a few farms.

Capacities increased manyfold as transportation facilities, control of milk quality, knowledge of the principles of cheesemaking, and mechanical methods of handling milk and curd improved. In Europe and parts of the U.S., the marketing of cheese developed through cheese fairs or cheese boards in market towns, but these have largely died out as factory production increased. The factory system of manufacture has led gradually to considerable changes in technique, as a result, for example, of pasteurization of milk and mechanization of its handling, so that the quality of cheese is much more uniform (although not necessarily better) and there are fewer varieties. By the early 1960s, almost complete mechanization of cheesemaking had been introduced for some varieties. The cheese moves from factory to warehouse, where carefully controlled temperature and humidity can be provided for the most efficient ripening of cheese from many factories. In the warehouse the product is analyzed, graded, and sorted. At the warehouses, factories, or special packaging centres the cheese is placed in protective wrappers or other containers before being shipped to stores and consumers. (W. V. P.)

VARIETIES OF CHEESE

Varieties of cheese can be classified for general consideration according to consistency (hard, semihard, soft, semisoft), methods of manufacturing (acid or rennet curd), and the degree or type of ripening (unripened, mold-ripened, etc.). The classification utilized for this article, although not entirely consistent, will serve.

HARD CHEESES

Grated Cheeses With a Very Long Curing Time.—These are mostly used in the kitchen, as in soups and with macaroni. The most important varieties are found in Italy. For the manufacture of Parmesan and Sbrinz (from which many Balkan cheeses, *e.g.*, Brinza, have been derived), cows' milk is used, while for Pecorino Romano ewes' milk is used.

Parmesan is the name commonly used outside Italy for the cheese that has been made at Parma for centuries under the local name of Grana, which refers to its granular appearance when broken. The cheese is low in moisture and ripens in one or two years in cool, well-ventilated storage. In the United States the surface is protected by a coating of black wax; in Italy carbon black is mixed with vegetable oil and rubbed on the surface. The ripened cheese has a pleasing, sharp aroma and a salty, meaty taste. It contains about 29% moisture and 28% fat. The cheese is frequently grated, further dried, and packaged in small shaker-type containers for home use. Similar varieties are Parmigiano, Reggiano, Lodigiano, and Emiliano. A type of Romano called Vacchino Romano, because it is commonly made from cows' milk, is a hard, ripened Italian cheese of the Parmesan type. Large amounts of it are made in Sardinia and the United States as well as in Italy. It is made somewhat like Parmesan, except that mildly lipolytic enzymes are added to the milk in paste or extract form to give the characteristic piquant flavour, whose slight saltiness is accounted for by the heavy salting of the pressed curd. The cheese is ripened at about 55° F (13° C), turned, scraped, and rubbed with olive oil to protect the surfaces. It may be used as table cheese after five months' ripening, and, after further aging, for grating purposes. Its consistency is hard, granular, and brittle when thinly sliced. It has few (if any) small, irregular holes, and the colour is white to very pale yellow. Romano contains about 32% moisture, 27% fat, and 6% salt. Similar varieties are Pecorino Romano (from ewes' milk), Caprino Romano (from goats' milk), Sardo, and Romanello ("little Romano"). These grated cheeses cure from the interior. The cooking temperature during manufacture is rather high.

Large Cheeses With a High Cooking Temperature.—Emmentaler, the largest, is made from cows' milk by a process that originated in the Emme River valley (Emmental) in the canton of Bern, Switz. The essential process is followed in the United States and most other dairying countries. The cheese is made in large wheel shapes, about 90 cm. (36 in.) diameter by 15 cm. (6 in.) thickness. The curd is formed by rennet. After the usual cutting, stirring, and heating to about 126° F (52° C), all the curd from 1,000 kg. (2,205 lb.) of milk is lifted from the whey in one mass in a fine-mesh net and pressed into the characteristic wheel. It is shaped in blocks, salted in strong brine, and then wrapped in film to prevent drying. The cheese is held at a temperature of 72° to 80° F (22° to 27° C), so stimulating production of carbon dioxide, which forms the characteristic glossy holes or "eyes" in six to eight weeks. Complete ripening takes three to six months. Pure cultures of *Streptococcus thermophilus*, *Lactobacillus bulgaricus*, and *Propionibacterium shermanii* are used to control development of acid, eyes, and flavour. This sweet-curd cheese has a pungent, sweetish odour and tastes slightly salty when fresh, and pleasingly sharp when fully ripened. Its consistency is firm and elastic, and the cheese is easy to slice; the interior is a uniform light yellow in colour with holes about 1.6 cm. (approximately ⅝ in.) diameter spaced 5 to 7 cm. (2 to 3 in.) apart. The rind being kept clean, the cheese cures from the inside; the propionic acid bacteria are largely responsible for the many big holes. Gruyère cheese, which is somewhat smaller than Emmentaler, shows an important surface ripening by bacteria and has few or no holes. French cheeses of this type are Comté and Beaufort.

English-Type, Rather Acid Cheeses.—The most widely known and consumed of these is Cheddar cheese, followed by Cheshire and some others. Acid development and salting of the curd before pressing is characteristic. These cheeses cure from the inside.

Cheddar is made in cylindrical and block forms, and in various sizes; *e.g.*, 2.5 kg. (5-lb.) midgets; 5.5 kg. (12-lb.) longhorns; 9 kg. (20-lb.) daisies; 9-, 18- or 27-kg. (20-, 40-, or 60-lb.) blocks; 35 kg. (75-lb.) cheddars; and mammoths ranging from 135 kg. (300 lb.) up to 3 tons and more. Blocks are often cut into small pieces that are sealed in protective wrappers for retail sales.

This cheese originated probably in or before the 16th century in Cheddar, Somerset, Eng. Early English settlers made it in America. It is most commonly made in England, Canada, New Zealand, Australia, and the United States, and is identified accordingly as Canadian Cheddar, English Cheddar, American cheese, or American Cheddar cheese.

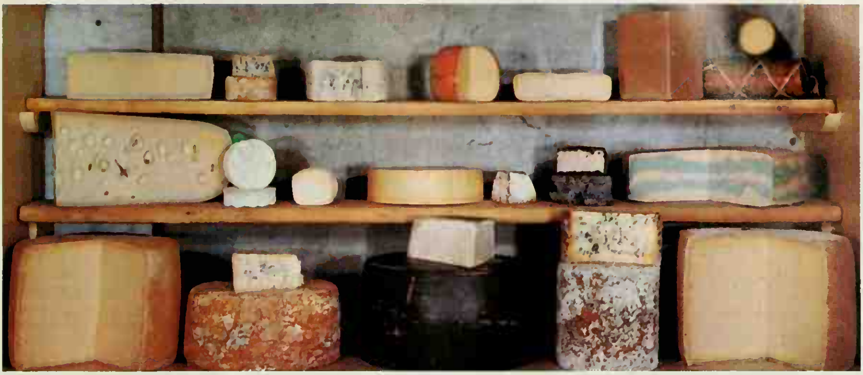
Cheddar has a mild aroma that becomes more intense with age; it is mildly salty, and when fully ripened gives a tingling sensation in the mouth and leaves a taste like sweet nuts. The consistency is elastic; firm, but not hard; and smooth like wax or cold butter when crushed. It has a few irregularly shaped openings and a uniformly coloured interior ranging from light amber to golden yellow or cadmium orange. It varies in moisture according to trade demands and country of origin, but averages 36% moisture with 34% fat. It can be much modified by varying its milk composition, curd treatments, and moisture content; as for example, in the types called Stirred Curd, Colby, and Washed Curd.

SEMIHARD CHEESES

Dutch-Type Cheeses.—The types called Edam and Gouda are produced throughout almost the entire world, sometimes under different names.

Edam is a semihard cows'-milk cheese. The curd is formed with rennet and finally pressed, usually in ball shapes, to remove the whey. It is salted, held briefly in the factory, and then ripened further in a warehouse. Then it is graded, smoothed (if necessary) in a turning machine, coloured red, oiled, and wrapped for distribution. The surface may be protected by immersing the cheese in red paraffin wax or by sealing it in tin cans. It is a sweet-curd cheese with a mild aroma and a slightly salty, tangy taste when ripened; its consistency is firm, and its interior is uniformly coloured yellow with few if any holes. Dutch cheese commonly has about 38% moisture and 32% fat. It is often made with less fat and sold under government label for use in warm countries. In other countries, *e.g.*, Germany and the United States, a similar cheese with the same name is made, but it is usually loaf shaped.

Gouda is a sweet-curd cheese made much like Edam but with



Top row: Gruyère, Bresse bleu, Roquefort, Edam, Italico, Gjetost, Hungarian Trappist
Centre row: Emmentaler, Camembert, Cream cheese, Caerphilly, Goat cheese, Tome au raisin, Sage Derby
Bottom row: Cheshire, Gorgonzola, Parmesan, Stilton, Cheddar

Camembert, soft cheese made from cows' milk. The creamy texture is produced by the action of an outer coating of *Penicillium candidum* and *Penicillium camemberti* mold

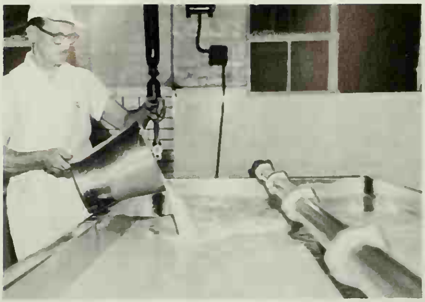
Roquefort, semisoft cheese made from ewes' milk. The sporulation of *P. roquefortii* mold during the ripening period causes the greenish-blue marbling characteristic of this cheese

Emmentaler, a hard cheese made from cows' milk. As the cheese ripens, it is kept at 72° to 80° F (22° to 27° C) to produce carbon dioxide which, with the help of added bacterial cultures, creates the holes, or "eyes"

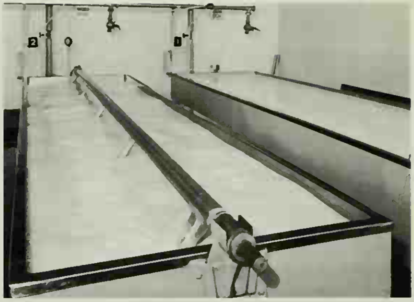
Edam, semihard cheese made from partly skimmed cows' milk. Its familiar red coating is applied after ripening by dipping the pressed cheese into red-coloured paraffin

EUROPEAN CHEESES

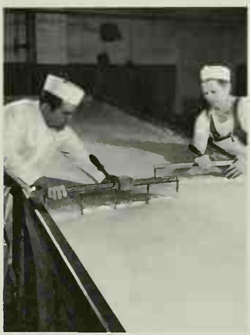
BY COURTESY OF (TOP) PAXTON & WHITFIELD LTD, LONDON; PHOTOGRAPHS, (OTHERS) © ENCYCLOPÆDIA BRITANNICA INC



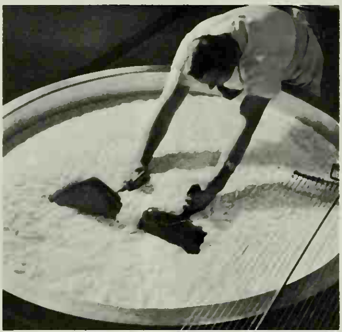
Rennet extract, the curdling agent used in cheese making, being added to a vat of warm milk. The action of the enzymes in the rennet causes the milk proteins to coagulate, producing a junketlike curd in the milk



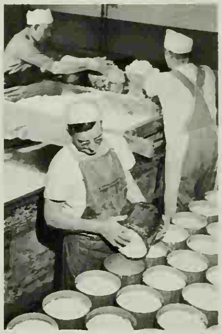
Automatic paddles stirring the milk-rennet mixture in order to keep the rennet evenly distributed throughout the milk before the enzymes begin to act on the milk proteins



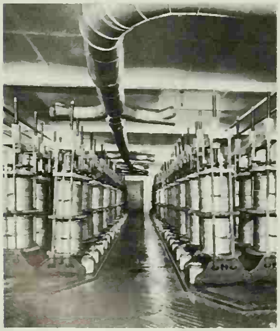
Cutting the curd with cheese harps into small cubes to facilitate draining off the whey, the liquid residue from the coagulated milk



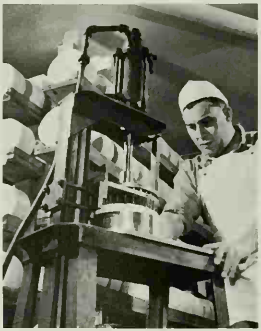
Swiss cheese curd, after cutting, being broken into smaller particles before draining. The curd is lifted from the whey in one large mass and pressed into a wheel



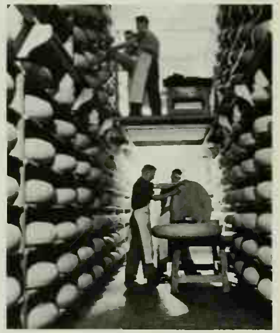
Drained curd being placed into hoops for pressing. In the back curd is being tossed in the air to further draining



Press room where the hoops containing cheese curd are subjected to high pressure to expel excess moisture and to form an outside coating



Holes being punched into blue cheese. During the ripening period mold grows in these and the natural openings in the cheese loaves



Wheels of Swiss cheese being stored in curing cellars where they are kept at controlled temperatures until they ripen

STAGES IN DIFFERENT CHEESE-MAKING PROCESSES

PHOTOGRAPHS, (TOP LEFT AND RIGHT, BOTTOM LEFT) ENGLISH COUNTRY CHEESE COUNCIL, (CENTRE LEFT AND RIGHT, BOTTOM CENTRE) © ENCYCLOPÆDIA BRITANNICA, INC., (CENTRE, BOTTOM RIGHT) SWISS CHEESE UNION INC

more fat and in a different shape. When sliced, it often shows round as well as irregularly shaped openings and a uniform, yellowish colour. The Dutch-type cheeses cure from the inside.

Tilsiter and Other Types.—Tilsiter and certain other cheeses like Stangenkäse may undergo surface ripening by bacteria. Nowadays, however, these cheeses are often classified with Edam and Gouda because the surface ripening no longer occurs.

Italian-Type Cheeses.—Provolone and Caciocavallo (*pasta filata*) have unique manufacturing procedures. When the necessary acidity has developed during curdmaking, the curd is made plastic by heating and kneading it in hot water or hot whey until it can be stretched into ropelike strands or threads. These strands are gathered into a ball and worked and molded by hand to make a crevice-free cheese of the desired shape and size. The shaped cheese is chilled in cold water, salted in brine, and smoked. It ripens in three to six months.

Provolone is a pear-shaped cheese weighing about 4.5 kg. (10 lb.). Smaller varieties are Provolette and Provoloncini. When made in a sausage shape, Provolone is known as Salame; in a small sausage shape, Salamini. It contains about 40% moisture and 28% fat. These cheeses cure from the inside. A soft and usually unripened variety is Mozzarella, which is mostly used for cooking, for instance in pizza.

SEMISOFT CHEESES

The manufacture of rather soft cheese developed rapidly at mid-20th century. It is relatively little ripened, and then mainly from the inside. It may be, for example, a variety of Gouda; another type is the original Port du Salut, made from cows' milk, and first developed by Trappist monks about 1865 at the abbey at Port du Salut, near Laval, France. It is much imitated and goes by the names of Saint-Paulin, Trappist, Italico, and Butterkäse.

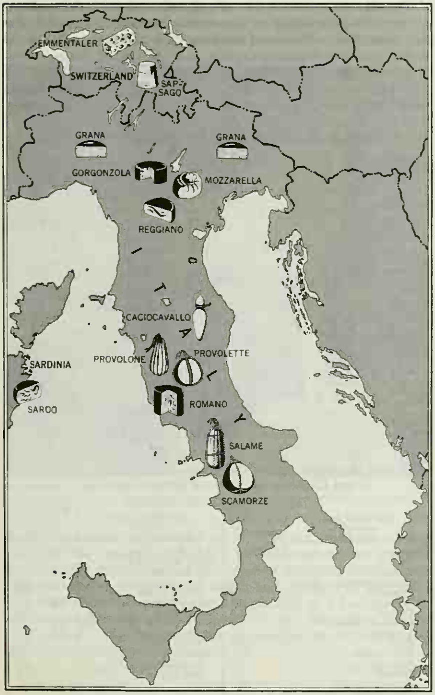


FIG. 2.—CHEESES OF ITALY AND SWITZERLAND AND THE AREAS IN WHICH THEY ARE PRODUCED

There are also cheeses with a rather soft but not creamy texture, which show more surface ripening. These include, for example, Saint-Nectaire and Vacherin. It is often difficult to distinguish such cheeses from those discussed in the following section.

SOFT CHEESES

These cheeses, mainly French types, are surface-ripened and are never pressed. They can be divided into two groups.

Cheeses With a White Mold.—The best known of these is Camembert, important in France and elsewhere; Brie should also be mentioned. Camembert is a small cheese made from cows' milk with rennet. It originated in France about 1791 and is now made in many countries. It is ripened with *Penicillium candidum* and *Penicillium camemberti*, which is mixed with the milk or placed on the surface of the cheese during or after salting. The mold forms a thick, white layer on the surface and causes the cheese to soften from the outside to the centre. The fresh curd has an acid taste, and is white in colour after salting. The ripened product is yellowish in colour and waxy, creamy, or almost fluid in consistency, depending upon the extent of ripening. The flavour varies from mild to strong as the cheese ripens. It contains about 52% moisture and 26% fat.

Cheeses Surface-Ripened by Red Smear.—A pronounced flavour is given by this smear which involves the growth of, first, yeasts and micrococci and then of small rod-shaped bacteria of *Brevi Bacterium linens* which have a reddish appearance. Strongly flavoured cheeses include: Reblochon, Pont l'Évêque, Carré, Münster, Limburger, Herve; the last two originated in Belgium. Some of these cheeses are popular in Germany, Austria and the United States. Numerous related but milder cheeses are also surface ripened, *e.g.*, the brick-shaped Brick, developed in the United States about 1880.

BLUE CHEESES

Blue is a semihard, mold-ripened cheese made in all dairy countries, and sometimes known as blue-mold or blue-veined cheese. It is made from cows' milk which may or may not be homogenized.

The blue mold is essential to the cheese. Spores of *Penicillium roquefortii* are mixed with either the milk or the curd. The mold, during three to six months of ripening, grows both in small, irregular, natural openings in the cheese and in machine-made perforations; it sporulates to give the typical blue or greenish-blue streaks in the white cheese, and, eventually, the characteristic flavour. The cheese is heavily salted. It is sometimes waxed or wrapped during ripening to minimize the growth of microorganisms on the surface; but usually it is scraped and wrapped in foil for marketing. The odour of the ripened cheese is fragrant and pungent, the taste is salty and tingling, and the consistency is crumbly or sliceable and soft to semihard. This cheese contains about 40% moisture and 32% fat.

There are several varieties of blue cheese. A semihard kind is Stilton, made in Leicestershire and Derbyshire, Eng. Semisoft varieties include the various French Fromages Bleus, Danish Danablu, and Italian Gorgonzola; the last named also showing surface ripening. Perhaps the best-known cheese in this category is Roquefort, made from ewes' milk. This cheese is ripened for three to five months in caves in or near Roquefort, France, where its manufacture dates back at least to the beginning of the 18th century. The curd was formerly made by shepherds, but now the milk is collected at factories and made into curd that is taken to the caves. The name "Roquefort" is trademarked.

GOATS'-MILK CHEESES

Small amounts of goats'-milk cheeses of many kinds are made in the usual way, and often not given an identification to distinguish them from cows'-milk cheese. This type of cheese is found in France, in Norway, and in semitropical countries. It is eaten

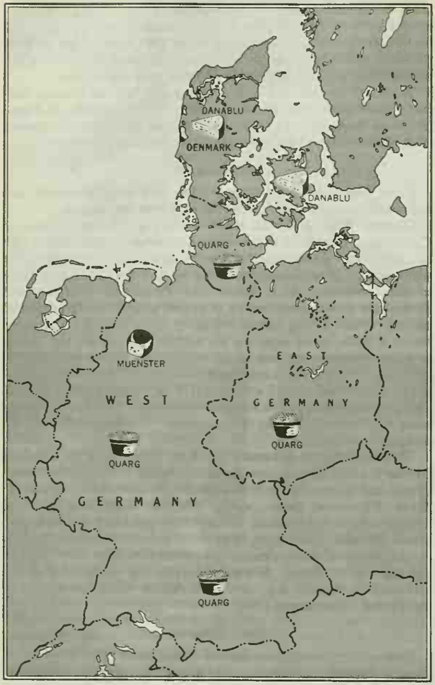


FIG. 3.—CHEESES OF DENMARK AND GERMANY AND THE AREAS IN WHICH THEY ARE PRODUCED

in small portions and in a thoroughly ripened condition, which gives it very pungent flavour. The cheese is mostly semisoft.

UNRIPENED CHEESES

Often, no rennet is used in the making of these. In Germany, Quarg is made; in France and elsewhere, Gervais. Petit Suisse has a high-fat content; it is made from fresh milk with cream added, and is not salted. Cream cheese and Neufchatel are made as both ripened and unripened cheese. Cottage cheese is made chiefly in the United States, where its rapidly growing production is second only to that of Cheddar; its popularity in Europe was increasing in the 1960s. It is made from pasteurized skim milk coagulated by lactic acid-producing microorganisms and usually minute amounts of rennet extract. It is usually mixed with cream and sold as creamed cottage cheese, and as such contains about 79% moisture and 4% fat. One kg. has a food energy value of approximately 1,400 calories compared with 1,040 calories for the uncreamed variety (1 lb. of creamed cottage cheese gives 636 calories; 1 lb. of uncreamed gives 473 calories). Cottage cheese is commonly packaged in closed, waxed containers in which it keeps fresh for a week or more when properly refrigerated. The flavour is mildly acid; the consistency is soft enough for the cheese to be served with a spoon; when it is creamed, the appearance is granular or glossy; and the colour is white or creamlike.

PROCESSED CHEESE

This is not another variety of cheese; it is made by grinding together different lots of cheese of the same or different varieties, and melting them after incorporation of certain emulsifying salts, which change the consistency of the cheese. Most varieties of cheese, when sufficiently ripened, may be used for making pasteurized processed cheese. Frequently, Cheddar serves as the base. Small amounts of other foodstuffs, such as seasoning and ham, often are added to processed cheese. Blending and heating of the natural cheese produces uniform quality and keeping properties but reduces flavour intensity. The hot, melted cheese is poured into lined boxes or other containers and sealed for protection. Its composition approximates that of the original cheese. Processed cheese was developed commercially after 1912, and the large volume produced has had a generally stimulating, competitive effect on production, packaging, and merchandizing of natural cheese.

CONSUMPTION, PRODUCTION, AND TRADE

The percentage of food energy supplied by cheese in the diets of different peoples varies quite widely, taking the food energy of cheese as approximately 3,924 calories per kg., as in Emmentaler or Cheddar. Of the Western countries, the Italians eat the most cheese, which represents 3% of their food energy; they are followed by the French, Swiss, Norwegians, Swedes, Dutch, and Danes. The West Germans, British, and Americans derive less than 1.5% of their calories from cheese, while the Canadians, Australians, and New Zealanders get less than 1% of food energy from cheese.

Production in each country is not directly related to consumption there, but to factors such as the cheesemaking tradition and skill, the number and productivity of cows, and cheese prices. Market factors, such as advertising and consumer demand, for instance for palatability or convenient forms of packaging, also play their part. Wholesale markets exist in many parts of the world, including England, Canada, and the United States. Production in certain countries is shown in Table I.

World trade in cheeses is governed by the normal rules of movement from points of surplus to areas of consumption. The Nether-

TABLE I.—*Percentages of Total Production of All Cheese by Certain Countries*

Country	Percentage of total production*	Country	Percentage of total production*
Argentina	3.4	Italy	8.3
Australia	1.3	Japan	0.2
Austria	0.9	Netherlands	5.4
Belgium	0.7	New Zealand	2.4
Brazil	1.0	Norway	1.0
Bulgaria	2.4	Peru	0.2
Canada	2.0	Poland	4.4
Chile	0.3	Portugal	0.1
Cyprus	0.1	Rumania	1.1
Czechoslovakia	1.8	South Africa	0.3
Denmark	2.8	Spain	1.2
Finland	0.8	Sweden	1.3
France	10.1	Switzerland	1.6
Germany, East	1.0	U.S.S.R.	5.2
Germany, West	7.7	United Kingdom	2.8
Greece	2.8	United States	23.5
Hungary	0.6	Uruguay	0.2
Ireland	0.2	Venezuela	0.5
Israel	0.4		

*Total production of all cheese made on farms and in factories from whole milk and skim milk from cows, ewes, goats, and buffaloes in 1962 was 4,180,000 metric tons (FAO) for countries mentioned in table.

TABLE II.—*Approximate Percentages of Total Exports of Cheese and Curd by Continents and Certain Countries*

Continent and country	Percentage of total exports*	Continent and country	Percentage of total exports*
Europe	73.4	U.S.S.R.	0.8
Austria	1.4	North and Central America	2.7
Bulgaria	2.1	Canada	1.8
Czechoslovakia	0.7	United States	0.8
Denmark	15.8	South America	0.8
Finland	3.6	Argentina	0.8
France	7.9	Asia	0.1
Germany, West	2.4	Africa	0.8
Hungary	1.6	South Africa	0.7
Italy	4.6	Oceania	21.5
Netherlands	21.6	Australia	3.7
Norway	1.9	New Zealand	17.8
Poland	0.7		
Sweden	0.7		
Switzerland	6.7		

*Total exports of cheese and curd in 1961 approximated 500,000 metric tons (FAO).

lands make up one-fifth of world exports while New Zealand and Denmark both export about one-sixth. Table 11 shows exporting countries by percentages. Because of the heterogenous character of the commodity, the important dairy countries of the world are both importers and exporters. Thus Europe, which makes up seven-tenths of the world exports, takes an even greater proportion of the imports. The leading importer is the United Kingdom which takes over one-quarter of world imports followed closely by West Germany; Belgium, Italy, and the United States all take sizeable quantities.

For information about the use of cheese in cooking, *see* FOOD PREPARATION: *Cheese, Eggs and Fruit;* FOOD PRESERVATION; FOOD PROCESSING INDUSTRY; FOODS, NATIONAL.

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CHEETAH (*Acinonyx jubatus*), a slender, long-legged carnivore of the family Felidae that lives on open plains from southern Africa to India. It reaches a length of 3 to 4 ft. with the tail accounting for another $2\frac{1}{2}$ ft.; it stands, on the average, $2\frac{1}{2}$ ft. at the shoulder and weighs about 100 lb. The colour of the coarse, crisp fur is sandy yellow, white below, with numerous small black spots and a black streak down the face from the corner of the eye. A variety with the spots partly confluent forming stripes and blotches has been erroneously separated as the "king cheetah." The litter is said to number from two to four. Cheetahs hunt alone or in small parties, stalking their prey, usually the smaller antelopes, and then running it down in a final rapid sprint; they are probably the fastest animals over a short distance and can attain 65 to 70 m.p.h. The cheetah has long been domesticated in Asia and used for coursing game; it is not, however, bred in captivity but captured when adult in nooses set around the trees used for claw sharpening. After a period of severe discipline the newly caught cheetah becomes docile and obedient to its trainer. It is taken into the field hooded and chained in a low cart without sides; when the game is about 200 yd. distant the cheetah is unleashed. The cheetah differs from other cats in that it lacks sheaths for retracting its claws.

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CHEETAH (ACINONYX JUBATUS)

See also CARNIVORE; CAT. (L. H. M.)

CHEFOO (YEN-T'AI), former treaty port of Shantung province, on the rocky north coast of the Shantung peninsula, People's Republic of China. The port, officially Yen-t'ai, is one of the few deepwater anchorages along the coast free from silting and sheltered by outlying islands that have been linked together by breakwaters to form a well-protected harbour. Pop. (1953) 116,000. The port was opened to foreign trade in 1863 following its occupation by French and British naval units three years before. Western traders soon began the export of strawbraid for hats, pongee silk cloth and tussore silk yarn, and ladies' hair nets; European missionaries trained women and girls in lace-making and needlework which became the basis of a large export industry. The peninsula is famous for apples, pears, peanuts and grapes that ripen well during the long, dry summer. Missionaries improved the local crops and helped establish a grape wine industry that still flourishes. For many years the port was a well-known summer resort for U.S. naval personnel and foreign tourists. Chefoo has had active trade with Antung across the Gulf of Chihli and with Japan. Until 1956 transportation with the hinterland was limited to mule trains and carts and eventually motor trucks. In that year a branch of the Tsingtao-Tsinan railway was opened from Lantsun, 114 mi. S.W., presumably to supply a port of naval significance and to bring farm, fish and salt produce of the area into the interior. (TE. H.)

CHEJU-DO (QUELPART or CHEJU ISLAND; Japanese, SAISYUTO), an island 60 mi. S.W. of Korea, once used as a place of political exile. It has an area of 692 sq.mi. and measures 40 mi. from east to west and 17 mi. from north to south It rises gradually from the seaboard, is heavily wooded and is cleared for cultivation to a height of 2,000 ft. The island is composed of a core of volcanic material which rises symmetrically to the crest of Halla-san, 6,398 ft. in height. There are several crateriform hills, out of which volcanic material has flowed. The soil along the coastal areas is finely disintegrated lava. The population (1960) of 281,663 was Korean by race and language. Since this population included many refugees driven to the island by the Korean War (1950–53), there were more women than men.

The valleys and slopes are carefully cultivated in fields divided by stone walls. The islanders manufacture, for export and local use, fine bamboo hats and mats, and wooden combs. For fishing the natives use double-decked raft boats, similar to those of southern Formosa. A valuable product of Cheju-do is a species of clam, the shell of which furnishes a specially iridescent mother-of-pearl that the natives sell to the Japanese for inlaying lacquer. Seaweed and shellfish are also obtained by organizations of skilled women divers. The upland areas were formerly used for pasturing ponies whose hair was used for weaving old-style Korean hats, but this industry has declined in favour of cattle raising.

Cheju (pop. [1960] 67,991) is the principal city and the capital of the province. The island was formerly a part of South Cholla (Chel-la) province but in 1948 was given independent status. It is divided into counties and has 90 villages and towns. (S. McC.)

CHEKE, SIR JOHN (1514–1557), English classical scholar who played a prominent part in the revival of Greek learning in England, was born at Cambridge on June 16, 1514. There, at St. John's college, where he became a fellow in 1529, he adopted the principles of the Reformation. On the foundation of the regius professorships in 1540, he was elected to the chair of Greek, and with Sir Thomas Smith, who shares with him the credit for the establishment of Greek studies at Cambridge, he introduced the Erasmian pronunciation of Greek there. Although at first it was strenuously opposed, Cheke ultimately triumphed. On July 10, 1544, he was chosen tutor to Prince Edward, remaining after the prince became king as Edward VI. Cheke was member for Bletchingly in the parliaments of 1547 and 1552–53. He was made provost of King's college, Cambridge, in 1548 and was one of those appointed to draw up a body of laws for the governance of the church. He was knighted in 1552 and became a secretary of state and privy councilor in 1553, keeping his offices during Lady Jane Grey's nine-day reign. In consequence Queen Mary imprisoned him in July 1553 and confiscated his wealth. Released in Sept. 1554 and allowed to travel abroad, he finally settled at Strasbourg, teaching Greek for a living. In 1556, on his return from a visit to Brussels to see his wife, he was treacherously seized by order of Philip II of Spain, hurried over to England and again imprisoned in the Tower of London. Cheke, terrified by the threat of the stake, gave way and was received into the Roman Catholic Church after being cruelly forced to make two public recantations. He died in London on Sept. 13, 1557.

Cheke was the author of several works of theology and classical scholarship. He also translated Greek authors and lectured admirably on Demosthenes. Among his most interesting works are *The Hurt of Sedition* (1549), written on the occasion of Ket's rebellion, and *The Gospel According to St. Matthew . . . Translated* (*c.* 1550; ed. by James Goodwin, 1843).

See John Strype, *The Life of the Learned Sir John Cheke* (1705).

CHEKHOV, ANTON PAVLOVICH (1860–1904), internationally famous Russian playwright and short-story writer, was born at Taganrog on Jan. 17 (old style; Jan. 29, new style), 1860. But for the fact that his grandfather had saved up enough money to buy his freedom from his master, a rich landowner, Chekhov would have been born a serf. His father, Pavel, owned a small grocery shop in Taganrog, where as a small boy Chekhov was left to serve the customers. With his two elder brothers Chekhov received his education first at a Greek preparatory school and then at the Taganrog secondary school. During his last three years at school Chekhov had to fend for himself, for his father, being more interested in local politics and the church choir than in keeping an eye on his business, had gone bankrupt and had to flee from his creditors to Moscow with his family. It was during these three years that Chekhov acquired his strong sense of independence and responsibility which enabled him to become the sole provider of his family in Moscow when he arrived there in 1879 to study medicine on a scholarship from the Taganrog municipality. He did this by writing humorous stories for the St. Petersburg and Moscow popular magazines.

Chekhov's real literary career, however, began a year after he had taken his medical degree with his first visit to St. Petersburg in Dec. 1885. There to his astonishment he discovered that he had become a famous writer and was horrified at the happy-go-lucky way in which he had been writing his stories. A letter he received from the veteran novelist Dmitri Grigorovich a short time after his return to Moscow, hailing him as a writer of genius and cautioning him against frittering away his talent on trifles, decided Chekhov to devote himself entirely to literature. It was through Grigorovich that Chekhov obtained an introduction to the influential newspaper publisher Aleksei S. Suvorin, whose close friend he became and in whose daily, *Novoe Vremya,* some of his most famous stories were published.

At the age of 23 Chekhov contracted tuberculosis, a disease to which he was predisposed by heredity (many of his relations, including his second brother, died of it) and which he seems to have been successful in concealing from his family for 14 years. He, too, died of it, at the early age of 44.

Chekhov's fame as a playwright began with the production of his full-length play *Ivanov* in 1887. Between 1886 and 1890 Chekhov fell under the spell of Tolstoi's teachings, though he did not himself meet Tolstoi till 1895. It was chiefly as a result of his Tolstoian convictions that he made his arduous journey to the island of Sakhalin to study the appalling conditions under which the convicts were forced to live, for which he declared every man in Russia ought to feel responsible. He left for Sakhalin in 1890 and published his impressions of the journey in 1894 under the title *The Island Sakhalin.* On his return he went for his first trip abroad with Suvorin, visiting Austria, Italy and France. He went abroad again by himself for health reasons in 1894, 1897–98 and 1900–01, staying mostly in Nice. During his stay in Nice in 1898 he took a great interest in the Dreyfus affair. His championing of Dreyfus' cause brought him into sharp conflict with Suvorin and was responsible for the breaking up of their friendship.

In 1892 Chekhov acquired the 300-ac. estate of Melikhovo in the province of Moscow. There he lived with his parents and his younger sister Mary, writing and giving free medical treatment to the peasants in the neighbourhood. He took an active part in combating the famine of 1891 in the Russian central provinces, in dealing with a cholera epidemic in his own district and in helping with the census of 1897, and he was responsible for the building of several village schools. In 1899 his health forced him to sell his estate and settle in the Crimean seaside resort of Yalta. The last period of his life (1896–1904) is particularly notable for his work as an innovator of drama and for his close connection with the Moscow Art theatre, one of whose actresses, Olga Leonardovna Knipper, he married in May 1901. He was elected honorary member of the Russian Academy of Science (literary section) in 1900 but resigned when the election of Gorki, whom he had befriended in the Crimea, was annulled at the behest of the tsar. He died at the Black Forest spa of Badenweiler on July 2 (O.S., 15, N.S.), 1904.

Short Stories.—Broadly speaking, Chekhov's short stories can be divided into three periods: (1) the bread-and-butter period (1880–86) when Chekhov used to toss off hundreds of humorous tales, some of them mere comic incidents showing here and there a keen sense of the social scene and of the incongruities of life, some revealing a deep feeling for human injustice and suffering; (2) the brief Tolstoian period during which he became conscious of his social and artistic responsibilities as a writer (1886–90); and (3) the period of his complete artistic emancipation (1891–1904).

Chekhov's first story, "A Letter to a Learned Friend," was published in *Strekoza,* a St. Petersburg comic magazine, in Jan. 1880 and was signed "-v." His subsequent stories began to appear regularly in St. Petersburg and Moscow popular magazines under the signature of Antosha Chekhonte. Already in what Chekhov himself described as his "thoughtless and frivolous" stories his characteristic quality of digging below the surface of life, exposing the hidden motives of his characters and revealing the influence of the prevailing social forces upon them can be easily discerned. His real chance as a writer came in 1882 when he became a regular contributor of short stories to *Oskolki,* a popular St. Petersburg weekly magazine for which he wrote about 300 stories. These included such miniature masterpieces as "A Daughter of Albion" (1883), "The Surgery" (1884), "A Chameleon" (1884), "A Dead Body" (1885), "Sergeant Prishibeev" (1885), "Misery" (1886) and "The Chorus Girl" (1886), some of them based on his experience as a medical practitioner in a small country town near Moscow. After his visit to St. Petersburg in 1885, he made his first entry into the daily press, becoming a regular contributor to *Peterburgskaya Gazeta,* for which he wrote, in 1885, "The Gamekeeper" and "The Burbot," in which he showed himself to be a descriptive writer of great originality, and, in 1888, the rather macabre slum story "Sleepy." A few months later he became a contributor to *Novoe Vremya* in which appeared some of his finest pieces of that period, such as "Easter Eve" (1886), "The Rolling Stone" (1887), "Happiness" (1887), an impressionistic story in which Chekhov, in his own words, described "a plain, night, pale sunrise, a flock of sheep, and three human figures discussing happiness," and his famous children's story "Kashtanka" (1887). His unfinished work "The Steppe" (1888), which he intended to make into a novel and for which he had undertaken a journey through the steppe region of southern Russia, he published in the March number of *Severny Vestnik,* his entry into the world of the so-called "fat" or intellectual monthly periodicals.

All the stories Chekhov wrote between 1886 and 1890 bear traces of Tolstoian philosophy of which he had certainly been more than a warm adherent at the time. The most Tolstoian of them, however, such as "The Cossack" (1887), "The Meeting" (1887) and "A Misfortune" (1886), he did not include in his collected works, while others, such as "Excellent People" (1886), "The Beggar" (1887), "The Bet" (1888) and "The Shoemaker and the Devil" (1888), he thoroughly revised. The most remarkable story written during his Tolstoian period is "A Boring Story," in its revised version a philosophic disquisition on art, the theatre and life in general, dealing more particularly with the life story of a stage-struck girl in many respects similar to the story of Nina in *The Seagull.* It was published in *Severny Vestnik* in 1889.

Between 1886 and 1890 were published four volumes of Chekhov's short stories entitled *Pëstrye rasskazy* (1886; Eng. trans. "Motley Stories"), *Nevinnye Rechi* (1887; Eng. trans. "Innocent Speeches"), *V sumerkakh* (1887; Eng. trans. "In the Twilight") and *Rasskazy* (1889; Eng. trans. "Stories"), all of them going through several editions during his lifetime. For the volume *V sumerkakh* Chekhov was awarded the Pushkin prize by the Russian Academy of Science.

Chekhov began his period of maturity as a creative writer by two stories in which he challenged the chief tenets of Tolstoi's teachings. In the first, "The Duel," his major work of 1891, he attacked Tolstoi's argument in *The Kreutzer Sonata* about the ideal of Christian love being incompatible with sexual love. In the second, "Ward No. 6," the only major and marvellously integrated work of art he wrote in 1892, he condemned the chief tenet of Tolstoi's faith, nonresistance to evil. Four years later he resumed his criticism of Tolstoi's ideas and exposed with devastating effect the tragedy of the people who tried to put them into practice in his two stories: "The House With the Attic" and "My Life," both written in 1896. Among the other masterpieces Chekhov wrote between 1891 and 1903 are "The Grasshopper," "A Woman's Kingdom" and his study of megalomania, "The Black Monk," all written in 1892; "The Student" (1894), in which he attempted to meet the accusation that he was a pessimistic writer; "Three Years" (1894), a story of Moscow life, including a great deal of autobiographical material; "Ariadne" (1895); "Peasants" (1897), a sombre description of the appalling conditions under which the peasants in the Russian central provinces were forced to live, which brought Chekhov into conflict with the censors who accused him of blaming the authorities for the peasants' illiteracy; "Ionych," a most perfect example of Chekhov's genius for compressing a man's life within 24 pages, "About Love," "The Man in a Case" and "Gooseberries," all written in 1898; "The Lady With a Lapdog," the story of an ordinary pickup developing into a great passion, and "In the Ravine," written in 1899; "The Bishop," the only story Chekhov wrote in 1901; and his last story, "The Betrothed," a girl's revolt against her middle-class environment, written in 1903.

In 1899 Chekhov entered into an agreement with the St. Petersburg publisher Fedor Marx for the publication of a complete edition of his works, which, with the exception of the royalties from his plays, he sold for 75,000 roubles. During the following three years he was largely occupied with the most thoroughgoing revision of his stories, completely rewriting some of his earlier ones and weeding out those which he did not consider worthy to be reprinted.

Dramatic Works.—It is mainly as a playwright that Chekhov won his fame outside Russia. He began his work as dramatist during his last years at school in Taganrog, where he took an active part in the life of the local theatre, appearing on its stage in several plays, and where he wrote two full-length plays and a one-act comedy, none of which has been preserved. On his arrival in Moscow he wrote another four-act play which he tried unsuccessfully to have performed at the Moscow State (Maly) theatre. This play, which is of quite inordinate length, has been preserved. Its title page is missing and it is known by its hero's name as *Platonov*. It represents Chekhov's first attempt to paint a large canvas of the social forces that were molding Russian life in the last decades of the 19th century. It contains a gallery of well-realized, if at times rather theatrical, characters belonging to different strata of Russian society and shows the clash between the economic forces these characters represent. Platonov, the 27-year-old hero of the play, is a typical rebel against his environment, an idealist who is aware of the folly, laziness and ineptitude of the people around him but is too weak to do anything about it.

In 1887 Chekhov wrote his first successful play *Ivanov*, performed on Nov. 19 of that year in Moscow and with even greater success on Jan. 31, 1889, in St. Petersburg. *Ivanov* shows a great advance on *Platonov* in that it is much more compact and its characters are much more true to life, but it is still full of overdramatized situations and is much too conventional technically. Chekhov wrote his next play, *Leshi* (Eng. trans. *The Wood Demon*), in 1889, during his brief period as a Tolstoian disciple. It is essentially a morality play in which vice is converted to virtue instead of virtue triumphing over vice. Chekhov's main idea in writing this "lyrical play," as he called it, was to show life on the stage "as it really is." In this he failed, for what he actually produced was a revival of an old romantic stage convention with all its incongruous crudities and not the illusion of real life. The play, in fact, teems with coincidences and *deus ex machina* situations. It was a complete failure when produced at a private theatre in Moscow in Dec. 1889 and Chekhov refused to include it in the edition of his collected works.

During his first period as a dramatist Chekhov wrote a number of one-act comedies, the most successful of which were *Medved* (1888; Eng. trans. *The Bear*) and *Predlozhenie* (1889; Eng. trans. *The Proposal*), as well as *Na bolshoi doroge* (Eng. trans. *On the Highway*), "a dramatic study in one act," which the censor banned as being "gloomy and sordid."

There is an interval of seven years between Chekhov's first and second periods of playwriting. During this interval Chekhov perfected his technique of the play of "indirect action," a play, that is, in which the dramatic action takes place off stage and the action of the play is concentrated on the reaction of the characters to the dramatic events in their lives. Chekhov's fame as an innovator of the art of drama rests entirely on this new technique of writing dramatic dialogue. A Chekhov indirect-action play cannot be read, for it only assumes shape and form on the stage. It has to be treated by a producer in the same way as a conductor treats the score of a symphony. It is, in fact, a dramatic score whose manifold themes and climaxes must be carefully studied prior to any production.

Chekhov's first indirect-action play, *Chaika* (1896; Eng. trans. *The Seagull*), was booed off the stage when first performed in St. Petersburg on Oct. 17, 1896. Its failure was due solely to the failure of the producer and actors to grasp the full implications of Chekhov's new dramatic method. On its performance by the newly founded Moscow Art theatre on Dec. 17, 1898, it was a resounding success, but this again was due to the novelty of the inspired stage direction of its producer, Konstantin S. Stanislavski, rather than to its own intrinsic merits as a work of art. In *The Seagull* the action flows logically and naturally out of the interplay of theme and character which have become completely integrated. Indeed, so complete is this synthesis of theme and character that an illusion of real life is created on the stage. Its chief theme, what makes a creative artist, deals with one of the most important problems in the world of art. Chekhov's second play in the new manner, *Dyadya Vanya* (1897; Eng. trans. *Uncle Vanya*), a thoroughly revised version of *The Wood Demon* stripped of its Tolstoian ideology and its melodramatic situations, was produced by the Moscow Art theatre on Oct. 26, 1899 and has proved to be one of the most successful plays in the repertoire of the theatre. Both structurally and psychologically it is not only one of the most compact of Chekhov's great plays but also one of the most dramatically expressive. Its main theme is not, as is often assumed, frustration, but courage and hope. Chekhov's most profound dramatic work, *Tri sestry* (1901; Eng. trans. *The Three Sisters*), is also a most perfect example of his indirect-action technique. It is a play which deals with the inmost mysteries of man's soul, the purpose of man's existence and the ultimate values of life. It was first performed by the Moscow Art theatre on Jan. 31, 1901, and published in the monthly periodical *Russkaya Mysl* in February of that year. Chekhov revised the text of the play in 1902 for the seventh volume of his collected works. His last play, *Vishnevy sad* (1903; Eng. trans. *The Cherry Orchard*), was first produced by the Moscow Art theatre on his last birthday, Jan. 17, 1904. It is a high comedy in which the great brooding intelligence of its creator is contemplating man's folly and a world on the brink of dissolution with the quizzical eye of the born humorist. Its main theme, the passing of the old order, is symbolically represented by the sale of the cherry orchard. In the final scene the sound of the ax felling the cherry trees is merged with the realization of the born serf, the butler

Firs, that the old order was wrong and that, whatever the younger generation may make of the new order, the past is dead.

Chekhov called *The Seagull* and *The Cherry Orchard* comedies and *The Three Sisters* a drama, and it is well to remember that he never used his terminology idly. A drama in Russian literary usage is halfway toward tragedy and what distinguishes *The Three Sisters* from Chekhov's two great comedies is that it completely lacks the elements of high comedy that are so characteristic of them. Chekhov considered *Uncle Vanya* old-fashioned because, since it was a revised version of a play of his earlier period, he could not satisfactorily apply the principles of the indirect-action play to it and for that reason he subtitled it: "Country Scenes in Four Acts."

Each of Chekhov's four dramatic masterpieces requires a perfect understanding of its themes, but what is most essential to bear in mind is the gradual increase in dramatic tension in the first two acts and the way this works up to a crescendo in the climax in the third act. The failure to observe this carefully built-up climax and the marvelous piling up and interweaving of the various themes in the play till they converge in one focal point at the end of the third act has repeatedly led to the total disintegration of the dramatic action of the play and its transformation into the all too familiar play of inaction and mood against which Chekhov protested so violently in the Moscow Art theatre productions of his plays.

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CHEKIANG (CHE-CHIANG SHENG), one of the smaller but most densely populated provinces of China. Area 39,305 sq.mi.; pop. (1957 est.) 25,280,000. It is the most northerly of the coastal provinces of south China where the southwest to northeast coastal ridges begin to sink beneath the Yangtze delta. These ridges, in the eastern and southern parts of the province, are cut by many gorge rivers and provide hundreds of rocky off-shore islands that attract Chekiang fishermen. The northern and western sections, drained by the Ch'ien-t'ang river into Hangchow bay, are on the Yangtze delta and surrounding foothills. These densely settled lowlands extend in a crescent from the port of Ningpo to Huchow (*qq.v.*) near the southern shore of Lake T'ai.

The crops—wheat, beans, rice, cotton, tea and silk—typify mid-China and the overlap of north and south. This is part of the premier quality silk area of the country, both for yarn and woven fabrics, while around Hangchow (*q.v.*) grows one of China's finest green teas, the famous Lung-ching or Lungtsing leaf. Chekiang is mainland China's biggest source of marine products, most of which are landed at Ningpo. Salt is produced along the coast. Upstream from Hangchow, the provincial capital, is an area noted for handmade paper where bamboo is converted into fine Chinese writing paper, and rice straw into coarser types. During the 12th and 13th centuries Hangchow, then known as Linan, was the capital of the southern Sung dynasty which stimulated for a time the production of light green celadon porcelains in Lung-ch'uan, southwest Chekiang. For centuries Chinese have visited the tomb of Yo Fei, a Sung general and national hero, in Hangchow, while many other monuments, temples and villas around West Lake (Hsi Hu) mark the city's long history in producing scholar-officials, artists and poets.

Light industry and handicrafts characterize Chekiang manufacturing. Huchow and Hangchow are renowned for plain and self-figured silks, while tapestry has become important in Hangchow; scissors, fans and various carvings are further specialties. Later mechanized industries in Hangchow are jute spinning and weaving, cigarette manufacturing and cotton weaving. Wenchow (*q.v.*) is an important commercial centre on the Wu river in southern Chekiang. One of China's largest hydroelectric power projects, capacity of 580,000 kw., is scheduled for the Hsin-an or upper Ch'ien-t'ang river to meet power demands in the Yangtze delta cities. Heavy industry does not seem likely to develop in Chekiang.

The central part of Chekiang province is a major fluorite producer, while a large iron ore deposit has been reported around Shao-hsing in the northeast. Hangchow is the southern terminus of the Grand canal, originally 1,286 mi. long. Chekiang is well supplied with railways to Shanghai, southwest to Ch'ang-sha in Hunan, and from Hangchow to Ningpo. (TE. H.)

CHELATES: *see* CO-ORDINATION COMPOUNDS.

CHELCICKY, PETER (*c.* 1390–*c.* 1460), Czech religious and political writer, the most eminent thinker of the Hussite movement, was born and lived in southern Bohemia. Chelcicky, who deliberately chose the life of a working farmer, had no academic training and, although a great admirer of John Wycliffe, could read only those of his Latin works which were translated into Czech. He pursued the critical assumptions of Wycliffe and John Huss to their logical conclusion, rejecting all authority except the New Testament and denying the necessity and lawfulness of coercive government in a Christian community. He condemned war and capital punishment, objected to towns, commerce and oaths, declared that a Christian should not serve as magistrate, judge, juryman or soldier and advocated a return to the primitive Christian order which, he believed, existed before the emperor Constantine I the Great's time. Chelcicky's teaching, which inspired the Bohemian Brethren and, through them, the Polish Brethren, is most fully expounded in *Sit Viry* ("Net of the Faith"), written in 1440 and first printed in 1520. His utopian anarchism was a powerful influence on political thought down to Tolstoi.

See P. Brock, *The Political and Social Doctrines of the Unit of Czech Brethren* (1957). (R. R. Bs.)

CHÉLIFF, the longest river in Algeria, is about 422 mi. long but unnavigable. The source of its farthest tributary, the Oued Sebgag or Touil, is in the Djebel Amour of the Saharan Atlas. For most of the year in crossing the steppes of the high plateaus this stream is a chain of marshes and muddy pools, being almost entirely dried up when it is joined by the second main tributary, the Oued Nahar Ouassel. This *oued* (stream) rises in the Tiaret on the southern side of the Ouarsenis massif of the Tell Atlas and flows eastward to join the Oued Sebgag at Chabounia. The combined streams spread out in marshes near Bou Ghezoul before turning abruptly north to pass more swiftly through the Tell Atlas in a series of entrenched meanders. Below Dollfusville the river swings to the west, flowing for about 145 mi. parallel with the coast in a depression between the Dahra and Miliana massif and the Ouarsenis of the Tell Atlas, reaching the Mediterranean about 8 mi. N. of Mostaganem. This depression, now filled with alluvial deposits, was formerly a gulf of the sea and is now known as the plain of the Chéliff; it is followed by the main east-west railway line. Two constrictions in the valley permit a subdivision into the plains of Affreville, les Attafs and Orléansville, named after the central market towns.

The river receives a number of tributaries from the Dahra and Ouarsenis but never attains much size. Its flow is irregular, the maximum being Nov. to March (usually running in spate in Dec. and Jan.), and by late summer the river is reduced to a chain of muddy pools. The Chéliff plains being on the lee side of the coastal ranges experience a moderate but irregular rainfall (Orléansville, average 16.3 in.). Evaporation is intense and the enclosed valley becomes intolerably hot in summer (Orléansville, mean daily maximum July–Aug. 99° F.). Cereals are the principal crops of both Europeans and Algerians; yields are uncertain, being dependent upon rainfall. Progress has been made with irrigation projects, including the establishment of pumping stations tapping underground water supplies and the construction of dams at Lamartine (near Orléansville) on the Oued Fodda and Ghrib (near Dollfusville) on the Chéliff. Hydroelectric power is generated at both. Irrigation improves yields and allows the replacement of annual crops by fruit trees such as olives, figs and apricots; it also sustains a small area under cotton centred on Orléansville. (A. B. M.)

CHELLEAN, the name formerly applied to an early Stone Age industry characterized by crudely worked hand axes. As the implements from Chelles, which is near the right bank of the Marne in France and which gave the name to the industry, are now grouped with the Acheulean, the term Chellean, in the sense of earliest hand-ax culture, has been replaced by Abbevillian (*q.v.*). (K. P. O.)

CHELM, a Polish town near the eastern frontier, lies 40 mi. (65 km.) E.S.E. of Lublin. Pop. (1960) 31,000. The town is situated in the marshy valley of the Uherka, a tributary of the Bug. Deposits of writing chalk, sand and loam contributed to the development of a mineral industry. The site is that of a pre-Slavonic fort. The settlement obtained town rights in 1233 and was joined to Poland in 1377. At the third partition of Poland (1795) it was transferred to Austrian rule and after 1815 was included in the Polish kingdom, under Russia. During the German occupation in World War II two concentration camps were set up in the town, where about 90,000 persons were exterminated. After Chelm was liberated in 1944, the manifesto of the Polish Committee of National Liberation was published there on July 22. (T. K. W.)

CHELMSFORD, FREDERIC JOHN NAPIER THESIGER, 1st Viscount (1868–1933), British statesman who, as viceroy of India, shared in reforms which set India on the path to self-government, was born in London on Aug. 12, 1868, the eldest son of the 2nd Baron Chelmsford. Educated at Winchester and Magdalen college, Oxford, he was called to the bar in 1893, was a member of the London School board from 1900 to 1904 and served on the London County council in 1904–05. In 1905 he succeeded his father as Baron Chelmsford and was appointed governor of Queensland, Austr. He held that office until 1909 when he became governor of New South Wales. He was an active and popular governor at a time of political conflict and labour unrest. Knighted in 1912, he left Australia in 1913 and served in India with the Dorset regiment during the early part of World War I.

From 1916 to 1921 he was viceroy of India. The outstanding feature of his period of office were the deliberations which culminated in the Montagu-Chelmsford reforms, based on the joint report of the secretary of state for India, E. S. Montagu, and of Chelmsford himself. The central and provincial legislatures were increased in size and given elected majorities. In the provinces the system of dyarchy was introduced, whereby certain departments of government were transferred to the control of ministers responsible to the legislature while control over the remaining departments was reserved to officials responsible to the governor. In addition, the number of Indians on the viceroy's executive council of seven was increased from one to three. The reforms were implemented in 1919, but before then there were serious riots in Gujarat and the Punjab. Another problem was the nonco-operation advocated by Mahatma Gandhi and adopted in 1920 by the Congress party, which boycotted the first elections to the reformed councils. However, the reforms were welcomed by more moderate nationalists. On his retirement in 1921 Chelmsford was created a viscount. He was first lord of the admiralty in Ramsay MacDonald's Labour government of 1924. He died on April 1, 1933. (Ke. A. B.)

CHELMSFORD, FREDERIC THESIGER, 1st Baron (1794–1878), lord chancellor of England and one of the most popular leading counsels of his day, was the third son of Charles Thesiger and was born in London on April 15, 1794. Young Frederic Thesiger was originally destined for a naval career, and he served as a midshipman in 1807 at the second bombardment of Copenhagen. His succession to a valuable estate in the West Indies and the subsequent destruction of this by a volcano led first to his leaving the navy and then to his being called to the bar in 1818.

In 1824 he distinguished himself by his defense of Joseph Hunt for the murder of William Weare, and eight years later at Chelmsford assizes he won a hard-fought action to which he attributed so much of his subsequent success that when he was later raised to the peerage he assumed the title Lord Chelmsford. In 1834 he was made king's counsel and in 1835 was briefed in the Dublin election inquiry that unseated Daniel O'Connell. In 1840 he was elected M.P. for Woodstock. In 1844 he became solicitor general and in 1845 attorney general, holding the latter post until the fall of the Peel administration on July 3, 1846. In 1852 he became M.P. for Stamford.

On Lord Derby's coming into office for the second time in 1858, Sir Frederic Thesiger was raised straight from the bar to the lord chancellorship. In the following year Derby resigned. Again in 1866, on Lord Derby's coming into office for the third time, Chelmsford became lord chancellor for a short period until Derby's retirement. He was a Conservative politician at a time when Whig administrations predominated, or he would almost certainly have left a greater name than he did.

Chelmsford died in London on Oct. 5, 1878.

His eldest son, Frederic Augustus, 2nd Baron Chelmsford (1827–1905), earned distinction as a soldier, while the third son, Alfred Henry Thesiger (1838–80), was made a lord justice of appeal and a privy councilor in 1877.

See *The Victorian Chancellors* (1906–08) by J. B. Atlay, who had access to an unpublished autobiography of Chelmsford.

CHELMSFORD, a market town, municipal borough (1888) and the county town of Essex, Eng., in the Chelmsford parliamentary division, 29 mi. E.N.E. of London by road. Pop. (1961) 49,810. It lies in the Chelmer valley at the confluence of the Can and has communication by river with Maldon and the Blackwater estuary 11 mi. to the east. Chelmsford (Celmeresfort in Domesday Book) consisted of two manors: Moulsham and Bishop's hall. Excavations established that the Moulsham district is the site of the Roman Caesaromagus, a small town of 20–30 ac. Early in the 12th century Bishop Maurice built the bridge over the Chelmer which brought the road from London directly through the town.

In 1225 Chelmsford was made the centre for the collection of fifteenths (taxes of one-fifteenth imposed on personal property) from the county of Essex, and in 1227 it became the regular seat of assizes and quarter sessions. The diocese of Chelmsford, established in 1914, coincides with the county of Essex. In 1951 the 15th century parish church of St. Mary, a Perpendicular building largely rebuilt after 1800, became the cathedral. Historic buildings include the grammar school founded in 1551 by Edward VI, New Hall (now a convent and school) and Boreham house. The Shire hall (1790–92) is by John Johnson, and there is a county museum. In 1199 the bishop obtained the grant of a weekly market, and in 1201 he obtained that of an annual fair, later discontinued.

There is an agricultural market and a corn exchange in the centre of the town square. Chelmsford is also an industrial centre; major industries include the manufacture of ball and roller bearings, radio, electrical and engineering equipment. There are also maltings, corn mills, optical instrument making and confectionery manufacture in the town. From the premises of G. Marconi's Wireless Telegraph company the first wireless telephone broadcasting service in the world was transmitted on Feb. 23, 1920.

CHELSEA, a metropolitan borough of London, Eng., which under the London Government Act 1963 was amalgamated on April 1, 1965, with the royal borough of Kensington to form a new London borough—the royal borough of Kensington and Chelsea (*see* London). Chelsea metropolitan borough is a residential area bounded by Fulham, Kensington, the City of Westminster, and the river Thames. Pop. (1961) 47,256. Area 1 sq.mi. Chelsea is a parliamentary constituency. The chief thoroughfares are Sloane street, running south from Knightsbridge to Sloane square, and King's road (named in honour of Charles II and recalling the private road from St. James's palace to Fulham), with its shops and varied life, leading west from Sloane square. The main roads south join with the Chelsea, Albert and Battersea bridges over the Thames. Chelsea embankment stretches for more than a mile between Battersea and Chelsea bridges.

Chelsea, especially the riverside district, has many historical associations. At Cealchithe a synod was held in 785. A similar name occurs in a Saxon charter of the 11th century and in Domesday Book. The manor was originally in the possession of Westminster abbey, but its history is fragmentary until Tudor times. Henry VIII acquired it, and also the estate of Sir Thomas More in Chelsea, in 1536 and passed it to his wife Catharine Parr. It fell afterward to the Howards and the Cheynes, and later to the Cadogans. The memorials in Chelsea Old church (All Saints) include those of Sir Thomas More (d. 1535); Sir Hans Sloane (d. 1753); Thomas Shadwell, poet laureate (1692); George Woodfall, the printer of Junius (1805); and many others. The church, which had never been spoiled, was ruined in World War II, though most of the fine monuments were rescued, many almost undamaged. The chancel and Lawrence chapel were rehallowed by the bishop of London in 1954. In 1819 the larger church of St. Luke's was built as a parish church. The new Church of Scotland church of St. Columba, designed by Sir Edward Maufe, was opened in 1955. It stands at the western end of Pont street and is of white stone. The original church was destroyed in World War II.

From the 18th and 19th centuries Chelsea has been a literary, artistic and (by mid-20th century) a Bohemian quarter; the Chelsea Polytechnic, with its art school and college of science and technology, was opened in 1895. Francis Atterbury and Swift lived in Church lane; Gay, Steele and Smollett in Monmouth house. Joseph Turner, J. S. Sargent, Whistler, Leigh Hunt, Carlyle, the "Sage of Chelsea" (whose house no. 24, formerly no. 5, Cheyne row is preserved as a public memorial), Lord Courtney, Count D'Orsay, Oscar Wilde, George Eliot (who died there as Mrs. Cross), and Isambard Brunel are connected with Chelsea. At Lindsey house Count Zinzendorf established a Moravian society (*c.* 1750). Sir Robert Walpole's residence was extant till 1810, and until 1824 the bishops of Winchester had a palace in Cheyne walk. Queen's (Tudor) house was the home of D. G. Rossetti.

Ranelagh (*q.v.*), in the second half of the 18th century, and Cremorne gardens (*q.v.*), in the middle of the 19th, were famous places of entertainment. Don Saltero's museum contained curiosities from Sir Hans Sloane's famous collections. In 1722 Sloane gave to the Apothecaries' guild the grounds of the Physic garden (established 1673), which in 1902 ceased to be maintained by the society though still used for research purposes. Cotton seed from the garden sent in 1732 helped to establish the American cotton industry. The original Chelsea bunhouse, claiming royal patronage, stood until 1839, and one of its successors stood until 1888. The celebrated Chelsea china factory, founded in 1745, was moved to Derby (*q.v.*) in 1784. Chelsea Royal hospital (*q.v.*) for invalid soldiers, initiated by Charles II, was opened in 1692. The picturesque building by Sir Christopher Wren, the great hall of which was damaged during World War II, stands in extensive grounds which include the former Ranelagh gardens, site of the annual flower show of the Royal Horticultural society.

Crosby hall, with new buildings adjacent to it, was opened in 1927 as a residence hall for university women. The hall, built by Sir John Crosby in Bishopsgate in 1466, was moved thence to a site on Sir Thomas More's former garden in 1910 to save it from demolition. The town hall, the centre of municipal activities in the borough, was built in 1886. The Chelsea public library contains an excellent collection relating to local history.

CHELSEA, a city of Suffolk county, Mass., U.S., 2 mi. N.E. of Boston (*q.v.*) and a part of the Boston metropolitan area. Settled in 1624 as Winnisimmet by Samuel Maverick, a trader, it was important to Boston, then an island, as the quickest route north. It became a town (Chelsea) in 1739 and a city in 1857. Its growth as a manufacturing and shipping city in the late 1800s destroyed its early role as a summer resort. On April 12, 1908, one-third of the city was destroyed by fire.

Chelsea's 3 mi. of waterfront on Boston harbour are dominated by wholesale oil plants. It is also a junk salvage centre. Chelsea is connected to Boston by the 2-mi. Mystic River (toll) bridge. Large numbers of persons of Russian, Lithuanian, Polish and Italian origin live there. For comparative population figures *see* table in MASSACHUSETTS: *Population.* (R. C. Mo.)

CHELSEA, THE ROYAL HOSPITAL, a home for "worthy old soldiers broken in the wars" in Chelsea, Eng., was founded by Charles II and completed in 1692. The king gave the site of the building and headed the list of subscribers, among whom was Sir Stephen Fox, the paymaster general, who was made responsible for the general administration of the buildings. Sir Christopher Wren was appointed architect, his plans being influenced to some degree by the Invalides in Paris and Kilmainham hospital in Dublin, both built for former soldiers. The Royal Hospital, Chelsea, has an establishment of 558 in-pensioners, organized in six companies and housed in two main blocks. Each man has a cubicle to himself and, except for the infirm, who are fed in their wards, eats in the Great hall which with the chapel forms the central part of the building. After the infirmary, built by Sir John Soane, was bombed and destroyed in 1941, sick in-pensioners were nursed in an infirmary at Leatherhead, Surrey.

Candidates for admission must be in receipt of a pension, either for service or for a disability; they must be at least 55 years old, be able to look after themselves and have had an army character of not less than "very good." In-pensioners may revert to out-pension at their own request but are not then eligible for readmission. The Royal hospital is regulated by royal warrant and controlled by a board of commissioners, of whom the paymaster general is the chairman and treasurer. After nearly 300 years, the responsibility of the board for the administration of pensions and for cases of commutation passed to the army pension office in 1955, when it was set up. The military trophies and standards which under the orders of William IV were kept at the hospital have mostly been returned to the regiments which captured them, but there is a fine collection of pictures and medals in the Great hall and adjoining rooms. (N. W. D.)

CHELTENHAM, a municipal and parliamentary borough of Gloucestershire, Eng., about 96 mi. W.N.W. of London. Pop. (1961) 71,968. The town lies where the Chelt, a small tributary of the Severn, breaks the western escarpment of the Cotswold hills. It is a residential, tourist and sporting centre and is also visited for its medicinal waters. There are three saline springs, the Pittville, Montpellier and Central spas. During the 20th century a number of light industries were established in and around the town. Four miles west is Staverton airport.

There was an early settlement at Cheltenham, and a church existed there in 803. The manor belonged to the crown and was granted to Henry de Bohun, earl of Hereford, in the 12th century. In 1252 it was bought by the abbey of Fécamp in Normandy and afterward belonged to the priory of Cormeilles, France. In 1415 it was confiscated, but at the dissolution it returned to the crown. It then became the property of the Dutton family. The town is first mentioned in 1223, when the benefit of the markets, fairs and hundred of Cheltenham was leased to it for three years. Henry III renewed the lease in 1226 and in 1230 granted a Thursday market and a three-day fair on July 24. It was governed by commissioners from 1852 to 1876, when it was incorporated. It became a parliamentary borough in 1832, returning one member. After the discovery of the mineral springs in 1716 and the erection of a pump room in 1738, Cheltenham rapidly became fashionable, the visit of George III and the royal princesses in 1788 ensuring its popularity. As an inheritance of those times the town is graced by delightful Georgian buildings, wide tree-lined avenues and open spaces. Gustav Holst (*q.v.*) was born there in 1874.

Cheltenham is a well-known educational centre, the principal institutions being Cheltenham college (founded 1841); Cheltenham Ladies' college (1853); Dean Close school (1886); a grammar school (founded 1586; rebuilt 1883); and teachers' training colleges. The town hall, the opera house and the civic playhouse are used for entertainments. After World War II festivals of contemporary British music and literature were established as annual events. Race meetings are held under National Hunt rules, and county matches are played on the cricket ground with an important cricket festival in August.

CHELYABINSK, an *oblast* (administrative division formed 1934) of the Russian Soviet Federated Socialist Republic, U.S.S.R., covers an area of 33,938 sq.mi., mostly along the eastern slopes of the Ural mountains at their southern end. A winding panhandle in the northwest of the *oblast* stretches across the series of parallel ranges of the Urals on to the western flank, while a small area in the extreme east extends out onto the West Siberian plain. The northern part is drained by the Miass and Uy rivers, flowing east to the Tobol, while the south is drained by the upper reaches of the Ural river flowing to the Caspian. The higher mountain areas are clothed in mainly coniferous forest, and the lower, eastern parts are open Black Earth steppes with groves of birch and other trees in the north. This reflects the difference in rainfall from 27 in. in the west to 12–15 in. in the east.

The population of Chelyabinsk *oblast* at the 1959 census was 2,976,625 of which 2,273,197 or 76% were urban. The largest towns are Chelyabinsk, the administrative centre (688,000), Magnitogorsk (311,000), Zlatoust (161,000), Kopeysk (160,000), Miass (99,000), Korkino (85,000) and Troitsk (76,000).

The main lines of communication are the east-west Trans-Siberian and north-south Urals lateral railways, which intersect at Chelyabinsk. The *oblast* is a major mining and industrial region. Its large-scale heavy industry is primarily based on local supplies of ores: magnetite iron ores from Mt. Magnitnaya near Magnitogorsk and from Bakal (one of the richest deposits in the country, with high quality ores up to 65% metal), titanium-magnetite ores near Zlatoust, nickel at Verkhni Ufaley, and supplies of chromite, copper and zinc. Coking coal comes from Karaganda in the Kazakh Soviet Socialist Republic or from the Kuznetsk basin of Siberia, but lignite is mined in the *oblast* (more than 20,000,000 tons annually), together with some anthracite near Magnitogorsk. Iron and steel plants are located in Magnitogorsk, Chelyabinsk, Zlatoust and Asha. There is widespread heavy engineering, including the production of steel tubing, vehicles, tractors, combine harvesters and other agricultural machines, rolling stock, machine tools and instruments. A chemical industry is based on coke byproducts. Agriculture plays a secondary role, but is important in the steppe areas, where considerable acreages were plowed under the Virgin Lands project (1954–57). Wheat is the main crop, but potatoes and vegetables are grown in quantity for the towns. Beef, dairy cattle and sheep are important. (R. A. F.)

CHELYABINSK, chief town of Chelyabinsk *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., is situated on the eastern flank of the Ural mountains, on the Miass river about 900 mi. from Moscow. Pop. (1959) 688,000. Founded in 1658, the town began to grow with the coming of the Trans-Siberian railway in 1892. Thereafter growth was continuous and Chelyabinsk, given added impetus during World War II, became one of the largest industrial cities of the U.S.S.R. The town is well served by railways; apart from the Trans-Siberian, lines run north and south to link up with other Ural industrial centres. On the basis of iron ore from nearby Bakal, coking coal from the Kuznetsk basin and local lignite (at Kopeysk and Korkino), large-scale heavy industry has developed, producing iron and steel, rolled steel, ferroalloys, tubes, steel pressings, zinc, bulldozers, scrapers and tractors, oil-drilling equipment, electrical and power machinery and machine tools. The tractor works, built in 1930–33, are the largest in the U.S.S.R. A thermal electric station, using the lignite, provides power to the city and a wide area. The town has institutes of mechanical engineering, mechanization of agriculture, and pedagogical, medical and polytechnical institutes; there are also two theatres and a philharmonic hall. (R. A. F.)

CHEMICAL ACTION: *see* REACTION KINETICS.

CHEMICAL APPARATUS. The manipulation of the gases, liquids and solids dealt with in the chemical laboratory requires a variety of specialized apparatus. Many of these items have counterparts in the home, since operations such as heating, cooling, solution, etc., are a necessary part of our daily life. There is no fundamental difference between the laboratory Bunsen gas burner and the burner on the conventional kitchen gas range. Frequently, the chemist uses the same glassware for a chemical manipulation that is used for cooking in the home kitchen. In general, however, he must conduct his work with great care; the reagents are often corrosive and the apparatus may be subjected to extremes of temperature or pressure. Over a period of many years there has been devised a large number of items to meet these and other special requirements.

Since chemical reactions can take place in the solid, liquid or gaseous phase a considerable proportion of laboratory apparatus is devoted to the processes of solution, extraction, filtration, precipitation, evaporation, distillation and desiccation. For these purposes flasks, beakers, suction pumps, suction flasks, water baths, funnels, fractionating columns and stills are employed. Gases are manipulated in drying towers, aspirator pumps, gas generators, wash bottles and related tubing. Typical analytical chemical apparatus illustrated below includes crucibles, weighing bottles, burettes, pipettes, graduates and volumetric flasks.

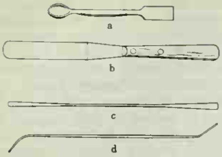
Different pieces of apparatus may be connected with glass, rubber or plastic tubing. Stoppers of rubber or cork are used to make renewable seals at certain points such as thermometer inserts or connections between tubes. There is available a complete selection of glass apparatus such as flasks, condensers, columns and stopcocks comprising units of various sizes which fit together with either standard taper or hemispherical (semiball) joints to form gastight and liquid-tight seals. Since this glassware may be arranged at will to perform a large variety of unit operations it is gradually supplanting cork and rubber stopper closures in the more advanced laboratories. In order to ensure uniformity between the products of several manufacturers the United States bureau of standards has established tolerances for these joints and certifies master joints of steel for their checking. Both types of joints may be lubricated with rubber-petrolatum or synthetic (Silicone) greases to render the joints completely gastight.

Physical measurements are an important part of laboratory practice and a chemical laboratory may employ a variety of measuring instruments. Mercury or liquid-in-glass thermometers, bimetallic thermometers, resistance thermometers and thermocouples are used for temperature measurement, whereas mercury or other fluid manometers and Bourdon gages are used to measure pressures. The chemical balance (*see* BALANCE) is used for weighing and it is constructed in many modifications depending upon the capacity and sensitivity demanded. The spectroscope (*see* SPECTROSCOPY) or spectrograph measures either the absorption or emission of light, and the colorimeter is used for exact colour comparison as in analytical determinations. Electrical measurements form the basis for the determination of hydrogen-ion (*q.v.*) concentrations using the *p*H meter, and reduction potentials are charted by the polarograph. Electrometric titrations as well as dyestuff indicators serve to determine the end-point in analytical titrimetry while burettes are available to measure amounts of liquids as small as .001 ml. with analytical accuracy. The index of refraction of light determined with the refractometer (*q.v.*) furnishes a useful guide to the purity and identity of chemical compounds, while the microscope makes it possible to manipulate and to observe beyond the capacity of the unaided eye. (*See* CHEMISTRY: *Analytical Chemistry.*) Laboratory technique is constantly being refined and improved. For the manipulation of a few milligrams of scarce or valuable material there has been developed a group of miniature beakers, flasks, funnels, etc., which is called microchemical equipment. Although some of these are merely small-scale models of the larger apparatus, others in the group are truly novel in design and are cleverly adapted to ultraprecise work. A few pieces of microchemical equipment are illustrated below.

The following list refers by number to the figure numbers of the accompanying illustrations of apparatus commonly used in a chemical laboratory.

General Apparatus

1. Spatulas and spoons, for dealing with small quantities of material without touching by hand. They may be made of (*a*) porcelain, (*b*) steel, (*c*) silver or other corrosion-resistant materials.
2. (*a*) Pinchcock or spring clip (Muhr's pattern). (*b*) Screw clamp or clip (Hoffmann).
3. (*a*) Bunsen burner (Tirrill type) with adjustable gas and air flow. (*b*) Meker burner for producing an intense flame over a broad area. Used for heating crucibles to high temperatures. (*c*) Wing-top which slips onto top of Bunsen burner to form "fish-tail"-shaped flame.
4. Water bath and rings on tripod. The bath is nearly filled with water which is heated by a burner underneath. Removal of one or more of the rings enables any circular vessel (*e.g.*, an evaporating basin) to rest in the hole of appropriate size, and its contents are slowly heated or evaporated. A constant-level device maintains the level of the water in the bath and obviates refilling.



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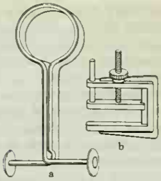

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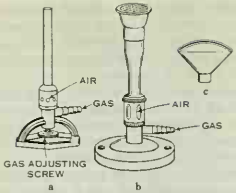
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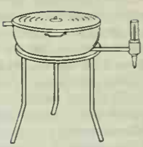
GAS
GAS ADJUSTING SCREW
a
AIR
GAS
b
c

3



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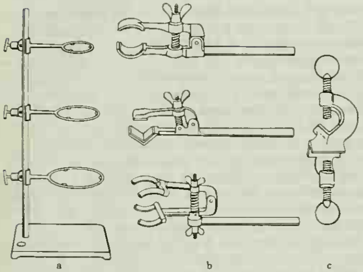

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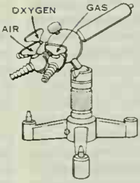
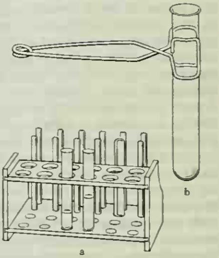
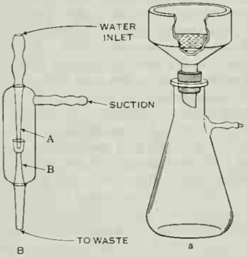

OXYGEN
GAS
AIR

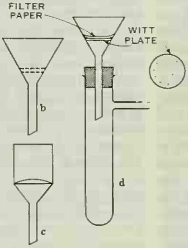
6



7


WATER INLET
SUCTION
A
B
TO WASTE
a

8


FILTER PAPER
WITT PLATE
b
c
d

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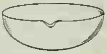

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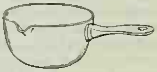

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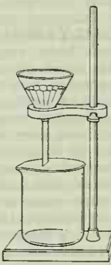

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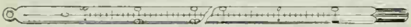

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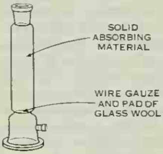
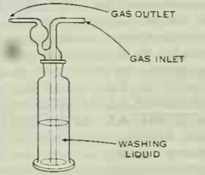
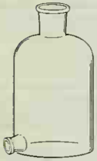

SOLID ABSORBING MATERIAL
WIRE GAUZE AND PAD OF GLASS WOOL

14


GAS OUTLET
GAS INLET
WASHING LIQUID

15



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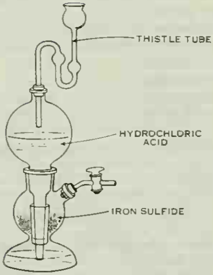
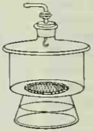

THISTLE TUBE
HYDROCHLORIC ACID
IRON SULFIDE

17



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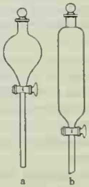

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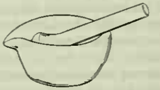

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FIGS. 1 AND 9 FROM LOUIS FIESER "EXPERIMENTS IN ORGANIC CHEMISTRY," COURTESY D. C. HEATH & COMPANY

FIGS. 1–21.—COMMON CHEMICAL APPARATUS (THE NUMBERS REFER TO DESCRIPTIONS IN THE TEXT)

5. (*a*) Support with iron rings, (*b*) clamps and (*c*) clamp holder (boss).
6. Blast lamp or blast burner. Separate valves are provided for controlling the flow of oxygen and air which are mixed and fed to the gas through a central tube. The gas issuing from the outer sleeve forms a brush flame or a fine-pointed flame depending upon the adjustment of the mixture.
7. (*a*) Test-tube stand and test tubes. (*b*) Spring-clamp test-tube holder.
8. Water-jet suction pump, for use with filter flask and either Büchner funnel (*see* fig. 9) or Gooch crucible (*see* fig. 33). The stream of water is broken up at the jet A and entrains air in its passage down the tube B. This is capable of reducing the pressure as low as the vapour pressure of water.
9. Apparatus for filtering by suction. (*a*) Büchner funnel fitted with a cork or rubber stopper into a filter flask which is attached to a suction pump (*see* fig. 8) by means of rubber tubing. A circle of filter paper is placed on the perforated bottom and the material retained by it can be sucked dry, washed and pressed. (*b*) Hirsch funnel. (*c*) Sintered-glass funnel. (*d*) Ordinary funnel.
10. Evaporating dish or basin (porcelain or glass).
11. Casserole (porcelain).
12. Filter stand, funnel and beaker for gravity filtration. A filter paper is folded so as to fit into the funnel as shown; it retains solids while liquids filter into the beaker.
13. Mercury-in-glass thermometer. Numerous scales are available for both higher and lower temperature ranges.
14. Drying tower. Similar in function to fig. 15, but used where gases have to be passed through a granulated solid.
15. Wash-bottle for gases (Drechsel pattern). If the gas is bubbled through the liquid it can be freed from one or more impurities, *e.g.*, it can be dried by passage through concentrated sulfuric acid, or freed from carbon dioxide by a solution of sodium hydroxide.
16. Aspirator bottle. A cork carrying a tube is inserted into the top opening while a stopcock may be attached to the lower opening and the bottle is filled with water. On opening the stopcock, water will flow out and this will draw air through the tube which may be attached to any other apparatus.
17. Kipp gas generator. Hydrochloric acid (HCl) is allowed to run down the central tube and rise so as to act on the iron sulfide; if the tap is open hydrogen sulfide gas (H_2S) is expelled by the pressure of the "head" of acid; when the stopcock is closed the gas forces the acid into the top bulb and no more gas is produced. If marble (calcium carbonate) is used instead of iron sulfide, carbon dioxide (CO_2) is obtained. It may also be used to generate hydrogen gas by zinc metal and dilute sulfuric acid.
18. Desiccator. Concentrated sulfuric acid, granular calcium chloride or other desiccant is kept in the bottom; the material to be dried is spread on a watch glass or evaporating dish resting on the gauze or on a perforated porcelain plate. An accelerated drying effect is produced by evacuating the desiccator through the stopcock tube by means of the suction pump shown in fig. 8.
19. Separatory funnels: (*a*) pear-shaped—also called a dropping funnel; and (*b*) cylindrical. If ether has been used to extract an organic substance from water, two layers are formed and the lower (aqueous) layer can be run off. Similarly, if chloroform had been used instead of ether, the lower layer would be the chloroform extract.
20. Pestle and mortar (of porcelain).
21. Watch glass for covering beakers while evaporating liquid. It is usually supported on glass U-shaped rods hung on the edge of the beaker.
22. Stopcocks or taps. (*a*) A half turn shuts off the flow. (*b*) Three-way oblique bore plug. A half turn connects the lower limb with the left hand tube. (*c*) T-bore stopcock.
23. Distillation with a fractionating column. The liquid in the round-bottom flask is boiled and the vapours pass through the column where partial condensation occurs. The reflux liquid washes the ascending gases which then pass into water-cooled condenser where they are condensed to a liquid. A thermometer indicates the temperature of the condensing liquid and an adapter leads to the receiver which is an Erlenmeyer flask.

Apparatus Used in Analysis

24. Crucible and lid made of porcelain, quartz or platinum. Used for igniting precipitates.
25. Clay triangle for supporting crucible on tripod or ring.
26. U-tube. May be filled with granulated soda-lime to absorb carbon dioxide, or with pumice soaked in sulfuric acid to absorb water vapour. The ground-in stopcocks can be turned to shut off connection with the outer air.
27. Absorption bulb (Turner). Used for the absorption of carbon dioxide formed by the combustion of steel in oxygen. The stopper may be rotated so as to close both openings after the combustion has been completed.

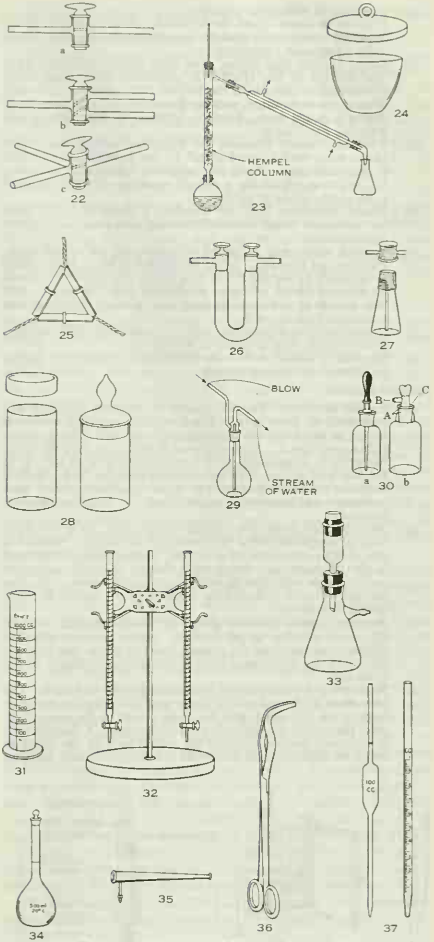


FIG. 23 FROM LOUIS FIESER, "EXPERIMENTS IN ORGANIC CHEMISTRY," COURTESY D. C. HEATH & COMPANY

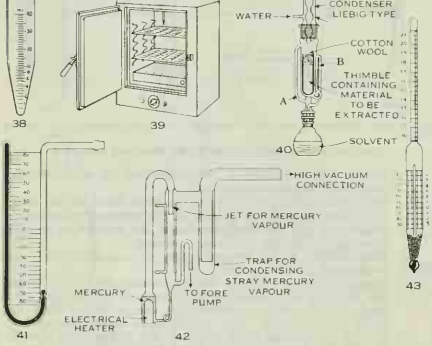
FIGS. 22–37.—CHEMICAL APPARATUS USED FOR ANALYSIS

28. Weighing bottles, for protecting material from the air while it is being weighed. A portion of the contained substance is shaken out and the whole reweighed, the amount of material thus taken being the difference in weight.
29. Wash bottle. A fine stream of water (or organic solvent) can be directed where required.
30. Dropping-bottles. (*a*) By slightly pressing the rubber nipple and releasing the pressure, a few drops are drawn up in the glass tube and can be squeezed out one at a time when the nozzle is withdrawn. (*b*) Liquid flows along the capillary tube at A when the bottle is tilted, and a drop falls from B, air entering through another channel at C. Used chiefly for indicators.

31. Graduate or measuring cylinder.
32. Burettes in stand. Used for titrations. The volume of liquid delivered is accurately read on the graduated scale (*see* CHEMISTRY: *Analytical Chemistry*).
33. Gooch crucible atop rubber cone, glass adapter and filter flask. The bottom of the crucible is perforated with small holes, and a mat of asbestos is formed on it by pouring in a pulp of asbestos and water, sucking it nearly dry and completely drying it in the oven. Used for filtering, washing, drying and weighing precipitates.
34. Volumetric flask. Contains the stipulated volume when filled to the mark with a liquid at 20° C., the temperature at which it was calibrated. Used for preparing "standard" solutions, *i.e.*, solutions containing a definite quantity of solid dissolved in an exact volume of solution.
35. Mouth blowpipe; used for directing a small flame jet onto the substance being analyzed (usually supported on a block of charcoal).
36. Crucible tongs; may be tipped with platinum for refined work.
37. Pipettes (not to scale). (*a*) If the pipette at left is filled exactly to the mark by suction it will then deliver the stipulated volume on draining for 15 sec. after continuous flow has ceased. (*b*) The pipette at right can be used to add small quantities that are read off on the scale.
38. Graduated conical centrifuge tube for measuring small volumes of centrifuged solid or liquid at the bottom.
39. Electrically heated oven with thermostatic control for drying precipitates to constant weight.

Special Apparatus

40. Soxhlet extractor. The material to be extracted is placed in a "thimble" of filter paper. Ether or other volatile solvent is boiled in the flask and passes through the side tube A to the reflux condenser C. The condensed liquid drops into the thimble where it accumulates until it reaches the level of the top of the side arm B, and then siphons over into the flask. Several complete cycles are permitted to occur before the solvent flask is disconnected and the solvent evaporated to leave the extracted material.
41. Mercury manometer for vacuum distillations. The left-hand tube is completely filled with mercury as shown. When the side tube is connected to a system being evacuated the level in the left-hand tube drops while that in the right-hand tube rises, and the difference in height between the tops of the two mercury columns indicates the pressure in the system in millimetres of mercury.
42. Mercury vapour diffusion pump for producing high vacuum. The high velocity jet of mercury vapour permits diffusion of the other gases in the system into it. These are then removed by the fore pump after condensing the mercury in the condenser.
43. Hydrometer for determining the specific gravity of liquids. The instrument is floated in the liquid and the point on the scale in the stem coinciding with the surface level of the liquid indicates the specific gravity compared with water. A thermometer in the lower portion indicates the temperature of the liquid at the same time. Usually the liquid is brought to some specified temperature before the specific gravity is determined.
44 Microchemical equipment. (E. B. HG.)



FIGS. 38–43.—CHEMICAL APPARATUS USED FOR ANALYSIS; AND SPECIAL APPARATUS

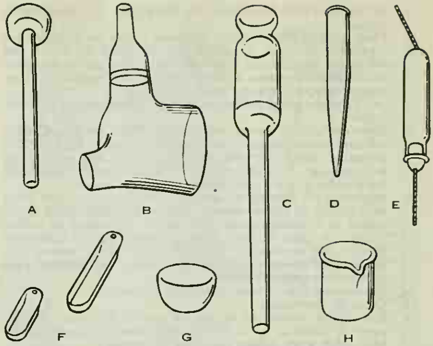


FIG. 44.—MICROCHEMICAL EQUIPMENT

Shown in approximately actual size are: (A) Porcelain filter stick for sucking liquids away from solids; (B) microfilter beaker; (C) sintered glass funnel; (D) microcentrifuge tube; (E) weighing tube (for protecting sample in boat from air during weighing); (F) microcombustion boats (small and medium size); (G) 1-ml. porcelain crucible; (H) 1-ml. glass beaker

CHEMICAL CYCLES IN NATURE. Living plants take inorganic (nonliving) substances from their surroundings and convert them into carbohydrates, proteins, fats and other compounds. These products are used by the plant either as energy sources or are built into the plant structure. Animals that eat the plants use the conversion products in similar ways. When the plants and animals die, decomposition, mostly by bacterial action, converts the carbohydrates and other organic materials back into basic raw materials. These are then available for use by new generations of plants. If these cyclic processes did not occur, life as it now exists on earth would become impossible after a relatively short time because the materials needed to support it would be tied up in unusable forms. These cycles come in all sizes, ranging from that occurring in a tiny lichen-encrusted depression on a rock to the largest of all—the one involving the whole earth. None of them, except the largest, is an entirely closed system; some, and often a large part, of the substances involved in each cycle come from outside the cycle and some are lost to other cycles. The most important of these exchanges occurs between the land and the ocean, the latter acting as a reservoir that holds a very large proportion of the inorganic (nonliving) substances.

Probably most of the chemical elements participate in these cycles, but information has been accumulated only on those that are the major components of plant and animal bodies; *i.e.*, hydrogen, oxygen, carbon, nitrogen and phosphorus (*see* separate articles on these elements). The first four commonly occur in volatile forms and can, therefore, escape from the ocean and be returned to land. Even so they spend a major part of the time in the ocean; on the average, a water molecule spends about 50,000 years in the ocean to each one spent on land and a carbon dioxide molecule spends about 120 years in the ocean to each one spent in the atmosphere. Phosphorus and metallic elements such as potassium and calcium do not form volatile compounds and consequently are largely lost to reuse by land plants and animals once they enter the ocean. Only $\frac{1}{200}$ of the phosphorus annually carried into the ocean by rivers is returned to land by the actions of men and other animals. By contrast, the water that flows from the land to the ocean—about 6,500 cu.mi. annually—is replaced each year by evaporation from the ocean surface.

These cycles would quickly come to a halt if the energy required to run them were not supplied by the sun. The sun's heat evaporates water and dissolved gases from the surface of the oceans, the land and bodies of fresh water, and provides energy for the winds that move the water vapour and other gases until the water falls as rain, snow or dew, and the gases are used by plants, animals, bacteria or fungi, or are redissolved in water. The sun's light enables green plants and some bacteria, both on land and in the upper layers of the ocean, to carry out photosynthesis (*q.v.*), an energy-storing reaction that converts water, carbon dioxide and light energy into oxygen and energy-rich carbohydrates. It is estimated that each year about 80,000,000,000 tons of carbon dioxide are converted by land plants and about 600,000,000,000 tons by marine plants, mostly one-celled phytoplankton. (E. I. Rabinowitch, *Photosynthesis and Related Processes*, vol. i, ch. 1, 1945.) Respiration by the plants, by animals that eat the plants, by animals that eat the plant-eating animals, or by bacteria and fungi that decompose dead plants and animals then reverses the process, forming carbon dioxide and water from the carbohydrates and oxygen in a series of steps that release the energy in amounts suitable for use in life processes.

Connected with the carbon cycle and supplied with energy by it are a number of other cyclic processes, some of which form and decompose biologically important compounds containing nitrogen or phosphorus while others convert gaseous nitrogen into forms usable by plants. The fact that forests and meadows and the animals living in them persist for long periods of time in the same place when undisturbed by man and yet do not smother under dead leaves, grass or animal bodies suggests that most of these processes are approximately in balance in nature. *See* NITROGEN, FIXATION OF. (E. W. FA.)

CHEMICAL EQUILIBRIUM. A chemical reaction may, under appropriate conditions of temperature, pressure and concentration, proceed not to completion but to a state of balance between all the reactants and products. The incompleteness of the reaction is caused by the fact that the reaction is reversible; *i.e.*, by the fact that the products of the reaction in one direction, as soon as they begin to form, begin to react to produce the original reactants. A balance, called equilibrium, is attained when the two opposing reactions go on at equal rates; there is then no net change in the amounts of the substances involved. A change in temperature, pressure or concentration may temporarily upset the equality of the two rates so that one reaction gains over the other until equilibrium is again established.

It is not easy for a reader unfamiliar with chemistry to visualize simultaneous, opposing chemical reactions; so it is well to begin with a more "physical" equilibrium, that between a liquid and its vapour. The change from one to the other is quite reversible; liquids evaporate and vapours can be condensed to liquids. But if some liquid is introduced into a large, evacuated vessel, held at constant temperature, molecules rapidly pass from the liquid into vapour, until they reach a certain concentration, or pressure, at which the number evaporating per second per square centimetre of surface is just balanced by the number of vapour molecules being recaptured by the liquid per second per square centimetre. If some of the vapour is pumped out, the two rates are thrown temporarily out of balance; evaporation proceeds at the previous rate while condensation is reduced, but this difference of rates builds up the concentration of vapour till the balance is again restored. A rise in temperature brings about a new equilibrium, because the molecules are all made to move faster, making it easier for them to escape from their mutual attraction in the liquid and requiring a higher concentration of them in the vapour to restore equilibrium. The essential test for a state of equilibrium is the ability of the system to readjust so as to neutralize, so far as possible, the effect of the change. This general principle is known as the theorem of Le Chatelier. It applies not only to a physical equilibrium, such as that between liquid and vapour, but equally to a chemical equilibrium, such as that between calcium carbonate, $CaCO_3$, and its decomposition products, solid calcium oxide, CaO, and carbon dioxide gas, CO_2, the chemical equation for which is, $CaCO_3 = CaO + CO_2$. The reversibility of the reaction is proven on the one hand by the decomposition of limestone by heating in a lime kiln and, on the other, by the ability of CaO to absorb CO_2 at ordinary temperatures. The reversibility of a reaction is often indicated by writing double arrows with the equality sign, thus $\overset{\longrightarrow}{\underset{\longleftarrow}{=}}$, often abbreviated to $\rightleftharpoons$. These representations should not obscure the significance of the equality sign, which is the conservation of atoms and masses. The two reactions are complete under the respective conditions just stated, but this reversibility indicates that there are intermediate conditions under which equilibrium is possible. The relation between temperature, t, in degrees centigrade, and equilibrium pressure, P, in atmospheres, for this particular equilibrium is as follows:

t	842	855	869	904	937
P	0.45	0.53	0.67	1.16	1.77

An equilibrium involving two or more visually detectable and mechanically separable phases, solid, liquid or gas, is called a heterogeneous equilibrium; one existing within a single phase, either liquid or gas, is a homogeneous equilibrium. As an example of the latter we may consider the partial ionization of acetic acid into charged ions, according to the equation, $HC_2H_3O_2 \rightleftharpoons H^+ + C_2H_3O_2^-$. If one gram-molecule, or mole, of the acid is dissolved in one litre of water, at 25° C., equilibrium is reached almost instantly with 0.0042 moles each of H^+ and $C_2H_3O_2^-$ and 0.9958 moles of un-ionized acid. If a little sodium acetate is added, which ionizes almost completely into Na^+ and $C_2H_3O_2^-$, the rate of reaction to the left is increased but the reaction to the right proceeds as before; consequently, the concentration of the H^+ is quickly reduced to such a value that the rates are again equal. Similarly, the addition of H^+ from another source, such as hydrochloric acid, would reduce the concentration of $C_2H_3O_2^-$ to a new equilibrium value. Dilution of the solution with water would diminish the rate of collision and recombination of the two ions until enough additional ions are formed to enable their rate of recombination again to equal their rate of formation. The fraction of the acid existing as ions is therefore increased by dilution.

These relations may be given an approximate quantitative formulation. The number of moles of acetic acid per litre decomposing per second into ions depends, at any one temperature, only on its concentration, which is customarily expressed by the formula in parentheses. The velocity of the reaction to the right, v_1, is $v_1 = k_1\ (HC_2H_3O_2)$ where k_1 is the constant of proportionality. The velocity of the reaction to the left, v_2, is similarly given by $v_2 = k_2\ (H^+)(C_2H_3O_2^-)$. At equilibrium, $v_1 = v_2$; therefore $(H^+)(C_2H_3O_2^-)/(HC_2H_3O_2) = k_1/k_2 = K$, the equilibrium constant. Its value for acetic acid can be obtained from the set of equilibrium concentrations previously given, as 1.8×10^{-5}. This constant expresses the strength of the acid and is valid for any set of concentrations at 25° C. In a solution of 0.1 mole of acetic acid per litre, for example, $(H^+) = (C_2H_3O_2^-)$ and $(HC_2H_3O_2)$ is still approximately 0.1; therefore, $(H^+)^2 = 1.8 \times 10^{-6}$ and $(H^+) = 1.3 \times 10^{-3}$. Again, in a mixture of an equal number of moles of $HC_2H_3O_2$ and $NaC_2H_3O_2$, $(HC_2H_3O_2) = (C_2H_3O_2^-)$ and hence $(H^+) = 1.8 \times 10^{-5}$. We thus have the means, by altering the relative amounts of acetic acid and acetate ion, of establishing any desired acidity through a wide range.

The following examples illustrate equations for equilibrium constants corresponding to equations for chemical reactions.

$$2SO_3 = 2SO_2 + O_2 \text{ (all gases)}: \frac{(SO_2)^2(O_2)}{(SO_3)^2} = K$$

Since the concentration of a gas is proportional to its partial pressure in a gas mixture, this equilibrium may also be expressed in terms of partial pressures, $P^2{}_{SO_2}P_{O_2}/P^2{}_{SO_3} = K_p$.

$$CO_2 + C \text{ (solid)} = 2CO;\ (CO)^2/(CO_2) = K \text{ or } P^2{}_{CO}/P_{CO_2} = K_p$$

Note that the concentration of solid carbon is not susceptible to change and therefore need not be expressed in the equilibrium equation.

$$3Fe \text{ (solid)} + 4H_2O \text{ (gas)} = Fe_3O_4 \text{ (solid)} + 4H_2 \text{ (gas)}$$

$$P_{H_2}{}^4/P_{(H_2O)^4} = K;\ \text{or } P_{H_2}/P_{H_2O} = K'$$

$$Ca\ (OH)_2 \text{ (solid)} = Ca^{++} + 2OH^-;\ (Ca^{++})(OH^-)^2 = K$$

The effect of total pressure upon an equilibrium involving gases is to favour the state with a smaller number of gas molecules. Thus, in the following equilibriums, $H_2+I_2=2HI$, $2SO_2+O_2=2SO_3$, $N_2+3H_2=2NH_3$, CO_2+C (solid) $=2CO$, increasing the total pressure would have no effect upon the first; it would shift the second to the right, the third still more to the right and the fourth to the left. Each effect can be calculated quantitatively from the expression for the equilibrium constant and the condition that the total pressure is the sum of the partial pressures.

The effect of temperature upon an equilibrium depends upon the heat absorbed or evolved when the reaction occurs under equilibrium conditions. If a vessel containing an equilibrium mixture is transferred from a lower to a higher temperature, heat will, of course, flow into the mixture, and it will shift the equilibrium in that direction which absorbs heat. In the reactions,

$$H^+ + OH^- = H_2O + 13.7 \text{ kg.cal.}$$
$$N_2 + 3H_2 = 2NH_3 + 24.0 \text{ kg.cal.}$$
$$H_2 + I_2 \text{ (gas)} = 2HI - 2.8 \text{ kg.cal.}$$

the equilibriums are shifted by rising temperature in favour of the substances on the left-hand side, in the first two cases, and in favour of more HI, in the third. The effect of changing temperature is given quantitatively by the approximate equation,

$$\log_{10}\frac{K_1}{K_2} = \frac{\Delta H}{4.575}\,\frac{(T_2-T_1)}{(T_1T_2)}$$

where ΔH is the heat, in calories, absorbed by the reaction as written, and K_2 and K_1 are the equilibrium constants at the respective temperatures, T_2 and T_1, on the Kelvin scale.

The Haber process for the chemical utilization of the inert nitrogen of the air furnishes a striking instance of the practical fruits of the principles of equilibrium. The reaction, $N_2+3H_2=2NH_3$, does not take place at all when nitrogen and hydrogen are brought together under any ordinary conditions, whereas ammonia is easily decomposed on moderate heating. The principles of equilibrium teach that the equilibrium would be displaced in favour of ammonia by increasing pressure and lowering temperature. But lowering temperature normally decreases the velocity at which equilibrium is approached; so a compromise is necessary here, and a catalyst to increase speed is indicated. Proceeding in this way, Fritz Haber was able to obtain a small equilibrium concentration of ammonia, from which he calculated the equilibrium constant and the effect of temperature thereon. With this knowledge the desirable conditions could be predicted for obtaining an industrially profitable equilibrium concentration of ammonia.

Catalysts have been developed which cause the reaction to proceed at reasonable speed at 500° C. assisted by pressures of the order of 100 atm., pressures unprecedented in technical processes at the time of Haber's investigation. These high pressures also shift the equilibrium strongly in favour of ammonia since four molecules become two in the reaction. Even so, the conversion to ammonia in one contact with the catalyst is only about 10%, but by liquefying and removing this ammonia, and repassing the nitrogen and hydrogen, augmented, over the catalyst, the equilibrium amount is again obtained, and so on.

See THERMODYNAMICS. (J. H. HD.)

CHEMICAL INDUSTRY. The chemical industry is one of the great giants of the technological world—making products used in practically every aspect of life. From such ordinary raw materials as coal, salt, limestone, sulfur, air, water and petroleum, the chemical industry turns out a prodigious number of compounds that are essential to the operations of every other industry.

In size, the chemical and allied products industry was the fourth largest in the United States in the early 1960s, surpassed only by petroleum refining and its related industries, primary metals and transportation equipment.

Some chemicals, such as aspirin and baking soda, are familiar to nearly everyone, but many more are as far removed from the average consumer as is the factory from the department store. There are two reasons for this anomaly. In the first place, the chemical industry is its own best customer, converting many of its chemicals into "intermediates" or building blocks that it uses to produce such materials as dyes, drugs, explosives, flavourings and plastics. Secondly, myriads of chemicals enter the processing industries where they are utilized to make the thousands of mass-produced items. The distinction between the processing group, which uses chemicals as a means to make something else, and the chemical industry proper, which manufactures chemicals as end products, appears to be disappearing as the chemical industry continues to expand its boundaries in all directions. This trend toward a merging of the groups accelerated after World War II as many chemical manufacturers became producers of semifinished or consumer products such as man-made fibres, fabric coatings, detergents, etc.

In entering these new fields, some chemical companies became affiliated with processing companies. On the other hand, many processing companies became important chemical manufacturers and many suppliers of raw materials to the chemical industry are themselves becoming important chemical manufacturers. Typical is the increasing expansion of the petroleum refining companies into chemical products manufacture. Also in the chemical industry are food processors and manufacturers of light metals.

The result of all of this expansion has been the creation of an enormously complicated industry—with a talent for reducing everything but its own particular make-up to a precise mathematical formula. The chemical industry, which cannot be defined with scientific accuracy, means many different things depending upon how it is classified by the statisticians. In the United States, government officials, for purposes of convenience, have reduced it to a category called "chemicals and allied products." Establishments in this major group manufacture three general classes of products: (1) basic chemicals such as acids, alkalies, salts and organic chemicals; (2) chemical products to be used in further manufacture such as man-made fibres, plastics materials, crude animal and vegetable oils, dry colours and pigments; and (3) finished chemical products to be used for ultimate consumption, such as drugs, cosmetics and soaps, or to be used as materials or supplies in other industries, such as paints, fertilizers and explosives.

Under this classification, the chemical process industry includes companies that manufacture such allied products as drugs, soaps, paints, fertilizers, vegetable and animal oils and a number of miscellaneous related products. Excluded, however, are companies engaged in the production of iron and steel, in petroleum refining, and in the manufacture of pulp and paper, rubber products, leather products and glass. Omission of the latter categories does not mean, of course, as one authority has commented: "That their operations are any less 'chemical' in nature than those used in the manufacture of soap, paint and many other products officially classified within the chemical industry. Their exclusion has probably been due primarily to the combination of their empirical origin, large size, simple product structure and well-defined markets." (John H. Perry, *Chemical Business Handbook*, McGraw-Hill Book Company, Inc., New York, 1954.)

Growth rate of the industry in 1940–60 was 7% per year, as compared with 3% for all industry. After World War II only one other industry, transportation equipment, exceeded chemicals in growth rate, according to statistics from the U.S. department of commerce.

Foundation of the Chemical Industry.—Regardless of how its operations are classified, or whether its sprawling plants shadow the Rhine or the Mississippi, the chemical industry has one great task: to take a relatively few fundamental raw materials and combine and recombine them into combinations and transformations of substances that are new and needed. In the chemical industry, this function is called synthesis and is understood to mean the building up of a compound for useful purposes by the union of simpler compounds or elements. Essentially, then, the industry depends upon the application of scientific principles for utilitarian purposes, and it is in the final analysis the offspring of chemistry and economics.

It was Nicolas Leblanc who united the two in the waning years of the 18th century when he set out deliberately to make soda ash (sodium carbonate) out of salt. Leblanc, of course, was not the first to put chemicals to work in the service of man. Centuries before, the ancient Phoenicians, Egyptians and Chinese had experimented with chemical processes in carrying out their dyeing, leather tanning and glassmaking activities. Their work was really an art rather than a science, however, since the first great principles of chemistry were not to be discovered until hundreds of years later.

In fact, it was not until about Leblanc's time that the foundations of modern chemistry were laid by Antoine Lavoisier, Joseph Priestley and Henry Cavendish (*qq.v.*). All three were far greater chemists than Leblanc, but it is to him rather than to the more celebrated trio that the title of founder of the chemical industry belongs—and for a very important reason. For unlike the rest of the chemists of his period, Leblanc was determined to make a chemical discovery that would have commercial application. He is generally credited with being the first person to carry out successfully a deliberate plan to convert one or more chemical products into different products, keeping in mind not only the product desired but the economics of the process as well. This remains the aim of the modern chemical industry: to produce new and better products economically.

A prize of 12,000 fr. offered by the French Academy of Sciences to anyone who could work out a method for making cheap alkali led to Leblanc's accomplishment in 1790. Now widely recognized as the most important industrial chemical process of the 19th century, it involved the treatment of salt (sodium chloride) with sulfuric acid to obtain salt cake, or sodium sulfate. This salt cake was then roasted with limestone or chalk and coal to produce black ash, which consisted primarily of sodium carbonate and calcium sulfide. Leblanc dissolved the sodium carbonate with water and then crystallized it.

As a result of his efforts, Leblanc won a little fame but no lasting fortune. During the French Revolution, his patents and factory were confiscated. In addition, there is no record that he ever collected his prize money. Eventually, Napoleon restored his works but Leblanc was never able to raise the capital to reopen them. Destitute and despondent, he committed suicide in 1806.

After Leblanc's death, his process was neglected in France, but it became extremely important in England as a source of alkali for the soap and textile industries. With the growing demand for their product the soda ash producers' business became increasingly complicated. Starting out with a comparatively simple process, they soon learned one of the fundamental truths of the chemical industry—that the manufacture of chemicals is a little like walking —one step inevitably leads to another. Alkali manufacturers, since they require sulfuric acid in their operations, began to make their own acid by burning sulfur or pyrites. Those who used roasted pyrites usually relied on mixed sulfides of copper and iron, and from this it was fairly easy to make copper sulfate and ferrous sulfate.

Utilization of By-Products.—Eventually too, the soda ash makers learned how to utilize the by-products that resulted from their operations. Some of these chemicals, at first regarded as nuisances, in time became as important as the soda ash itself. One of these was hydrochloric (muriatic) acid, formed as a result of the reaction between the salt and sulfuric acid. In the beginning, it belched out of the alkali factory smokestacks as a foul-smelling gas that destroyed vegetation for miles around. In response to complaints from the irate citizenry, the alkali makers desperately sought a way to get rid of these objectionable fumes.

James Muspratt (1793–1886), the first Britisher to manufacture alkali on a large scale, constructed skyscraper chimneys—one almost 300 ft. high—in the futile hope that the vapours would drift away on the clouds. Finally, William Gossage found that the gas could be absorbed by passing it through towers packed with coke over which water trickled. This produced commercial hydrochloric acid and more difficulties because there was no great demand for this by-product. In fact, for awhile it was put in casks, carried out to sea and dumped overboard. Then it was found that the surplus hydrochloric acid could be oxidized with manganese dioxide to make chlorine, which could be combined with slaked lime to form bleaching powder. The reaction left behind a residue of manganese chloride, however, that had to be discarded until Walter Weldon (1832–85) invented a process that enabled manufacturers to recover the manganese and use it again, thereby reducing costs. Around the same time, Henry Deacon discovered a way to oxidize hydrochloric acid to chlorine without using manganese dioxide. Ultimately, a method for recovering the expensive sulfur from the mountains of alkali waste piled up during the last stage of the Leblanc process was also found.

Organic Chemicals.—As the British alkali producers gradually became manufacturers of most of the important "heavy chemicals" they laid the foundation for what is now called the inorganic branch of the chemical industry. The chemicals in this category are all derived, directly or indirectly, from the inanimate material of the earth's crust. In contrast to these materials, almost all of which stem from minerals, are the organic chemicals, so-named because in the early days of the industry they were all obtained from living organisms. From plants and animals come a wide assortment of organic substances including fibres, such as cotton and silk; drugs, such as quinine; acids, such as tartaric and citric; and even such natural plastics as rubber.

Although these natural organic compounds had been known to man for centuries, it was not realized until the 19th century that they all contain carbon as a constituent element. Further studies revealed that carbon is able to combine freely with itself to form long chains—some of them intricately branched—as well as rings. In addition, it was discovered that carbon could unite with other elements such as nitrogen, hydrogen, oxygen, sulfur, chlorine, bromine and iodine. Once these facts became part of scientific knowledge, chemists set to work to create their own substances using carbon as the basic building block. In the beginning, they were satisfied only to imitate nature; later, however, they learned how to make a vast number of new substances not found in any part of the animal or vegetable kingdoms.

William Henry Perkin (1838–1907) was the first to make one of these synthetic organic chemicals commercially. For his efforts, he was knighted in England and honoured by the rest of the world as the founder of the other great half of the chemical industry—the synthetic organic segment. At the time of this discovery in 1856, Perkin was 18 years of age and home on Easter vacation from the Royal College of Chemistry in London. Working in a make-shift laboratory fitted out in his father's house, he was trying to find a way to synthesize quinine. For his raw material, he chose coal tar, a heavy black liquid by-product of the gas works. It was a happy choice, for this material turned out to contain about a dozen primary products that chemists have been converting ever since into plastics, paints, perfumes, dyes, medicines, printing inks, building materials, weed killers and insecticides.

When Perkin set to work, however, little was known about coal tar except that it contained benzene. That much had been established by his teacher, the great A. W. von Hofmann, who had prepared aniline from benzene. But neither professor nor pupil had any reason to suspect the tremendous potentialities of either chemical until Perkin happened to treat a salt of aniline with potassium bichromate. Instead of obtaining the white crystals of quinine he was seeking, he found himself with an unpromising tarry black solution. Into it, for reasons which he was never able to explain, Perkin tossed a piece of silk and drew out a beautiful mauve-coloured cloth. He had made the first synthetic dye and laid the foundation for the great new field of pure and applied coal-tar chemistry. Withdrawing from college, Perkin set up a factory and by Dec. 1857 was supplying his colouring to silk dyers. Within a few years many more such new dyes were manufactured by the oxidation of aniline and other aromatic amines as factories sprang up all over Europe.

Despite all these discoveries, however, the structure of these dyes remained a mystery until Friedrich von Kekulé announced his theory of the benzene ring in 1865. Once this doctrine was formulated chemists understood exactly how the six atoms of carbon in the benzene molecule are linked together in a circle with an atom of hydrogen attached to each. Using this concept as an architect would a blueprint, they were then able to build millions of new compounds.

Carl Graebe and Carl Liebermann were the first to apply this new structural principle to the dyestuff industry with their synthesis of alizarin from another coal-tar chemical, anthracene. Using natural alizarin, obtained from madder root, as their starting point they established its structure and then duplicated it synthetically in the laboratory in 1868. Within a few years, they had worked out an industrial process that soon drove the natural dye off the market. Adolph von Baeyer 30 years later figured out the molecular make-up of natural indigo, and later a process for its industrial synthesis was developed that produced a material that quickly took the place of the old plant dye.

As a result of Baeyer's discovery, the Badische Anilin und Soda Fabrik, which had spent $5,000,000 and 17 years in chemical research on this problem, gained a virtual monopoly, and Germany strengthened its standing as the world's dominant dyestuff producer—a position it held for more than 50 years. Unlike the rest of the world, Germany recognized the tremendous importance of these new rainbow dyes from the beginning and did its best to foster and encourage their production.

Instead of letting the valuable raw materials essential for their manufacture drift off in smoke from wasteful beehive ovens, Germany installed by-product coke ovens and recovered the essential coal-tar crudes. Thus it had a plentiful supply of benzene and a number of closely related "primaries" such as toluene, phenol, naphthalene and anthracene that it could use for making not only dyes but also hundreds of other valuable organic compounds. For example, when benzene is treated with sulfuric acid and then caustic soda it is converted to phenol, an intermediate for aspirin, methyl salicylate (oil of wintergreen) and phenol-formaldehyde plastics. Naphthalene when treated with air under special conditions gives phthalic anhydride, which can be combined with glycerin to make resins, the basis of many paints and surface coatings. When treated with other chemicals, phthalic anhydride forms polyesters, plastic materials used in boats, fishing rods and wall panels. Toluene can be converted into the intermediates mononitrotoluene and dinitrotoluene, and then into trinitrotoluene (TNT), the explosive. By means of another process, toluene can be made the starting point for the manufacture of saccharin.

Despite their versatility, these products were not considered important outside Germany until World War I. Then Great Britain, France and the United States realized how necessary these coal-tar crudes were for their economy—indeed for their survival—and they began a frantic effort to build up a full-scale organic chemical industry. Although handicapped by many difficulties in the beginning, this industry grew rapidly with the result that after World War II the United States greatly exceeded Germany as a producer of organic chemicals.

Petrochemical Industry.—Meanwhile, in their search for additional raw materials for organic chemical synthesis, chemists turned to petroleum and natural gas, giving rise to the petrochemical industry. Chemists had been interested in oil ever since Benjamin Silliman, the younger, had made the first careful and studied fractional distillation of oil about 1855. In the beginning, his process was used by others to obtain coal oil for lamps and thus save the world from the "threat of darkness" occasioned by the shortage of whale oil. Some time later the higher boiling fractions produced by Silliman's process were discovered to be useful as lubricants, and only about 40 or 50 years later was a lower fraction, gasoline, put to work in automobiles.

The increasing demand for gasoline led to the so-called catalytic or thermal cracking of petroleum, which yields light oils corresponding to gasoline and heavier oils and gases such as methane, ethane, ethylene, propane and propylene. These gases, first used for fuel or even wastefully burned as flares, proved to be an important source of chemical raw materials. Together with natural gas, which is essentially methane, they are the starting point for the production of a large number of compounds that comprise five major groups of end products: synthetic rubber, plastics, textiles, detergents and agricultural chemicals.

The chemical industry first utilized these hydrocarbons about 1920 when isopropyl alcohol was manufactured from cracking plant propylene. A few years later, commercial production of ethylene glycol was achieved using natural gas fractions as the starting material. Pioneer research on ethylene was done by G. O. Curme and his associates, who are generally credited with laying the foundations of the petrochemicals industry in the U.S., where all of the pioneering work was done.

The importance of petrochemicals increased enormously during World War II as shortages of many vital chemicals previously obtained from other sources became acute. As a result of this expansion, petroleum became an additional source of the important benzene, toluene and xylene, which previously had been obtained only from coal tar. Also of increasing significance in the petrochemicals industry was the use of methane as a basic material for the manufacture of methanol and ammonia and for the production of acetylene, which previously had been obtained exclusively from calcium carbide.

Because petroleum can be made to yield such an assortment of useful products its utilization as a source of raw materials for the chemical industry ranks along with Leblanc's process and Perkin's discovery as one of the great milestones in the history of industrial chemistry.

Solvay Process.—The development of the Solvay process for making alkali ranks as another important chemical landmark. Commonly referred to as the ammonia-soda process, it was first put into successful commercial operation in 1865 by Ernest Solvay, who started a plant at Couillet in Belgium.

Solvay's process operates on the following principles. Salt (sodium chloride) is treated with ammonia and carbon dioxide to form ammonium chloride and sodium bicarbonate. The sodium bicarbonate can be converted with heat into soda ash (sodium carbonate). Carbon dioxide lost during this reaction is recovered and used over again in the first step of the operation. The ammonium chloride can be heated with lime, yielding ammonia, which can be circulated back for reuse, and calcium chloride.

For some years after this process was introduced, it encountered stiff competition from the Leblanc method. Ultimately, however, the cheaper Solvay soda ash drove its rival off the market.

Electrolysis.—Another important development that proved of major significance in the chemical industry was the commercial application of electrolysis. This principle had been demonstrated in 1800, the same year that Alessandro Volta discovered the electric battery. Not long after that, several important discoveries were made that established electricity as a useful tool in the chemical industry. In 1886 Charles Martin Hall discovered the electrolytic process for producing aluminum from alumina (aluminum oxide) dissolved in molten cryolite. By 1900 several plants in the U.S. were producing caustic soda (sodium hydroxide), chlorine and hydrogen by electrolyzing salt. For a while the chlorine was converted with lime into bleaching powder in a manner reminiscent of the old Leblanc process, but in time chemists learned how to liquefy chlorine gas and ship it safely in cylinders.

Production of Sulfuric Acid.—During the same period that electrolysis won commercial acceptance, a new mining process was developed by Herman Frasch that freed sulfuric acid producers from their dependence upon Sicilian sulfur and other sulfur-bearing materials. In 1891 he figured out a way to bring to the surface the sulfur that lay 500 ft. underground in Louisiana. His process involved sinking three concentric pipes—one to carry superheated water down to melt the sulfur, another to blow in compressed air to force the sulfur out and the third to carry the melted sulfur to the surface. It worked perfectly and gave the industry a less costly and much more pure raw material.

Once Frasch sulfur became available, chemists set to work to develop a process that would take full advantage of its extraordinary purity (more than 99%). Out of their efforts came an improved and more economical contact process utilizing the first commercially successful vanadium catalyst. This produced sulfuric acid, the "pig iron of the chemical industry," much less expensively.

Haber Ammonia Process.—To assure a supply of saltpetre in the event that the Chilean nitrate deposits (the world's principal supply) should become exhausted, chemists attempted to find a way to take nitrogen from the air and to combine it with other elements to make useful compounds, in imitation of a process employed by certain nitrogen-fixing bacteria that live on the roots of leguminous plants. In 1908 a German, Fritz Haber (*q.v.*), developed a process that could be used anywhere that coal and water could be brought together economically.

Using a catalyst made mostly from iron and employing extremely high pressure and moderately high temperatures, he caused nitrogen from the air to combine with hydrogen in the ratio of one atom to three, producing ammonia. The ammonia may be used for the production of fertilizers, or it may be oxidized to nitric acid for explosives or the production of nitrates for use as fertilizers. It is also possible to convert it into urea, which is useful in making both fertilizers and urea-formaldehyde plastics.

Polymerization.—During this same period a Belgian chemist, Leo Baekeland, working in a New York laboratory, produced phenol-formaldehyde resins, considered to be the "first modern plastics." In making this new synthetic, he used a principle called polymerization by which simple molecules are linked in chains or rings to form giant molecules (polymers). Baekeland was the first to make successful use of polymerization commercially when he founded his own manufacturing company in 1910.

From a modest beginning that year, industrial plastics by the early 1960s were filling needs ranging from toys for children to structural materials for skyscrapers, from sheer fabrics to rocket nose cones. The plastics industry in the United States in 1958 turned out almost 4,500,000,000 lb. of products valued at approximately $2,000,000,000. The growth was attributed to the ability of the industry to engineer materials to meet specific needs, and to produce them at a cost that made their use feasible. (*See* PLASTICS.)

Development of Atomic Energy.—The chemical industry made important contributions to the development of atomic energy; industrial chemists, together with their colleagues in the universities, teamed up with physicists, engineers, military and governmental administrators to produce fissionable materials. The chemical industry's role in this group effort was a complex one, beginning with the mining of the ore and continuing through nearly every stage of the entire undertaking.

Through the use of organic phosphate, a practical way was found to extract uranium from ores that had been considered marginal. After initial processing, the uranium goes to chemical refineries where, through a series of complicated reactions, various impurities are removed and it is converted into uranium oxide powder—commonly called brown oxide. This in turn is converted through an industrial chemical process to green salt (uranium tetrafluoride), which may be used for one of two purposes. It can be converted into uranium hexafluoride and fed to gaseous diffusion plants where uranium-235 (present in 1 part in 140 of natural uranium) is concentrated; or, it can be reduced to uranium metal used in the reactors that produce plutonium. The plutonium is then separated from the parent uranium in chemical plants. The uranium-235 and plutonium may be fabricated into weapons, or put to work for peace.

Continuing its key role in the development of atomic energy, the chemical industry in the early 1960s was concerned with the production of certain materials for construction of nuclear reactors and associated equipment, of fuels for nuclear reactors, of radioisotopes for industrial and medicinal use and of radiation-resistant materials.

Fundamental Characteristics.—The result of all these developments was to produce an industry that has been credited with turning the 20th century into a veritable "chemical century." The chemical industry is, in a sense, a great creative dynamo that uses its energies to devise new processes and molecular motifs to serve industry better. In carrying out this task, it displays certain fundamental characteristics. The first of these is progressiveness: it is constantly seeking to improve old manufacturing techniques and to invent new ones. As a consequence, the chemical industry invests heavily in research and development. In this highly competitive industry, a vigorous research program to discover new products or processes or to improve present ones is essential to success.

One inevitable result of all this scientific investigation is rapid obsolescence of both plant and equipment. Often a process still in pilot plant stage will be made obsolete by one newly developed in the laboratory. Fortunately for the industry, it is flexible enough to keep pace with this ceaseless change.

This flexibility is a characteristic that the industry demonstrates over and over again. It can, for example, manufacture a particular product from completely different raw materials and by a variety of different methods. Ethanol, for example, may be produced by synthesis from petroleum ethylene or by fermentation of molasses. There are, for example, at least four processes in use for making phenol from benzene, and about ten processes for making acetic acid, starting with three raw materials.

This same versatility extends to the chemical manufacturing units themselves, making it possible, for instance, for a producer to convert a polygasoline plant in a relatively short time into a plant producing intermediates used in making alcohol for plasticizers or in manufacturing synthetic detergents such as sulfonated alkyl benzenes.

The variety of alternatives available to the industry, together with the extraordinary proliferation of products that it turns out, explains why the chemical industry is justly considered to be extremely complex. It is virtually impossible, as the Leblanc process demonstrates, for the chemical industry to make one product by itself. The necessity for finding uses for its "extras" provides the chemical industry with an ever-present challenge.

End Products.—In accepting this challenge, the chemical industry has become a contributor to all the basic fields of life including food, shelter, transportation, health and communication. By so doing, the industry has contributed immeasurably to a world-wide rising standard of living.

To help feed an expanding world population, the industry plays a role in all aspects of food from its production to its purity, properties, preparation, preservation, transportation and presentation. For crop farmers, it has developed whole new families of agricultural chemicals for killing weeds and insects and rebuilding the soil. For stock farmers, it has helped in developing the science of animal nutrition, and produces animal feed supplements, such as amino acids, synthetic vitamins, antibiotics and antioxidants, that promote animal health, quality and growth. For food processors, the industry learned how to manufacture flour improvers, synthetic vitamins, artificial sweetening agents, food preservatives and a variety of plastic films that have revolutionized the packaging of all food products.

To help clothe an expanding world population, the chemical industry discovered and produced the man-made fibres that have revolutionized the textile industry. No longer is there competition between man-made and natural fibres. Rather, the emphasis is on blending man-made and natural fibres so as to make the best use of all available materials for apparel, decorating and industrial service. Furthermore, chemists have discovered ways of modifying the natural fibres to produce new and improved materials. Fabrics, through chemical treatment, may be made resistant to shrinkage, water, wrinkles, sunlight and moths and other pests. The fabrics are, in short, engineered for the services they are expected to perform.

The industry also supplies materials that enable man to construct better houses and office buildings, and to furnish them more attractively. Plastic wall-paneling, draperies, table tops, furniture upholstery, long-lasting and easy-to-apply paints and stain-resistant enamels for appliances earned a respected place in the construction and decorating fields. And as polymer technology advanced from an art to a science, man learned to engineer synthetic materials for specific jobs: urethane foams for furniture cushioning; vinyl flooring to replace wood or marble tile; reinforced polyesters for furniture or for home swimming pools; plywood bonded with superstrong adhesives for subflooring, sidewalls and roofing; resilient, moth-proof carpeting from man-made fibres; plastic insulation; and adhesives for prefabricated houses.

With the assistance of the chemical industry, the world moved faster and more surely from its horse-and-buggy era into the age of swift transportation and travel. Chemicals added to fuel and lubricants helped make engines work better and last longer. Truly synthetic lubricants, for specialized uses, became available. Synthetic rubbers, created from simple chemical compounds, were used for improved tires and other rubber products, while natural rubbers were improved by chemical additives and chemical treatments. Wear-resistant, colour-stable acrylic coatings imparted beauty to the automobile's exterior, and foam rubber cushions upholstered with plastic or man-made fibre fabrics added comfort and attractiveness to the interior. For aircraft, the chemical industry created fire-resistant hydraulic fluids, additives for fuels, lubricants and superstrong synthetic adhesives to replace rivets for some uses, and recovered magnesium from sea water for use as a lightweight structural material. And for the journey to outer space, the chemical industry engineered the materials—fuels, lubricants, plastics and ceramics, to name but a few—that can withstand the rigours of space travel.

As a result of the partnership between medicine and the pharmaceutical segment of the chemical industry, new drugs were discovered and developed to fight disease and lengthen life. Products that prevent disease include such vaccines as those for smallpox, typhoid, and, more recently, the Salk vaccine for poliomyelitis. Typical of drugs that cure disease are the sulfas and the antibiotics. Chemical products used to control illness and promote health are the hormones, such as cortisone and hydrocortisone, antihistamines (for control of allergies), psychosedatives (popularly known as tranquilizers) to control some mental disorders, hypoglycemic agents to reduce the high sugar level associated with diabetes and diuretics, for treating some circulatory or kidney disorders. In the early 1960s pharmaceutical research was focused strongly on virus-caused diseases and on cancer.

Such fields as publishing, telephony, telegraphy, radio, television, electronic computing and photography could not exist without the products of the chemical industry. Pen and ink, paper and pencil, wires and cables, sound recording and videotape, transistors and diodes, all depend upon one or more essential chemicals. And the past is but a prelude to the future: as new needs arise, the chemical industry, servant of all other industries, will supply the materials to meet these needs.

See also references under "Chemical Industry" in the Index volume.

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(Cs. A. T.)

CHEMICAL WARFARE. Chemistry has affected military science throughout recorded history. It was not, however, until the 20th century that chemical warfare in the modern sense of the term became a distinct feature of military operations. Modern chemical warfare represents essentially the application of chemical energy in military action, in contrast to physical energy as represented by the impact of bullets or the shock of explosives. The substances employed in chemical warfare are known as chemical agents. Those that react directly on the human body are called war gases. A second group of agents are smokes that are useful in obscuring the vision of the enemy. Incendiaries or fire producers comprise a third group.

In each case the desired effect is achieved by chemical reactions that take place after the appropriate agent has been released to atmospheric conditions. It is to be noted that these reactions are not necessarily instantaneous, as is the case when firearms or explosives are employed; chemical warfare agents may act slowly and continue to be effective for extended periods of time.

Modern chemical warfare is a product of industrial chemistry. Most of the chemicals used in manufacturing chemical warfare agents have been known for many years, some of them for centuries. To use certain of these chemicals (as, for example, chlorine) for the production of chemical warfare agents is to compete with the vital needs of industry. It has been only in relatively recent years that the chemical industries of the industrial nations have developed adequate production capacities to provide significant quantities of these basic chemicals for military use, as well as to meet the needs of industry.

HISTORY

The application of chemical warfare really began before recorded history with the use of fire, smoke and noxious gases to overcome an opponent. History records that a highly combustible mixture of chemicals called Greek fire (*q.v.*), invented about 670 A.D., was used as an incendiary in land and sea warfare for many centuries—as late as the middle ages. For many years, until the late 19th century, the American Indians made effective use of incendiary arrows in attacks on white settlers. Smoke was used by the forces of King Charles XII of Sweden in crossing the Dvina river (1701). The observation of the opposing Polish-Saxon army was obscured by burning large quantities of damp straw. During the Peloponnesian War between Sparta and Athens (431–404 B.C.) burning pitch and sulfur were used to produce suffocating gases. At the siege of Sevastopol in the Crimean War, Lord Dundonald proposed (1855) the use of burning sulfur on a large scale under favourable wind conditions. The British government, however, declined to permit this method of warfare. Similarly, during the American Civil War, it was proposed (1862), and disapproved by the U.S. government, that artillery shells containing chlorine be employed by the Union forces.

The science of chemistry advanced rapidly during the 18th and 19th centuries, and the use of toxic substances in war was foreseen and considered at The Hague International Peace conference of 1899. At this conference a resolution was offered "to abstain from the use of all projectiles, the object of which is the diffusion of asphyxiating or deleterious gases," on the grounds that this method of warfare was inhumane. The United States did not support the resolution, principally because the inhumane aspects of this type of warfare were not clearly established. A further reason offered was that such restrictions to inventiveness were not of themselves conducive to world peace. The other great powers supported the resolution, however, except that Great Britain's vote was contingent upon unanimous acceptance.

World War I.—Use of chemicals as weapons during World War I was logical because the principal combatant nations were highly developed scientifically and industrially. A stalemate had been reached when both sides entrenched themselves so firmly that advance was impracticable without terrific losses. Means were sought to restore open warfare. At the outbreak of the war, none of the combatant nations was prepared to use or defend itself against chemicals.

The introduction of gas as an effective weapon in modern warfare actually dates from April 22, 1915, when the Germans launched a cylinder attack with chlorine against the Allied position in the Ypres salient where the British and French lines joined. Although intelligence reports had given warnings of an impending attack, little credence was given to them by the Allies. The attack came as a complete surprise to unprotected troops; its success was so far beyond German expectations that adequate reserves to exploit the breakthrough for a decisive stroke had not been provided. Within a few days Allied troops were equipped with pads of cotton dipped in a chemical solution and tied over the nose and mouth. These were soon followed by a crude form of respirator (protective mask) which was continually improved throughout the war both for comfort and efficiency. As protection was obtained against one chemical, the offense sought for and introduced new agents. These frequently required radical changes in the mask. Since cloud gas attacks were launched by releasing the gas from cylinders in friendly territory and allowing it to drift to the enemy, the users were dependent on favourable wind conditions and were limited in the type of agents which could be used successfully. Gas-filled projectiles soon appeared on the battlefield and an extensive and ever-increasing use of gas-filled artillery, mortar and projector shells occurred from 1916 to the end of the war.

With the Germans taking the lead, many varieties of war gas were introduced on the battlefields. In July 1917 the Germans began using mustard gas, which caused severe, slow-healing burns on the skin and damage to the respiratory tract. It was difficult to provide effective protection against this agent, which accounted for the majority of gas casualties. Next to mustard gas, chlorine and chlorine-phosgene mixtures were the greatest producers of gas casualties.

The number of gas casualties as compared to casualties from other means (bullets, high explosives, disease, etc.) increased in the last months of the war, although deaths among gas casualties were few. For example, in the Somme offensive against the British and French (March 1918) the Germans conducted a ten-day artillery bombardment (Ypres-San Quentin area) in which they used over 500,000 mustard gas shells. Gas casualties produced in this bombardment alone totaled over 7,000, but only 87 deaths resulted directly from gas. Also, the American expeditionary forces (A.E.F.), who participated as an organized force during the last nine months of the war, sustained nearly 27% of their total casualties from gas, yet only 2% of these casualties died from the effects of gas. In contrast, 26% of the total A.E.F. nongas casualties resulted in death.

Both sides had plans ready for increased chemical warfare activity in 1919, had the war continued. The British, for example, planned on loading 20% to 30% of all types of artillery shells with toxic chemicals, and the German artillery shell program provided for up to 50% gas ammunition.

Post-World War I.—In the field of international agreements, the subject of toxic chemical warfare was considered by the League of Nations, with inconclusive results, on two principal occasions: the Geneva Traffic in Arms conference (1925) and the General Disarmament conference (1932–34). (*See* DISARMAMENT.)

All major world powers maintained chemical warfare research and development facilities after World War I. Between 1918 and the middle 1930s a limited quantity of defensive equipment for military personnel, principally protective masks, and a limited quantity of chemical warfare munitions were manufactured. Chemical warfare preparedness of the major powers, along with other military preparedness measures, was accelerated during the 1930s because of the unrest throughout the world, typified by the warfare in China, Ethiopia and Spain. As World War II approached, civil defense measures of the major powers, particularly the United Kingdom, included means of passive defense against chemical attack.

During World War II and the Korean conflict there was considerable military use of nontoxic chemical agents; *i.e.*, smokes and incendiaries. Smoke was disseminated on land and sea and from the air by devices ranging from burning-type smoke pots to aircraft spray tanks. Incendiary materials were used in a variety of bombs, grenades and flame-throwing devices.

During the entire period from the end of World War I to the end of hostilities in Korea only two instances of the use of toxic chemicals in warfare were recorded. These were by the Italians against the Abyssinians (1935–36) and by the Japanese against the Chinese (1937–42). In both cases blister gases were used. The Italian use of mustard gas in aircraft spray and aerial bombs was reported to be highly effective against the unprotected Abyssinians. A particularly successful use of mustard gas by the Italians occurred near Makale, Aby. (Jan. 1936). Within four days one of the finest armies of Haile Selassie lost its effectiveness as a fighting unit. The Japanese used both gas shells and gas bombs. As in the case of the Abyssinians, the Chinese had no protective devices to employ. Although the Japanese use of gas was reported with frequency, in no case was it employed on a grand scale. The most effective attack occurred when quantities of gas-filled artillery shells were fired on Ichang, a town on the Yangtze from which the Chinese had succeeded in driving the Japanese (Oct. 1941). Relief of the hard-pressed Japanese forces resulted, with the Chinese withdrawing along the entire Ichang front. A strong protest and a threat of "retaliation in kind and in full measure," announced by Pres. Franklin D. Roosevelt to the Japanese government (June 5, 1942), were instrumental in preventing recurrence of these incidents during the remainder of the fighting.

World War II and Korean War.—Throughout World War II the Allies maintained a policy of using toxic chemicals in retaliation only. President Roosevelt's 1942 pronouncement to the Japanese was followed (June 8, 1943) by a statement that "Any use of gas by any Axis power . . . will immediately be followed by the fullest retaliation upon . . . military objectives throughout the whole extent of such Axis country." Prime Minister Winston Churchill issued similar warnings to the Axis powers. Preparation for gas warfare, however, was not neglected by either side. The Germans, in particular, were well prepared at the outset of the war. Their failure to employ gas can be attributed in part simply to a policy not to use it except in retaliation; in part to their awareness of Allied readiness, offensively and defensively, for gas warfare; and in part to the fact that it was unnecessary, militarily, for them to use gas at the outset of the war. Later, when situations more suitable for the use of gas arose, Germany had lost aerial supremacy. At this time Germany stood to lose on the strategic side any advantage that might have been gained tactically by the use of gas. To the German high command there was obviously no profit in releasing gas on the beaches of Normandy or Anzio if this would mean a retaliatory showering of toxic chemicals on German cities, already hard pressed by Allied bombings. Perhaps the most significant development in chemical warfare occurred during World War II with the German discovery of a new series of chemical agents called nerve gases. These agents (called Tabun, Sarin and Soman by the Germans) were found to be much more toxic than any previously discovered, and vastly more toxic than World War I agents. Although the Germans had some of these agents in limited production at the close of World War II, none was used during the conflict.

Nor was poison gas used during the Korean war of the early 1950s. But it was not considered an obsolete weapon on that account. Because of the giant strides made in means of delivering agents to the target, and because of the marked increase in toxicity of agents, gas was still regarded as a powerful instrument, useful particularly when material destruction is not desired or when the enemy is dug in too firmly even for nuclear weapons to dislodge him.

CHEMICAL AGENTS

The term gas is applied to those chemical agents used in war which, by ordinary and direct chemical action, produce a toxic or powerful irritant effect on the human body. Solids, liquids or true gases may be so employed; however, in their actual use in the battle area, the solid or liquid is converted by normal or artificial volatilization into a true gas or is disseminated as minute solid or liquid particles called aerosols. Irritant smokes are types of aerosols included under the term gas because their principal use is for their physiological effect.

Classifications.—From the military viewpoint the most important classifications of chemical agents are in accordance with (1) physiological effect; (2) persistency; and (3) tactical use.

Physiological effect classifies the chemical according to its primary action on the human body even though it may produce other secondary effects. The severity of effect is roughly proportional to the concentration (amount present in a unit volume of air) and the time of exposure.

Choking gases (lung irritants) act on the respiratory system and are often lethal. When breathed, they irritate and inflame the interior portion of the bronchial tubes and lungs, cause coughing, impede breathing and, in severe cases, acute pulmonary edema will result. Chlorine, phosgene and diphosgene are examples.

Blister gases (vesicants) attack any part of the body with which the liquid or vapour comes in contact, especially moistened parts. They are absorbed or dissolved on exterior or interior parts of the body, followed by production of inflammation, burns and destruction of tissue. There is no immediate pain and effect is delayed for some period after exposure. Protection against this class of agents is very difficult because of their insidious action. Examples are mustard gas, lewisite and ethyldichlorarsine.

Sneeze gases (sternutators or irritant smokes) are disseminated into the air as minute solid or liquid particles which, if inhaled, cause sneezing, intense pain in the nose, throat and chest followed by violent nausea, headache, mental depression and physical weakness. No fatal cases have been recorded from this class; effect, although severe, is temporary, lasting about 12 hours. The charcoal and soda lime mixture of the gas mask canister will not remove these small particles from the air. A most efficient mechanical filter is necessary to give protection. Diphenylaminechlorarsine, an aromatic arsenical derivative, is an example of a sneeze gas.

Tear gases (lachrymators) irritate the mucous membrane around the eyes, causing intense smarting and a profuse flow of tears with resultant hampering of vision. Effect from concentrations in the field is only temporary, recovery being complete within a few minutes after removal from the contaminated area. Chloracetophenone, bromobenzylcyanide and xylyl bromide are examples.

Blood gases (systemic poisons) directly affect the heart action or nerve reflexes, or interfere with absorption and assimilation of oxygen by the body. Carbon monoxide and hydrocyanic acid, which pertain to this class, have never been effectively used in war because they are lighter than air and do not remain for long on a given ground area.

Nerve gases inhibit the normal action of the body enzyme, cholinesterase, thereby causing an accumulation of toxic amounts of acetylcholine. This leads to continual stimulation of the parasympathetic nerve system. The vapours, when inhaled, may cause nausea, vomiting and diarrhea; these effects may be followed by muscular twitching and convulsions. Even in low concentrations the vapours cause eye pupils to contract; vision becomes difficult and headache may result. After short exposure a sense of tightness in the chest may be noticed. Small amounts of liquid nerve gas on the skin may cause salivation and a twitching of the affected area. Severe cases of nerve gas poisoning rapidly result in convulsions, coma and—unless promptly treated—death.

The persistency of a chemical agent is determined by the length of time it will maintain an effective concentration without being renewed. Chemicals that remain effective for longer than ten minutes after release in the open are defined as persistent. Usually dispersed in the liquid state, persistent agents contaminate the ground on which they are released and continue to give off dangerous vapour for long periods. Nonpersistent gases are those whose effectiveness in the open continues for less than ten minutes. They vaporize rapidly, forming concentrated clouds that drift with the wind, increasing in size but becoming diluted in gas content until they finally disappear.

Tactical classification, which is influenced by the persistency, is based on the primary military objective for which any particular chemical is used in the field. War gases are thus classified as casualty or harassing agents; smokes as screening agents; and the various fire producers as incendiaries.

Chemical Agents Described.—No attempt will be made to enumerate all of the chemical agents that might be used in war. Many thousands of compounds have been thoroughly studied, but only a relatively few have been selected for actual development and test under field conditions. Continued effort undoubtedly will result in new chemical agents or better ways to produce those already known.

To be useful as a chemical warfare agent, a material must meet certain requirements. It must give effective physiological action, screening power or incendiary action. It must be stable in storage and resistant to the effects of moisture. It must be economical to manufacture from easily procurable, nonstrategic raw materials. It must be safe to handle, transport and load in munitions, and must not have any corrosive effect on ordinary steel. It must be capable of dissemination in effective quantities under field conditions. And, in the case of a gas, it must be heavier than air, readily compressible to the liquid state and easily vaporized when released. Brief descriptions of a few chemical agents follow.

Phosgene under ordinary conditions is a colourless, nonpersistent gas with an odour varyingly described as a new-mown hay, green corn or green apples. Tactically, it is classified as a casualty agent. At low temperatures it is a clear, colourless, mobile liquid, which boils at 8.3° C. Under ordinary summer conditions, it will disappear from a given locality about as fast as the wind moves. Even in winter it evaporates rapidly. In a light wind an effective concentration of phosgene can readily be produced. It is used commercially for dye manufacture. During World War I it was first employed by Germany in Dec. 1915, in a cloud gas attack from cylinders.

Mustard gas is a compound of carbon, hydrogen, sulfur and chlorine. It should not be confused with the true natural mustard oil or the artificial compounds having similar properties. It was because of its sharp pungent odour and vesicant properties, which resembled but greatly exceeded those of natural mustard oil, that British soldiers first called it mustard gas. The commercial product is a heavy oily liquid of dark colour and in low concentrations has the distinct odour of garlic or horseradish. This product freezes at about 10° C. It is a persistent vesicant agent that is also very effective as a lung irritant. In vapour form, after prolonged exposure, it attacks the whole respiratory system producing inflammation of the trachea and bronchi with necrosis of the mucous membrane and development of secondary bronchitis or bronchopneumonia. Upon slight contact with the liquid it is absorbed in the skin and produces serious burns. First employed by Germany at Ypres in July 1917, it was thereafter known to the French as Ypérite. It hydrolizes slowly and may be neutralized by intimate mixture with bleaching powder, steam or gaseous chlorine.

The nerve gas Tabun is a colourless to brownish liquid with a low freeing point, 49° C. For all practical purposes it is odourless. It is typical of the nerve gases in that it is a quick-acting casualty gas that causes its effects on man through the respiratory tract or through the skin. In the latter case, a small drop absorbed through the skin may cause death within 15 minutes, unless appropriate first-aid treatment is quickly administered. Unlike the effect of blister gases no harm is caused to the surface of the skin by contact with the liquid agent.

Hydrocyanic acid is a paralysant that acts on the central nervous system to produce quick death. It has a slight odour, resembling that of bitter almonds. This agent, long known as one of the deadliest of compounds, was used in artillery shells during 1914–18. However, its usefulness was limited, principally due to the rapid dissipation of the agent in the field because of its high volatility. Somewhat better success in building up effective field concentrations may be obtained by delivering the agent to the target in gas bombs of large volume; when this is done, a phenomenon of cloud cooling occurs, permitting a nonpersistent gas cloud to remain in the target area for several minutes.

Diphenylaminechlorarsine, better known as adamsite, is representative of the large group of irritant smokes which may be used in war. Physically, in pure form it is a bright canary-yellow crystalline solid. Commercially, it is produced in a dark green or sometimes brownish colour. In its solid state it is almost odourless, but when dispersed as an irritant smoke, a hazy yellow cloud is formed that has a smoky odour. The first symptoms are usually a burning sensation in the nose and throat. Adamsite is classified as a nonpersistent harassing agent, but as such is extremely potent because very small concentrations with a brief period of exposure will prove effective. The headache, nausea and vomiting which it causes, followed by physical debility, render a person practically helpless. Effective use of the irritant smokes is largely dependent on penetration of the filtering device used with the gas mask.

White phosphorus, a pale yellowish, translucent crystalline solid of waxy consistency, is very active chemically and combines readily with oxygen. Unless protected from air it will burst spontaneously into flame. White phosphorus can be loaded into shells, bombs or grenades. When the bursting charge explodes the solid phosphorus is broken into small fragments which are scattered in the air. The heat of explosion assists their immediate ignition, forming a cloud of phosphorus pentoxide. This smoke has the highest known obscuring power, yet is harmless when breathed. Fragments of considerable size are scattered about and continue to burn for some time, thus prolonging the emission of smoke. In addition, white phosphorus has limited incendiary value against readily combustible matter. Physiologically it may be classed as a casualty agent, since its ignited particles cause painful flesh burns that heal very slowly. Although primarily used for smoke production within the enemy lines, white phosphorus is also a formidable weapon against machine gun nests or troop concentrations.

FS, a mixture of about 55% sulfur trioxide and about 45% chlorosulfonic acid, by weight, is an excellent cheap liquid smoke for release from containers or for dispersion from airplanes.

Metal incendiaries include those consisting of magnesium, in various forms, and powdered aluminum mixed with powdered zinc and iron oxides. Metal incendiaries were much used by the Germans against the United Kingdom in the early part of World War II and by the Allies in air raids against Japan in the latter stages of the war. Typical oil incendiaries are mixtures of gasoline with heavier oils, or with an aluminum soap thickener. The latter incendiary mixture (commonly called Napalm) saw much effective use during World War II and the Korean conflict in tank and portable flame throwers, as well as in the wing-tank type fire bombs, dropped principally from fighter-bomber aircraft. (*See* also FLAME THROWER; INCENDIARY MIXTURES; NAPALM.)

The table briefly summarizes characteristics of some important chemical agents used in war.

Characteristics of Some Important Training, Toxic and Riot Control Chemical Agents

Class	Common and chemical name	Physical state at 68° F. and 760 mm. pressure	Physiological effect	Rate of action	Persistency*	Odour
Choking gas	Phosgene (carbonyl chloride)	Colourless gas	Affects lungs and results in damage to the capillaries. Causes edema of the lungs (air cells become so flooded that the victim dies of oxygen deficiency)	Immediate to 3 hr.	Nonpersistent	New-mown hay, green corn
Choking gas	Diphosgene (trichloromethyl chlorofomate)	Colourless liquid	Same as for phosgene	Usually delayed 3 hr or more	Moderately persistent	New-mown hay, green corn
Blister gas	Distilled mustard [bis(2-chloroethyl) sulfide]	Colourless to pale yellow liquid	Blisters, destroys tissue, injures blood vessels. Conjunctivitis (inflammation) of eyes. Erythema (reddening of skin). Inflammatory reaction of nose, throat, trachea, bronchi and lung tissue.	Delayed usually 4 to 6 hr. but periods as late as 24 hr. or more have been observed	Highly persistent	Garlic or horseradish
Blister gas	Nitrogen mustard [methyl bis (β-chloroethyl) amine hydrochloride]	Dark liquid	Irritates eyes in dosages which do not damage skin or respiratory tract. Erythema (reddening of the skin). Blisters in erythematous areas. Affects respiratory tract. Bronchopneumonia may appear after first 24 hr. Following ingestion or systemic absorption, causes injury to intestinal tract.	Delayed 12 hr. or longer.	Persistent	Fishy or musty
Blister gas	Lewisite [dichloro(2-chlorovinyl)-arsine]	Dark oily liquid	Effects similar to mustard gas and in addition acts as a systemic poison, causing pulmonary edema, diarrhea, restlessness, weakness, subnormal temperatures and low blood pressure.	Immediate irritation, delayed blistering	Persistent	Geranium
Nerve gas	Tabun (cyanodimethylaminoethoxyphosphine oxide)	Colourless to brown liquid	Inhalation produces nausea, vomiting and diarrhea followed by muscular twitchings and convulsions. Even low concentration causes eye pupils to contract Liquid on skin penetrates very rapidly. Primary physiological action is on the sympathetic nervous system causing a vasoparesis.	Immediate to 15 min.	Moderately persistent to persistent	None when pure; otherwise faintly fruity
Nerve gas	Sarin (fluoroisopropoxymethylphosphine oxide)	Colourless liquid	Same as for Tabun	Immediate to 15 min.	Nonpersistent to slightly persistent	None when pure
Nerve gas	Soman (fluoromethylpinacolyloxyphosphine oxide)	Colourless liquid	Same as for Tabun but Soman acts faster and in lower concentrations. In equal concentrations Soman produces much more severe effects.	Immediate to 15 min.	Persistent	Fruity; with impurities, odour of camphor
Training agent	Chlorine	Greenish-yellow gas	Powerful irritant, first on upper and then on lower respiratory tract. Also irritates eyes.	Immediate	Nonpersistent	Pungent, such as bleaching powder
Blood gas	Hydrogen cyanide	Colourless gas or liquid	Interferes with utilization of oxygen by the body tissue or hemoglobin. Also poisons the central nervous system.	Immediate to 15 min.	Nonpersistent	Slight, resembling bitter almonds
Blood gas	Cyanogen chloride	Colourless gas	Similar to action of hydrogen cyanide.	Immediate	Nonpersistent	Irritating and lachrymatory properties; conceals odours
Blood gas	Arsine (arsenic trihydride)	Colourless gas	Interferes with functioning of the blood and damages liver and kidneys.	Delayed from 2 hr. to 11 days	Nonpersistent	Practically odourless when pure; otherwise garliclike (metallic taste)
Vomiting gas	Adamsite (diphenylaminechlorarsine)	Yellow to green solid	In progressive order Irritation of the eyes and mucous membranes, viscous discharge from the nose, sneezing, coughing, severe headache, acute pains and tightness of chest, nausea and vomiting.	1 min.	Nonpersistent	None
Tear gas	Chloracetophenone	Solid	Lachrymates. Also irritates upper respiratory passages. In high concentration, irritates the skin, especially on moist parts of the body.	Immediate	Nonpersistent	Apple blossoms

*Length of time an agent normally remains effective in the open at the point of dispersion. A nonpersistent agent is one whose effectiveness dissipates in 10 min. or less.

Dispersion of Agents.—Chemical warfare agents are dispersed either as liquids, aerosols or gas clouds. The agents may be released upon an area rather than upon a pin-point target. Once released, the agents travel with the air and wind currents, gradually diffusing to a point of noneffectiveness. This diffusion process varies with the agent employed and with temperature, wind speeds, terrain and other considerations. Once released in a target area, the behaviour and effectiveness of chemical warfare agents are greatly dependent upon the weather. The more numerous and larger the air currents, the more widely the chemical clouds are dispersed. Under more stable meteorological conditions; *i.e.*, low wind speed and slight turbulence, chemical clouds remain near the ground and may travel for long distances before being dissipated. Under less favourable conditions more munitions per target area are required to achieve the tactical result desired. Large area attacks can be made with wind speeds up to 12–15 m.p.h., whereas small area attacks are generally not effective in wind speeds of over 6 m.p.h. The degree to which temperature variations limit the tactical use of chemical agents is dependent on the physical properties of the particular agent; generally, however, the higher the temperature the less effective is a given quantity of any agent. Humidity does not seriously decrease the effectiveness of most war gases. High humidity coupled with high temperature increases the effectiveness of some blister gases such as the mustards. Rainfall reduces the effectiveness of chemical clouds and may even cause them to be ineffective. Heavy rainfall also will wash away persistent liquid agents. Snow reduces the evaporation of persistent agents so that little vapour hazard exists, but contact with the liquid still presents a hazard. When the snow melts, the vapour hazard of the persistent liquid agents reappears. The behaviour and effectiveness of chemical agents are affected by the contour and conditions of the surface of the ground and by the presence or absence of trees and vegetation.

Military Application.—Chemical warfare agents may be employed in either tactical or strategic operations. Chemical munitions differ in several important respects from conventional high explosive munitions and atomic or thermonuclear devices. The most important properties of chemical warfare attack are selectivity, persistency, area coverage, freedom of trajectory pattern and mobility. The effects of chemical agents range from harassment of personnel to instantaneous lethal effect. Chemical agents also permit interdicting and obscuring target areas. The flame and incendiary agents are also capable of materiél destruction. The highly persistent agents can be employed to deny terrain to the enemy unless he is willing to absorb a high number of casualties by crossing or occupying the contaminated area. The wide range of agent-munition combinations permits a range of effectiveness in the area of release from a few minutes' duration to indefinite periods ranging into days and months. Compared with conventional high explosives, which act instantaneously at the impact point, chemical munitions afford a distinctly wider range of effectiveness. Conventional, atomic or thermonuclear munitions have a definite radius of effectiveness. Chemical agents, on the other hand, are effective not only in the area of release but also for considerable distances downwind from the place of release. Chemical agents, moreover, flow with the air currents. Thus, being independent of trajectory in the area of release, they will penetrate defenses that normally give full protection from the effects of other weapons systems. The mobility of toxic gas clouds may be from 5 to 25 times as large as the area of release.

PROTECTION

Having in mind the three distinct types of agents employed in chemical warfare, protection is of interest principally against war gases, since nontoxic smokes are relatively harmless (except in confined spaces) and protection against incendiary agents is limited to measures customarily followed in fire fighting. In considering protection against war gases, it is necessary to distinguish between the direct effect on the respiratory organs and the effect on the body caused by contact of the agent with the body surface.

For protection against lung irritants, of which phosgene is typical, the gas mask is the primary protective device. The principle on which the military mask is based is that of filtering out or neutralizing noxious substances that may be present in inspired air. In order to accomplish this, air before it reaches the lungs must first pass through a filtering element containing materials that act mechanically or physically or react chemically with the toxic agents. For this reason a characteristic feature of the protective mask (from which the original U.S. designation "gas mask" was derived) is a tight-fitting facepiece so designed as to prevent air from reaching the respiratory organs from any direction except through the filter. (*See* figure.) Since the mask must necessarily cover the entire face in order conveniently to permit normal respiration, it incidentally affords protection against lachrymators which, when the eyes are unprotected, cause eye irritation.

The principal materials used in protective mask filters (or canisters) are charcoal and soda lime. Charcoal absorbs and holds a relatively large volume of poisonous gases. Soda lime supplements the action of charcoal by neutralizing any toxic materials that might eventually be released by the charcoal and otherwise would pass to the lungs with incoming air. Having a proper balance of charcoal and soda lime the gas mask may be worn with safety even after it has been used in concentrations of war gases.

Besides soda lime and charcoal, masks are sometimes provided with some means of mechanical filtration to strain out finely divided solid particles (toxic smokes), which severely irritate the nasal passages. The life of a gas mask filter depends on two factors: the length of time it has been exposed in gas attacks and the concentrations of gas that have been encountered. Military masks generally remain serviceable even after use in several gas operations. When the capacity of the filter is approaching exhaustion a slight odour of gas can be detected. This indicates that replacement with a fresh filter is necessary.

Although it is possible to design filtering devices that will neutralize any toxic substance, it is not feasible to combine in one mask protection against all of them. Military masks are accordingly constructed with a view to counteracting the chemicals that are thought most likely to be used in war. The introduction of new types of military gases in the future will undoubtedly be followed by appropriate modification of masks now considered standard. For safeguarding personnel who must perform functions which are extremely difficult to accomplish while wearing the mask (*e.g.*, eating) gasproof installations may be provided. These are known as gas shelters or collective protectors. A typical installation is equipped with a filter similar in principle to that used in the protective mask, although much larger. Incoming air is drawn through this filter and is thus purified; other outside air is excluded, so that all air within the enclosure may be inhaled safely.

Protection by filtration applies only to those chemical warfare agents that are dispersed as true gases and are therefore injurious when breathed. Agents such as mustard gas that are dispersed in liquid form and attack the body through the skin surface necessitate the use of special protective clothing. To insure complete protection for persons obliged to remain in contaminated areas, fabrics used in this clothing must be treated with moisture-resisting compounds (*e.g.*, oilskins), and garments must be designed positively to exclude air at all points. The gas mask is invariably worn with protective clothing to prevent inhalation of noxious fumes which are always present where liquid agents are released.

Ground or other surfaces saturated by persistent (liquid) chemicals may be treated to hasten decomposition of toxic materials. Chlorine is most effective for this purpose and is commonly applied in the form of chloride of lime.

The effective use of antigas equipment is dependent on thorough military training and organization. Gas defense organization, based on the assignment of suitable gas specialists to various units, insures attention to all features of chemical security, including such matters as the alerting of troops to gas attack and the degassing of areas contaminated with persistent chemicals.

All measures for protection against gas contribute toward the development of gas discipline. When this is high, military organizations are able to face gas attacks with confidence born of the knowledge that gas casualties will be light and that gas will not unduly impede the attainment of objectives.

Self-Aid and First Aid.—Individuals who have been subjected to a chemical attack may take measures themselves (self-aid) to neutralize or to minimize the effects of the agents. Others may administer the same or more complicated nonmedical measures as first-aid treatment. Speed is an essential element in either self-aid or first-aid treatment against the effects of the war gases. Use of devices such as the protective mask (respirator) is another essential element in the treatment of chemical warfare casualties. With contamination by certain agents, such as the blister and nerve gases, however, personal decontamination of the eyes, face, neck and head areas is necessary before donning the mask. The military forces provide certain ointments, decontaminants and antidotes for use in specific self-aid and first-aid techniques. Military forces, moreover, prescribe a progressive treatment technique to be followed once the agent has been identified through sensory or mechanical detection means or through preliminary diagnostic evaluation of the physiological effects. Effective self-aid and first-aid measures for civilians can be achieved only if the civilian population is provided with the necessary items for the treatment of chemical warfare casualties. To be adequate, civilian defense planning must include provision for such decontaminants, antidotes and ointments as are necessary to neutralize or minimize the effects of the various agents which might be employed by an enemy.

See also references under "Chemical Warfare" in the Index.

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(F. M. A.; W. FY.)

CHEMILUMINESCENCE is light of chemical origin. This includes all forms of radiation—whether visible, infrared or ultraviolet—emitted in excess of the black body radiation, where the energy is supplied from simultaneously occurring chemical reactions. Chemiluminescence is most commonly generated by oxidation. The light emitted can usually be ascribed to the transfer of the energy of oxidation to a molecule not itself undergoing oxidation in which light is thus generated. A large number of substances, such as formaldehyde, dioxymethylene, paraldehyde, acrolein, lophine, glucose, lecithin and cholesterin, luminesce if slowly oxidized in alkaline alcoholic solution (B. Radziszewski, 1877–83). Another group of chemiluminescences described by M. Delépine (1910–12) is connected with the oxidation of sulfur compounds. The widespread luminescence of living organisms such as fireflies and luminous bacteria was shown by R. Dubois (1885–87) to be based on the oxidation of a substance of unknown structure, luciferin, in the presence of an enzyme luciferase. When the chemiluminescence occurs in living things it is called bioluminescence.

See also LUMINESCENCE. (M. POL.; X.)

CHEMIN DES DAMES, BATTLE OF THE, sometimes known as the battle of the Aisne and part of the 1918 German offensive on the western front in World War I. At the end of May 1918 the Germans assembled 41 divisions on the stretch of front running 24 mi. N.W. from Reims, held by 11 French and 5 British divisions. This area included the Chemin des Dames ridge, regarded as an exceptionally strong and well-organized defensive position. At 1 A.M. on May 27, the Germans opened an intense bombardment, which included gas shells, and at 3:40 A.M. the 17 assault divisions advanced. They made rapid progress and by evening German infantry were swarming over the still intact bridges over the Aisne river and had reached the Vesle on a 9 mi. front. By June 3, their centre had advanced 30 mi. to the Marne at Château-Thierry. Meanwhile Gen. Henri Philippe Pétain had directed large reserves (25 French and 2 American divisions) to the threatened area; but the German advance had lost its momentum, and on the evening of June 3, the German crown prince ordered the offensive to stop.

See Sir James E. Edmonds (comp.), *History of the Great War Based on Official Documents*, vol. iii, *Military Operations, France and Belgium, 1918* (1939). (C. N. B.)

CHEMISTRY (ARTICLES ON). Chemistry is concerned with the properties of matter—broadly, with its structure, composition and susceptibility to change. Like physics, it has undergone a vast evolution in theory since the invention of quantum mechanics and statistical mechanics. There is no better way to communicate the new developments than to retrace the steps of the scientists who first arrived at them. For this purpose, CHEMISTRY begins with a general historical survey; also, each of its major divisions—inorganic, organic, physical and analytical chemistry—includes a further summary of the series of discoveries that led to present-day knowledge.

Since chemistry seeks to investigate all the properties and mutations of matter, it is closely allied with many sciences, and particularly with physics. The collaboration of physics and chemistry is illustrated in the section of PHYSICS: GENERAL SURVEY headed *The Electrical Nature of Matter*, and in such articles as ATOM; NUCLEUS; NEUTRON; PHOTOCHEMISTRY; RADIOACTIVITY; SPECTROSCOPY; and X-RAYS.

Every substance so far found in nature or produced in the laboratory consists of one or more of the hundred-odd species of atom that have been identified as elements. ELEMENTS, CHEMICAL gives a general discussion of these and data on the atomic number, atomic weight, terrestrial abundance, etc., of each. The factors governing distribution of the elements are reviewed in GEOCHEMISTRY. Many articles are devoted to individual elements, their properties, industrial applications, etc. Another series of articles deals with groups of elements; *e.g.*, ALKALINE EARTHS; PLATINUM METALS; TRANSURANIUM ELEMENTS; etc. Also, important compounds and groups of compounds are treated in a number of individual articles; *e.g.*, ACETYLENE; ACIDS AND BASES; AMMONIA; AZO COMPOUNDS; HYDRIDES; NITRIC ACID AND NITRATES.

Many of the elements as found in nature are mixtures of atoms that have identical chemical properties but vary slightly in nuclear mass. ISOTOPE discusses these chemical siblings and their significance in atomic energy and biochemical experimentation.

One of the most important principles in the study of the chemical elements was arrived at by a method of startling simplicity. This is the discovery, described in PERIODIC LAW, that when the elements are arranged in groups according to atomic weight, the positions on the chart correspond to similarities in chemical properties.

The factors determining the capacity of an atom for combining with other atoms are discussed in VALENCE. Among the articles dealing with other aspects of chemical combination and interchange are CO-ORDINATION COMPOUNDS; ION EXCHANGE; POLYMERIZATION; and RESONANCE.

In many cases, chemical properties are keyed to the architecture of atoms or of the molecules in which they are grouped. Among the articles treating of the relationship between the properties of chemical compounds and the configuration of their building blocks are CRYSTALLOGRAPHY; ISOMERISM; MOLECULE; and STEREOCHEMISTRY.

BIOCHEMISTRY surveys the role of chemistry in the study of plant and animal life. Other articles dealing with chemistry of living matter are CARBOHYDRATES; CHLOROPHYLL, CHEMISTRY OF; CYTOLOGY; ENZYMES; METABOLISM; PROTEINS; and PHOTOSYNTHESIS.

Articles dealing with laboratory equipment and techniques include CHEMICAL APPARATUS; CHROMATOGRAPHY; INDICATOR, CHEMICAL; POLAROGRAPHY; ULTRAMICROCHEMISTRY; etc.

The survey article CHEMICAL INDUSTRY is supplemented by articles on individual operations and processes—*e.g.*, ALKALI MANUFACTURE; ATOMIC ENERGY; DISTILLATION; HYDROGENATION; NITROGEN, FIXATION OF; PHARMACOLOGY; etc. Many articles discuss the chemistry of materials of commerce—*e.g.*, COAL TAR; GLASS MANUFACTURE; PLASTICS; RUBBER; etc. The contributions of chemistry to the economics of agriculture by the creation of new uses for farm products are treated in CHEMURGY.

Two articles that present a significant contrast are ALCHEMY and SCIENTIFIC METHOD. The relationship of chemistry to science as a whole is discussed in SCIENCE. Scientific approaches to the philosophical question of the origin of matter are summarized in COSMOGONY.

The chemists responsible for the major achievements described in the above articles are represented by biographical articles—*e.g.*, BERZELIUS, JÖNS JACOB; DALTON, JOHN; KEKULÉ VON STRADONITZ, FRIEDRICH AUGUST; LAVOISIER, ANTOINE LAURENT; LIEBIG, JUSTUS VON; VAN'T HOFF, JACOBUS HENDRICUS.

For information on any phase of chemistry, the reader should make use of the Index—a guide to individual articles on the subject as well as to relevant sections of other articles.

CHEMISTRY is the science that deals with the nature of and the changes in the composition of matter. It once was regarded as a well-defined, separate science, but now the border lines between chemistry and other sciences have almost completely disappeared in some areas. Since 1885, for example, certain portions of physics and chemistry have been united in a new joint discipline, physical chemistry. From about 1900, biology and chemistry have been joined in another new scientific area, biochemistry. Inasmuch as the techniques and subject matter of chemistry are sometimes shared with related fields of study, a comprehensive view of modern chemistry must take into account the relationships between chemistry and these other fields. For a survey of important separate articles in the various fields of chemistry, *see* CHEMISTRY (ARTICLES ON).

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I. HISTORY OF CHEMISTRY

A. PRESCIENTIFIC PRACTICAL CHEMISTRY

Chemistry was not recognized as a science in its own right until about the 16th century, but its subject matter had been an object of human concern from the earliest days of primitive man. Early man could not avoid noticing the material changes with which chemistry is concerned, and he learned to utilize some of the natural changes for his own benefit. The discovery of fire, for instance, gave him a tool with which he soon learned to bring about some of these changes deliberately, and even in the most primitive times the utilization of metals became extremely important. Copper, Bronze and Iron ages succeeded each other, each representing a further step in the development of metallurgical technology. As civilization developed, technological skills broadened, and in the early cultures of Egypt and Mesopotamia a practical chemistry of high quality already existed.

It is true, of course, that the practitioners of this chemistry did not think of their arts as in any sense chemical. They were artisans, workers in metals, dyes, perfumes and drugs. They often worked in close association with temples, and they made luxury articles for the priests and nobles as well as cheaper imitations for the poorer citizens. Most of their methods were kept as trade secrets, to be handed down from father to son, but enough written records have been preserved to show their techniques for preparing glazes and perfumes and for assaying gold, silver and other metals. When considered in conjunction with the pieces of apparatus that have been found in archaeological excavations and the analyses of other objects recovered from the ruins, the records of techniques disclose much of the nature of the technological processes used by the ancients. Many of their methods of distillation, digestion and extraction of natural products formed the basis on which later alchemists and chemists developed their own methods and ideas.

The chemistry of these ancient civilizations was essentially practical, but most of its theoretical explanations of natural events had a mythological and magical character. Nevertheless, some of the concepts greatly influenced later and more rational thinkers. In particular, the Mesopotamian idea that the world was made up of a number of contraries, such as male and female, hot and cold, wet and dry, and so on, was taken over by Greek thinkers. Equally important was the idea that events in the macrocosm, the great world of the sun, moon and stars, were paralleled by events in the microcosm, the small world of man. This idea was originally of astrological origin, but it fitted well into the biological bias of many Greek thinkers and became an important factor in their explanation of many chemical facts.

1. Greek Classicists.—The concepts and techniques developed by the older civilizations reached the Greeks through the city of Miletus in Ionia and were organized by the Ionian school of philosophers that began with Thales in the 6th century B.C. These Ionian philosophers were cosmologists who sought to explain all the workings of nature in the simplest and most logical terms; *i.e.*, in terms of purely physical phenomena. They wished to find a single basic substance from whose changes all the visible alterations around them could be understood. They were greatly impressed by the changes of state produced by temperature. Liquid water could be converted to solid ice or to gaseous steam (air). Thus it was natural that the earliest choices for a primal substance were made in terms of physical properties. Matter could exist in the form of a solid, a liquid or a gas, and these states could be equated with earth, water or air. The changes between the states were brought about by heat; that is, by fire. Therefore the primal substance must be similar to, or identical with, one of these. Thales thought this substance must be water; Anaximander conceived of a rather indefinite mass out of which matter was created; Anaximenes chose air as the basic material; and Heraclitus chose fire. All, however, believed that each of these substances could he converted to the others under the proper conditions. Heraclitus further amplified these ideas by the concept of constant change, a sort of dynamic equilibrium ("everything flows"), and by bringing in the old concept of contraries whose combinations gave material substances.

These physical explanations of the behaviour of the macrocosm were applied by philosophically minded physicians to the microcosm (man). The interaction of biological and physical speculations produced the idea that the innate heat observed in living animals was the same as the fire that composed material objects, and that it could bring about many changes that would now be called chemical. This process of "coction," represented by digestion in animals and by the cooking of food, became a familiar idea. Almost all later Greek thinkers used biological and physical explanations interchangeably.

The next great theoretical advance was made by Anaxagoras, who assumed that all material objects were made up of infinitely small particles, which he called "seeds." On the principle that like attracts like, he assumed that the seeds of flesh, for example, would aggregate to produce flesh itself.

Empedocles generalized this idea by reducing the infinite number of types of seeds to four, the atoms of earth, air, water and fire. This was the basis for the four-element theory that dominated scientific thought in one form or another for 2,000 years.

The atomic theory was best expressed by Leucippus and his pupil, Democritus of Abdera, who proposed a true kinetic theory of atoms moving in a void. The size and shape of the four kinds of atoms explained many of their properties. The theory of Democritus was completely materialistic. It became the basis for the later Epicurean school of philosophy and so was preserved for future generations, but it was strongly opposed by the more mystical philosophers who had made up the school of Pythagoras and who now became influential in Greek philosophical thought under the leadership of Socrates, and especially of Plato.

Plato.—Plato was not basically interested in physical theory; his speculations concerned instead the moral and ethical nature of man. He was enough of a philosopher, however, to wish to explain the nature of the world, and he did so in his dialogue *Timaeus*. He drew on much of the previous thinking of the various philosophical schools, and he added his own teleological preconceptions, holding that everything was designed by nature for the best of all possible worlds. The system of cosmology that he proposed was, in his own words, "as probable as any other." He accepted the four elements of Democritus, but his atoms were geometrical abstractions: fire was composed of tetrahedral atoms whose sharp points gave them their penetrating power; earth was made up of cubical atoms that were the most stable and solid of the four forms; water consisted of icosahedra, and air of octahedra. By rearrangements of the bounding planes of these figures the atoms could be converted into each other. This concept of the interconvertibility of the atoms gave a theoretical basis to later alchemy.

Aristotle.—The abstract theories of Plato were brought into closer touch with reality by his great pupil, Aristotle. Though Aristotle took all fields of philosophy for his own, he was basically a scientist who did his best work in the biological field. His explanations of the composition and changes of matter were the standard of scientific thought until the 17th century.

Aristotle assumed a primal matter, as had the Ionian philosophers. Upon this matter were impressed various forms, and the differences in material objects resulted from these different forms impressed on the primal matter. Thus, as in the thinking of Plato, any material could be converted into any other. However, Aristotle made the picture more concrete than had most of his predecessors. Turning to the concept of contraries proposed by Heraclitus, he assumed that there were four qualities, heat, cold, moisture and dryness, which combined to make up the atoms of the physical world. Obviously, heat and cold could not combine, nor could moisture and dryness, since these nullify each other, but heat and dryness could combine to form atoms of fire; heat and moisture could give air atoms; cold and moisture could make up water, and cold and dryness could produce earth. Thus, the changes in matter resulted from impressing on the primal matter various changes of qualities, and changes in qualities could produce changes in form. Changes in the combinations of the four atoms could then bring about a second type of change to produce such visible materials as stones, blood or flesh, and combinations of these gave a third type of combination that produced faces, hands and so on. Aristotle worked out explanations of both physical and biological phenomena in the greatest detail.

2. Emergence of Alchemy.—*Alexandria.*—With the death of Aristotle, the classical period of Greek philosophy ended, and scientific leadership passed gradually from Athens to the Hellenistic city of Alexandria in Egypt. Under the stimulus of the work at the museum, which was actually a great research institute, science flourished and a combination of factors led to rapid advances in chemistry. Alexandria was a place where many cultures met and mingled. Greek philosophy, which had tended to become very abstract, met practical oriental technology that had been highly developed for hundreds of years. Oriental mystical religions also flourished in Alexandria. From these three sources—Greek philosophy, oriental technology and oriental religious mysticism—first alchemy and later chemistry were born. (*See* ALCHEMY: *Early History and Philosophical Basis.*)

The earliest alchemists were artisans who were stimulated by the philosophers to attempt to explain the nature of their technical processes in terms of philosophical theory. The idea of the interconvertibility of matter led them to believe that the imitations of gold they had made for their poorer customers might become true gold and that they could make this precious metal from baser materials. This was for a long time the practical goal of the alchemists, but their theoretical speculations and actual laboratory work went far beyond this. They learned much true chemistry from preparing metals and reagents that changed the metals to make them resemble gold externally. The Alexandrian alchemists greatly improved chemical apparatus and learned many new reactions of inorganic substances.

Gradually, however, the mystical ideas that had entered alchemical thought from the oriental religions became dominant in Alexandrian alchemy. The perfection of metals into gold was thought to be merely a symbol of the perfection of the human soul. Interest in actual laboratory work declined, and chemical discoveries nearly ceased in the Byzantine empire during the 4th and 5th centuries.

Syriac Translations.—At just this period, however, the religious controversies in the early Christian church resulted in the splitting of the Nestorian body from the Orthodox Church. The Nestorians were driven into Asia Minor, where they established a number of important schools and taught the theoretical principles of the Greek philosophers. They translated most of the Greek writings into their own language, Syriac, and much of the valuable Greek literature was thus preserved when western Europe fell into what is called the dark ages.

Arabic Golden Age.—The Nestorians soon came into contact with the rising Arab empire, and under the encouragement of enlightened caliphs in Baghdad a new set of translations of the Greek authors was made, this time from Syriac into Arabic. In the golden age of Arabic science, the 8th to the 11th centuries, a number of physicians and alchemists once more turned to actual laboratory work. They took over the Aristotelian theories of nature and used them to explain chemical changes and the elements that resulted from combining Aristotle's four qualities. However, they modified these somewhat by assuming that the Aristotelian elements formed a second set of contraries, sulfur and mercury, from which metals were then composed. This sulfur and mercury were not the physical substances, which were well known at the time, but rather represented the qualities of earthiness and combustibility (sulfur), and lustre and fluidity (mercury). Thus the idea of qualities in the Aristotelian system became converted to the concept of the existence of more or less immaterial "principles" that conferred certain physical properties on material substances. This idea was first set forth in the writings of the Muslim sect of the Isma'iliya, a group with strong mystical and alchemical interests. They ascribed these writings to a perhaps mythical alchemist, Jabir ibn Hayyan, and the works became so popular that later generations had no doubts as to his actual existence. Other Arabian physicians and chemists, such as Avicenna (Ibn Sina) and al-Razi, introduced a number of important substances into chemistry, including the caustic alkalies (*e.g.*, sodium hydroxide) and ammonium chloride.

Introduction Into Western Europe.—After the 11th century, Arabic alchemy, like the Hellenistic alchemy before it, began to lose its practical character. At this time, however, western Europeans were beginning to awaken from the long period of scientific inactivity that had followed the fall of Rome. There was much curiosity among them regarding the science of the Arabs, and schools arose in Spain and Sicily for translating the ancient Arabic manuscripts, many of which had come from the Greek through Syriac. Scientific works of all types, including many of the alchemical manuscripts, were at this time translated into Latin.

These were seized upon with enthusiasm in the west, and the practice of alchemy began to flourish. Actually, it was superimposed upon the craft of metalworking, which had been continued as a practical art throughout the middle ages. Now these artisans, like their Alexandrian predecessors, found a theoretical basis for their practical observations, this time in the form of the sulfur-mercury theory of the composition of metals. The new approach was summarized in the extremely popular works of an author who wrote under the name of Geber, pretending to be the Arabic alchemist Jabir ibn Hayyan. He was probably in reality a practicing Spanish alchemist. His books, written about 1310, reveal great technological advancements in laboratory operations. They describe methods for assaying metals and for preparing and purifying reagents. These directions possess a clarity and lack of mysticism of a high order. It was at about this time that the art of distillation improved to such an extent that mineral acids and alcohol were obtained for the first time.

The alchemy of the 13th and 14th centuries was notable for its practical application of chemical apparatus and methods in laboratory work, but, as in the Hellenistic and Arabic periods, it eventually began to shift its emphasis in the direction of mysticism and charlatanism. In this case, however, it was not necessary that a new culture should take it over in order to revive its progress toward the science of chemistry. Although one branch of alchemy became and remained abstruse and impracticable, the other did not die out.

Predominance of Practical Alchemy.—The scientific revival that took place in the early Renaissance brought about conditions for the encouragement and further development of the practical branch of alchemy. This was first revealed in a series of books on practical procedures. In the 16th century appeared the works of Hieronymus Brunschwigk on distillation and the excellent books of Vannoccio Biringuccio, Georgius Agricola and Lazarus Ercker on mining and metallurgy. New metals and compounds were described in these publications. The use of chemical remedies in medicine was advocated with considerable violence by Theophrastus Bombastus von Hohenheim, called Paracelsus, who founded the school of iatrochemistry that tried to introduce chemical remedies into medicine and was thus the forerunner of pharmacology. The abundance of new information that could not be fitted into the framework of the Aristotelian theory now demanded a whole new theoretical approach.

At this time, Paracelsus modified the sulfur-mercury theory of metallic composition by adding a third component, salt, as a constituent of the metals. He felt that this was necessary to account for the stability (earthiness) of metals, and so sulfur now became merely the principle of combustibility. Mercury still conferred metallic lustre and fluidity. This formulation by Paracelsus became known as the *tria prima* theory.

B. CHEMISTRY AS A SCIENCE

1. Developments From 1597 to 1700.—Chemistry by this time was becoming recognized as a science. Its methods of that era were discussed in what is often described as the first textbook of chemistry, the *Alchymia* of Andreas Libavius, published in 1597. He declared, "Alchemy [that is, chemistry] is the art of producing magisteries and of extracting pure essences by separating bodies from mixtures." Magisteries signified reagents and the methods of their use.

Developments were rapid in the 17th century. Acids, bases and salts were studied, and a beginning was made in the use of the balance and the quantitative study of reactions. Chemical theory also began to change sharply at this time. Iatrochemists devoted most of their attention to developing new chemical remedies. Many, especially in France, were pharmacists; these included Christopher Glaser and Nicolas Lémery. They wrote textbooks of chemistry that were little more than collections of recipes. They prepared many of their remedies by distilling animal or vegetable substances, and they observed that in their distillations they often obtained a volatile liquid, an inflammable oil, a heavy fluid, a water-soluble substance and a solid residue. Since they believed that by their distillations they were "analyzing" materials into basic constituents, they felt that there must actually be five elements out of which all matter was built. Thus, in the 17th century various chemists held to theories that accepted the existence of one, two, three, four or five basic elements.

New and Old Ideas.—The astronomical and physical theories of Copernicus and Galileo influenced chemistry at this time. In particular, the older Greek atomic theories, as preserved in the Epicurean poem *De rerum natura* by the Roman writer Lucretius, began to be revived in one form or another. Pierre Gassendi and René Descartes were influential in this revival. The application of these ideas to chemistry was the chief work of Robert Boyle, who in his "corpuscular theory" attempted to expel all the occult influences from chemistry and to explain chemical reactions on a purely mechanical basis. In his famous book *The Sceptical Chymist* (1661) he attacked the Aristotelian theory of the four elements, the *tria prima* theory of Paracelsus and the idea that distillation could yield the basic elements of matter. His own definition of an element had a decidedly modern ring. In his laboratory he discovered many new chemical facts and processes.

It cannot be said that Boyle succeeded immediately in establishing his mechanical philosophy in the minds of his contemporaries, but he did encourage them to think more rationally, and his ideas eventually resulted in great progress. Nevertheless, at almost the same time Boyle was doing his work, the theory of the *tria prima* took on a new and important form.

In Germany J. J. Becher renamed the three principles of Paracelsus as the vitreous, fatty and fluid earths that respectively conferred the properties of body, combustibility and density with metallic lustre on substances. It is noteworthy that at this time all idea of the importance of air as a constituent of matter had disappeared from the minds of chemists. Air was thought to be an unreactive medium that was usually present but acted only as a physical agent. Even the Belgian physician and chemist, J. B. van Helmont, who in the mid-17th century discovered carbon dioxide and proposed the name "gas" for it, did not believe that this gas possessed any properties other than physical ones. Thus Becher concentrated his attention on solids as the sole constituents of matter.

The Phlogiston Theory.—The ideas of Becher were taken up by his pupil, Georg Ernst Stahl, who gave special prominence to the fatty earth described by his master. Stahl called the fatty earth "phlogiston," and upon it he erected the first great generalization of chemistry. Phlogiston to him was the fire principle. When a body burned, phlogiston was lost. Men had long felt, as they watched a flame, that something was departing. The idea was quite logical when the object burning was an organic substance, since in this case only a small residue was left behind. Stahl felt that the rusting of metals was also a form of combustion, and so he applied his theory chiefly to metals. Thus he believed that when a metal was converted to its calx (oxide, in modern terms) phlogiston was lost. Therefore the calx was a simple body and the metal a compound one, composed of calx plus phlogiston. The function of air, which was known to be necessary for the reaction to occur, was merely to carry away the phlogiston as it was liberated. By this theory it was possible to explain most of the reactions that are now ascribed to oxidation or reduction, though the mechanisms of the phlogiston theory were the exact reverse of those now accepted.

The major objection to the phlogiston theory, *i.e.*, that the calx was heavier than the metal from which it was derived, was of little significance to Stahl, since he thought of phlogiston as a more or less immaterial "principle" rather than an actual substance. As chemistry advanced and chemists applied quantitative methods more frequently, such a view became impossible to them. To the later phlogistonists, phlogiston became as much a substance as any other material with which they worked in the laboratory, and much ingenuity was expended in accounting for the effect of its loss or gain on the weights of the substances involved in its reactions. Sometimes it was even thought that phlogiston had a negative weight. When hydrogen was discovered, some chemists thought that it was pure phlogiston.

2. Understanding of Combustion (1700–1800).—In the 18th century a series of discoveries made it possible to understand the nature of combustion. This could not have been grasped until the chemistry of gases was worked out. The English botanist Stephen Hales showed that many substances evolved "airs" when they were heated, and he devised a pneumatic trough for collecting such airs. Hermann Boerhaave, an influential Dutch teacher of chemistry, began to suspect that air might take part in a chemical reaction. This was shown to be true by Joseph Black in Edinburgh in 1756 when he demonstrated the uptake of carbon dioxide by quicklime (calcium oxide) to form chalk (calcium carbonate), and the reverse of this process when chalk was heated. Because of the radically new idea that a gas could be present in a solid, he called carbon dioxide "fixed air." His work was eagerly continued by other chemists, and a number of new gases were discovered. This line of investigation culminated in the discovery of oxygen almost simultaneously by K. W. Scheele (1772) and Joseph Priestley in 1774.

All the necessary information was now at hand for the overthrow of the phlogiston theory and the establishment of the true nature of combustion. This was accomplished by Antoine Laurent Lavoisier, the "father of modern chemistry," between 1770 and 1790.

Lavoisier made quantitative studies of the gain or loss of weight when tin, lead, phosphorus and sulfur underwent reactions of oxidation or reduction and showed that the newly discovered oxygen was involved in all these reactions. He was thus led to an understanding of the actual nature of the reactions that were occurring. He formulated the explanation of combustion and the composition of metals and their oxides that was still accepted in the early 1960s. All forms of the sulfur-mercury theory were finally abandoned. Lavoisier's definition of an element was essentially modern, and it did away with the confusion that had long prevailed in the thinking of chemists as to the number of elements.

Lavoisier also was active with Guyton de Morveau and several other chemists in devising the modern system of chemical nomenclature and in demonstrating that respiration in animals is a special form of oxidation. He performed the earliest true biochemical experiments in his studies on respiration.

Although a number of older chemists, including Priestley, stubbornly tried to retain some form of the phlogiston theory, they quickly lost ground, and by 1800 practically everyone recognized the correctness of Lavoisier's oxygen theory.

3. Studies of Chemical Composition (1800–1900).—*General.*—During the 18th century quantitative methods had come into common use, and many minerals had been analyzed and new elements discovered. Much attention had been devoted to the subject of affinity. This was the name given to the force that held chemical compounds together, and it was thought that the strength of affinity of a given group of elements could be measured by noting the ease with which one element could replace another in a given compound. Although elaborate tables of relative affinities had been drawn up by Torbern Bergman, there was no satisfactory explanation of the nature of the forces involved.

By 1808 it was accepted that chemical compounds had fixed compositions. An explanation for this fact was offered in the first truly chemical atomic theory, that of John Dalton of Manchester, Eng. He assumed that each element consisted of its own type of atoms, each with its characteristic size and weight. Thus the idea of atomic weights was introduced. Dalton had no means, however, of calculating true atomic weights or the number of atoms present in a compound. He assumed, however, that the constant composition of compounds was due to the combination of a constant number of atoms in them. He made a number of rigid postulates that greatly limited the generality of his theory.

These limitations were largely removed by the investigations of J. L. Gay-Lussac into the combining ratios of various gases. He demonstrated that equivalent amounts of different elements could combine with each other but made no distinction between atoms and molecules, and so the distinction between atomic and molecular weights could not be made. In 1811 Amedeo Avogadro pointed out that equal volumes of gases should contain equal numbers of molecules, and from this the distinction between atoms and molecules could be derived, but Avogadro's work was disregarded for nearly 50 years.

Meanwhile the great Swedish chemist Jöns Jacob Berzelius had been carrying out a large number of analytical studies of minerals and, on the basis of the Dulong-Petit rule that the product of the atomic weight and the specific heat was a constant, had drawn up a table of atomic weights that was, in the main, accurate. But his results were not accepted by most chemists, who preferred to use equivalent weights as determined in the laboratory, even though these were very relative and differed when derived from different compounds.

Berzelius made many contributions to chemical theory, including the description and naming of the phenomena of catalysis and isomerism, and the invention of the modern system of chemical symbols. His major theoretical contribution was his dualistic or electrochemical theory of atomic combination, in which he sought to settle the old problem of the nature of affinity. He was greatly impressed by the newly discovered process of electrolysis and the separation of gases and metals at the poles of a Voltaic pile.

He believed that all atoms were electrically charged, both negatively and positively, but that the positive charge predominated in some and the negative in others. Negatively charged atoms would then be held to positively charged atoms by electrostatic forces. This theory of chemical affinity worked well for many inorganic salts, which were the substances most studied at the time of Berzelius, and his theory was widely accepted among chemists.

The accumulation of compounds of carbon that resulted from the intensive study of organic chemistry in the first half of the 19th century soon showed the inadequacy of the dualistic theory. In particular, the substitution of elements such as chlorine for hydrogen in organic compounds could not be explained by Berzelius, since these atoms should carry opposite electrical charges and so could not occupy the same position in a compound held together by electrostatic forces. Organic chemists therefore tended to think of radicals, that is, groups of atoms that acted as a unit in chemical reactions. These radicals were believed to combine with elements in much the same way that simple substances combined in water or ammonia, so that two radicals joined to an oxygen atom (to form an ether) were said to belong to the water type, and three radicals joined to a nitrogen atom (to form an amine) were said to be of the ammonia type. The attempts to fit all organic compounds into a few rigid types proved difficult, and new types were constantly being proposed. The failure to agree upon the use of molecular or atomic weights or of equivalents in writing formulas further added to the confusion, and at one time various chemists were proposing 19 different formulas for acetic acid.

The water-ammonia type theory at least suggested that individual atoms could hold only a limited number of atoms of other elements or radicals, and the studies of metalloorganic compounds by Edward Frankland in the 1850s strengthened this idea. The concept of "affinity units" passed gradually into the modern concept of valence. This was a major step in making possible the elucidation of the nature of organic compounds.

Organic Compounds (1858–1900).—In 1858 Friedrich von Kekulé and Archibald Scott Couper independently proposed the tetravalence of the carbon atom and its ability to link with other carbon atoms to form long chains. The way was thus opened for the development of the structural theory of organic compounds. The major portion of this development was carried out in the 1860s by A. M. Butlerov. The explanation of the nature of aromatic compounds as ring structures was made by Kekulé in 1865. (*See* also *Organic Chemistry* below.)

Once an understanding of the structure of organic compounds had been reached, it became logical to extend the flat formulas that were at first written on paper into three dimensions. This extension was made simultaneously by Jacobus Hendricus van't Hoff and J. A. Le Bel in 1874 when they postulated a tetrahedral carbon atom. The field of stereochemistry (*q.v.*) was thus opened. It became possible to explain many puzzling properties of organic compounds by this concept, and a number of workers developed the idea over the following 30 years. At the end of the 19th century, Alfred Werner applied stereochemical ideas to complex inorganic compounds of platinum and similar metals and explained the nature of many previously misunderstood compounds.

Atomic Weights and the Periodic Law.—In 1860 the first international chemical congress met at Karlsruhe, Ger., in an attempt to settle the confusion in chemical theory, especially in regard to atomic weights. At the congress, the Italian chemist Stanislao Cannizzaro revived the Avogadro hypothesis and showed how atoms and molecules could be distinguished from each other. This concept was quickly accepted, and true atomic and molecular weights were recognized. This in turn made it possible to complete earlier tentative studies that had attempted to classify the properties of elements in terms of their atomic weights. Between 1869 and 1871 D. I. Mendeléyev and Lothar Meyer offered their versions of the periodic table, and Mendeléyev, on the basis of his table, predicted the existence and properties of three then-unknown elements. When these were discovered (gallium in 1875, scandium in 1879 and germanium in 1886) and their properties were found to agree with Mendeléyev's predictions, the periodic law (*q.v.*) was accepted, and inorganic chemists had a systematic generalization upon which to build their science.

4. The Founding of Physical Chemistry (1875–87).—During the first three quarters of the 19th century the major developments in chemistry had occurred in the inorganic and organic fields. While the science of physics had been developing as rapidly as had chemistry, there was relatively little scientific contact between the followers of the two disciplines, and there was often even a certain sense of antagonism between many individual physicists and chemists. Nevertheless, rapid developments in the field of energy relationships could not fail to attract the attention of some chemists who were concerned with the study of affinity and reaction rates.

It was these studies that finally led to the establishment of the science of physical chemistry. In 1850 Ludwig Wilhelmy showed that the rate of hydrolysis of cane sugar could be calculated by a mathematical equation; this marked one of the first occasions in which a mathematical formula was used to express a chemical process. Wilhelmy's work was followed by a number of studies of reactions that involved equilibria, and these led in 1863 to the formulation of the law of mass action by the Norwegian chemists C. M. Guldberg and Peter Waage. This law permitted prediction of the direction in which a reversible chemical reaction would proceed in terms of the concentrations of reactants involved. It was soon shown to have far wider consequences than had originally been foreseen. Chemists began to think in terms of the kinetic properties of atoms, and to explain the mechanism of chemical reactions from this viewpoint.

At nearly the same time the ideas of thermodynamics, which physicists had been developing from the days of Sadi Carnot, began to penetrate into chemistry. The way for this was paved by studies on heats of reaction made around 1850 by G. H. Hess in Russia, Pierre Eugène Berthelot in France and Julius Thomsen in Denmark. In 1869 A. F. Horstmann utilized the principle of entropy for the first time in chemistry. The mathematical basis for the treatment of heterogeneous equilibria and the derivation of the phase rule were given by an American, Josiah Willard Gibbs, in 1876–78. The importance of his work for both pure and applied chemistry was not recognized, however, for 20 years.

Electrochemistry, which had been important ever since the discovery of the Voltaic pile in 1800, played a part in the establishment of the dualistic theory and in the isolation of a number of metals by the electrolytic process. As chemists continued to study conductivity in solutions, they realized that salts behaved in unpredicted ways in the dissolved state. The studies of F. Kohlrausch and J. W. Hittorf indicated that in an electrical field salts broke up into charged ions. The theory of electrolytic dissociation, which was first announced by Svante Arrhenius in 1884, showed that such ions existed at all times in solution, even in the absence of an electrical field. This idea revolutionized the theory of solutions. (*See* ELECTROCHEMISTRY.)

All of these studies represented a growing interest in the physical properties and behaviour of chemical compounds, but they were not united into an organized branch of chemistry until Wilhelm Ostwald wrote a general textbook of physical chemistry (1885–88) and, assisted by van't Hoff and Arrhenius, established a specialized journal in this field in 1887. From this time on, physical chemistry ranked with the inorganic and organic branches as a full specialty of chemistry. (*See* also *Physical Chemistry* below.)

5. Changes in Structural Concepts After 1895.—As a result of studies in all branches of chemistry, the behaviour of chemical elements and compounds by the end of the 19th century had come to be explained in terms of the properties of individual atoms. The organic chemist thought of the atoms as tetrahedra with valence bonds projecting out at the angles. The physical chemist considered them to be balls bouncing in all directions and sometimes carrying an electrical charge that modified their properties. Some leading chemists, such as Ostwald, insisted that, since all the evidence for their existence was purely circumstantial, atoms probably did not exist at all. No chemist had the least idea that there might be a possibility of a subatomic structure. It was at this time that a completely new field was opened by studies made by physicists on atomic structure and by the discovery of radioactivity. The concept of atoms had to be changed radically.

Physicists had for a long time been studying the nature of the radiation produced by electrical discharges in rarefied gases. Some of the resulting rays were found to be composed of charged particles, negative in the case of cathode rays and positive in the case of canal rays (now called positive rays). After Arrhenius announced the ionic theory, it was natural to assume that the cathode and canal rays were produced by particles that must be ionic in character. In 1895 W. C. Röntgen discovered X-rays, which were very penetrating but did not consist of charged particles. They were of the same nature as ordinary light. Detailed study of the cathode rays led to the discovery of the electron by Joseph John Thomson (later Sir) in 1897. Its charge was determined by Robert A. Millikan in 1911. The electron came to be recognized as the unit of negative electricity, identical no matter from what element it was obtained. Positive (canal) rays were composed of ions of different elements. Thus the atom was made up of electrons and ions, a structure that recalled the dualistic theory of Berzelius.

The attention of chemists was attracted to these studies, after the discovery of radioactivity by A. H. Becquerel in 1896, by the extensive investigation of uranium ores by Marie and Pierre Curie. By the end of the 19th century their investigations had led to the discovery of polonium and radium. (*See* also RADIOACTIVITY.)

Ernest (later Lord) Rutherford and his students discovered at the beginning of the 20th century that new elements were produced during radioactive decomposition, and that the rays given off in this process consisted of helium ions, electrons and X-rays. On the basis of these discoveries Frederick Soddy worked out the mechanism and pathways of radioactive disintegrations and showed that elements with the same chemical properties but with different atomic weights could exist. He called such elements isotopes. Chemical proof of the existence of isotopes was obtained by T. W. Richards and O. Hönigschmidt, who found that samples of lead from different radioactive sources showed different atomic weights when studied by classical quantitative methods. The mass spectrograph designed by F. W. Aston proved the existence of isotopes for nearly all elements in 1919. (*See* also ISOTOPE.)

In 1913 H. G.-J. Moseley, on the basis of X-ray spectrography, discovered that each element had a characteristic atomic number that represented the positive charge on the central nucleus. These numbers agreed with the position of the elements in the periodic table and placed this arrangement on a much sounder basis in theory than it had possessed when the classification was made according to atomic weights. The discovery of isotopes was already making the older basis of arrangement suspect.

All these discoveries, coming with extreme rapidity in the first 15 years of the 20th century, compelled chemists to reorganize their thinking completely. It was obvious that in the subatomic structure could be found an explanation of affinity and valence, the phenomena that had puzzled chemists for so long. The first major attempts to utilize these new ideas in explaining the nature of chemical combination were made by G. N. Lewis, W. Kossel and Irving Langmuir in 1916–20. They reconciled the old dualistic theory of Berzelius as it had been modified by the electrolytic dissociation theory of Arrhenius with the affinity unit concept of the organic chemists when they distinguished between ionic and covalent bonds. The picture of the atom as a sort of solar system with a heavy central nucleus and electrons revolving about it in shells, as proposed by Niels Bohr in 1913–14, fitted this explanation very well, since all valence forces could be attributed to the number of electrons in the outermost shell. (*See* also ATOM.)

The importance of the positions of these electrons and their interrelations in complex organic molecules was soon realized by C. K. Ingold and others and their early investigations were quickly supplemented by the work of numerous other chemists who attempted to explain the mechanisms of organic reactions in terms of electron structures. The quantum theory was applied in a mathematical treatment of valence forces and led to the concept of resonance. Work in this direction by Linus Pauling did much to explain the nature of the chemical bond. (*See* also RESONANCE, THEORY OF.)

Physicists continued to develop powerful tools, such as the cyclotron, for the study of atomic structure. These tools in turn supplied the chemist with new elements to fill the empty spaces in the periodic table, and even to furnish elements beyond uranium, which had been considered the last and heaviest element. The discovery of atomic fission in the late 1930s resulted in increases in the number of new elements and the radioactive isotopes of even the normal stable elements. After World War II, these new materials became generally available and radioactive isotopes came into wide use as tracers that were employed to follow the course of chemical and biological reactions. As a result of work with the new elements and tracers, many important discoveries were made in the field of reaction mechanisms. (*See* also TRANSURANIUM ELEMENTS; NUCLEAR INSTRUMENTS.)

6. Biochemistry.—Biochemistry was recognized as a specialty branch of chemistry at about the beginning of the 20th century. From the time of Lavoisier physiologists occasionally had used chemical methods and ideas to explain biological phenomena. Biological studies were made by some chemists, notably Justus von Liebig, who investigated many agricultural problems around 1840. Louis Pasteur, W. Kühne and others studied the nature of enzyme action in the latter half of the 19th century, and in 1897 Eduard Buchner showed that enzymes could function independently of the living cell and therefore probably were chemical compounds. However, not much progress was made in understanding the chemistry of the living organism until the brilliant studies conducted by Emil Fischer between 1890 and 1910 revealed the basic chemical structures of such important cellular constituents as carbohydrates and proteins. After 1910 such studies became common, and the new specialty of biochemistry could be considered to have taken its place alongside the older branches of chemistry.

Progress in this field was very rapid, since the methods of all the other branches of chemistry were available to it. Therefore knowledge of the chemical nature of vitamins and hormones was accumulated quickly, especially in the 1930s. The study of energy metabolism soon revealed the complexities of carbohydrate metabolism in the living cell and the enormous importance of phosphate esters in plant and animal life. Applications of this knowledge to an understanding of the nature of photosynthesis followed. Rapid improvements in the isolation and study of individual proteins opened new prospects for a comprehension of the function of these indispensable compounds, and the study of the nucleoproteins opened the way to an understanding of the nature of life. (*See* BIOCHEMISTRY.)

7. The Chemical Industry.—The development of the chemical industry has had important effects on chemistry itself and on the entire world. Small local factories for supplying soap, alum, acids and other basic chemical products existed in most countries after the middle ages. As society became more complex, larger sources of the most important chemicals had to be developed. This need was felt very strongly during the French Revolution and the Napoleonic Wars. Attempts then were made for the first time to employ scientists to work out the production of chemical substances. From this effort came the Leblanc soda process, the Gay-Lussac tower process for making sulfuric acid and methods for the manufacture of beet sugar.

When William Perkin discovered the first aniline dye in 1856, he founded an industry that was centred first in England and France but came to be centralized in Germany by the late 19th century. The Germans developed enormous dye factories that also manufactured drugs and organic intermediates; these could be used to manufacture other new materials. In these factories was developed the pattern of industrial research that later became standard throughout the world. The team system of research by groups of scientists, often employing the services of an academic consultant, grew up in these factories and was so successful that by World War I Germany controlled the world chemical market. The important Haber process for the synthesis of ammonia was developed under these conditions, and the synthetic nitrates the Germans obtained from the process permitted them to continue the war after the first year, when their supply of Chilean nitrates for the manufacture of explosives was exhausted.

The Allies were forced in 1914 into a frantic development of their own chemical industries. After the end of the war, all major nations built up their industries with large research staffs patterned after the German system. This resulted in a greatly increased demand for trained chemists and was at least partially responsible for enormous increases in the growth of science and the rate of discoveries. (*See* CHEMICAL INDUSTRY.)

8. Chemical Societies.—Chemistry became an organized profession during the 19th century, when chemical societies were founded in all the leading nations. Nearly all these societies established journals to report the scientific work of their members; as specialized branches of the science developed, new journals were founded in each specialty. Abstract and index journals were added as the need for them developed. With the enormous growth of chemical literature, especially after World War II, the chemical profession found that one of its major functions had become the control and organization of this literature. *See* CHEMISTRY, SOCIETIES OF. (H. M. L.)

II. INORGANIC CHEMISTRY

A. INTRODUCTION

Inorganic chemistry, which is concerned with the study of the elements and compounds other than those of carbon, was developed primarily through the investigations of minerals, whereas organic chemistry resulted from the study of substances of plant or animal origin. Although it was recognized that the two classes of substances were amenable to the same general chemical laws, it was supposed that a fundamental difference existed between the mineral (inorganic) substances and those which were the products of life processes (organic). However, during the middle of the 19th century it was found that organic substances could be prepared from their elements or from inorganic compounds, a fact that gave great impetus to the study of organic substances in the latter half of the 19th century. Nevertheless, it is usual and convenient to divide chemical substances arbitrarily into the two classes but to include the oxides of carbon, the carbonates, metallic carbonyls and certain other simple compounds of carbon as well as water and ammonia in the domain of inorganic substances. For detailed discussions of the chemical elements, *see* the article on each element.

1. Early Discoveries.—The earliest discoveries in inorganic chemistry were made in the metallurgical and medical arts and in the domestic economy of the ancients. Gold, silver, copper, tin, iron and lead, some of the simpler alloys, metallic salts and mineral products, and the rudiments of metallurgical, glassmaking, enameling, painting, dyeing, alchemical and medical arts were known to the ancient Chaldeans, Hindus, Chinese, Egyptians and Greeks many centuries before the Christian era. By about the middle of the 17th century, the alchemists were acquainted with most of the common metals, their alloys and salts, a few acids, alkalies, medicinal minerals and nonmetallic elements. In 1733 G. Brandt of Sweden isolated cobalt, and in 1750 A. F. Cronstedt prepared metallic nickel. These discoveries were followed by Henry Cavendish's recognition of elementary hydrogen in 1766 and by the isolation of nitrogen by Daniel Rutherford in 1772, manganese by J. G. Gahn in 1774, oxygen by Priestley in 1774, chlorine by Scheele in 1774 and molybdenum by P. J. Hjelm in 1782. Cavendish in 1784 made the far-reaching discovery that water is composed of two volumes of hydrogen to one of oxygen, and in the following year he succeeded in synthesizing nitric acid by passing electric sparks through moist air. His further discovery that a minute residue of the air would not combine with oxygen was ignored for more than a century until Lord Rayleigh and Sir William Ramsay proved in 1895 that the inert residue consists of a mixture containing four of the gases, argon, krypton, neon and xenon.

Other elements discovered during the 18th century include uranium, zirconium, titanium, tungsten (wolfram), platinum, beryllium, chromium, tellurium and a number of the rare-earth metals. The quantitative studies of chemical reactions by Lavoisier and others during the last part of the 18th century led to a clarification of the nature of combustion and the abandonment of the doctrine of phlogiston. Laws governing chemical combinations were formulated and the atomic theory announced by Dalton in 1803 was generally accepted. (See *History of Chemistry* above.)

At the beginning of the 19th century the discovery of methods for the generation of electric current gave to chemistry a most effective means for separating compounds into their elements. By the use of electrolysis, Sir Humphry Davy in 1808 decomposed the supposed elements soda and potash and isolated the metals sodium and potassium. Shortly thereafter he obtained magnesium, calcium, strontium and barium from their respective oxides. With the new tools and techniques, chemistry and other sciences underwent a rapid growth. In addition to the striking developments in analytical and preparative chemistry there were numerous advances in the theoretical sciences; physical laws and principles were found to be applicable to chemical phenomena.

Among all the advances in theoretical, descriptive and industrial chemistry that took place in the 19th century, the two events that perhaps contributed most to inorganic chemistry were the formulation of the periodic law and the discovery of the electron. The periodic law (*q.v.*) and the periodic classification of the elements announced by Mendeléyev (1869) are the great fundamental generalizations of chemistry, stimulating to research and serving as a framework for the organization of the vast amount of factual material that had been gathered previously but organized only to a limited degree. The discovery of the electron (1897) and the later development of quantum mechanics (1923) provided a foundation for the theoretical understanding of the nature of the binding forces in chemical molecules. A systematic description of chemical behaviour will be given after a brief introduction to chemical formulas and a few of the basic concepts.

2. Symbols and Formulas.—The chemical symbol for an atom of an element is either the capital letter of its English or Latin name, as C for carbon and K for potassium (Latin, *kalium*), or the capital letter followed by a small letter as Co for cobalt and Cr for chromium. A symbol is not merely an abbreviation but has a quantitative significance. It may represent one atom of the element whose weight relative to an arbitrarily selected unit is a number known as the atomic weight (*q.v.*), or it may represent a gram atomic weight (or gram atom), which consists of 6.024×10^{23} atoms of the element and whose weight expressed in grams is numerically equal to the atomic weight. For example, the symbol C may stand for one atom of carbon whose relative weight is the pure number 12.011; or if more convenient it may stand for 12.011 g. of carbon, which contains 6.024×10^{23} atoms. (*See* AVOGADRO'S CONSTANT.)

A chemical formula represents a molecule of a substance that may be either an element or a compound. Since the formula is composed of symbols it shows qualitatively the constituent elements and quantitatively the number of atoms of each element in the molecule. Thus O_2, the formula for oxygen, indicates that the substance is an element and that a molecule of it consists of two atoms; He, the formula for helium, indicates that the molecule is monatomic and is identical with the atom; H_2O signifies that a molecule of water consists of two atoms of hydrogen and one atom of oxygen, and, since it contains more than one element, that the substance is a compound. Chemical formulas are established by experimental methods that involve a chemical analysis and the determination of the molecular weight of the substance. Empirical formulas are those that indicate the simplest ratio between the numbers of the component atoms while molecular formulas indicate the actual number of atoms of each element in one molecule of compound; *i.e.*, in the smallest portion of the compound that can exist as a separate entity. The empirical formula of hydrogen peroxide, for example, is HO but the molecular formula is H_2O_2. Empirical and molecular formulas of inorganic compounds are often identical. The establishment of an empirical formula requires only a chemical analysis of a compound and the atomic weight of the constituent elements, but that of a molecular formula requires, in addition, the molecular weight of the compound.

Once the molecular formula of a compound is determined it may be used in turn to calculate the molecular weight by addition of the atomic weights of all the atoms in the molecule. Hence the formula implies the molecular weight, which may be a pure number expressing the relative weight of the molecule on the same arbitrary standard used for atomic weights, or the formula may represent a gram molecular weight or mole, which consists of 6.024×10^{23} molecules of the substance and whose weight in grams is numerically equal to the molecular weight. (*See* MOLECULE.) (J. B. Ps.)

Many substances known only in solid and liquid states are not constructed of discrete molecules. For example, a crystal of sodium chloride is made up of sodium ions, Na^+, and chloride ions, Cl^-, held together primarily by the electrostatic attraction of ions of opposite charge. Each sodium ion is surrounded by six equivalent chloride ions arranged at the corners of a regular octahedron; each chloride ion is surrounded by six sodium ions in the same way. There are no identifiable molecules with the composition NaCl; in fact, the crystal may be considered as one giant molecule. In such cases the formula written is the simplest possible consistent with the known structures of the ionic units. Examples of such substances are: C (diamond), Fe_2O_3 (iron [III] oxide, or ferric oxide), SiO_2 (silicon dioxide), Na_2CO_3 (sodium carbonate, composed of Na^+ ions and CO_3^{2-} ions), $Na_2H_2P_2O_6$ (disodium hypophosphate, composed of Na^+ ions and $H_2P_2O_6^{2-}$ ions).

3. Nomenclature.—Compounds containing atoms of only two elements are called binary. It is conventional to write the formulas for binary compounds with the more electropositive element first and more electronegative element second; for example, HCl (hydrogen chloride), Cl_2O (dichlorine monoxide), OF_2 (oxygen difluoride). Exceptions are made for CH_4 (methane) and NH_3 (ammonia). The electropositive element is named by its usual name; the electronegative element is given the suffix *-ide*. (The two elements of a binary compound have different powers to attract the electrons in the chemical bond between them. Electronegativity is a measure of this attraction for electrons in the bond.)

Many substances can be considered to be related to binary compounds in which either the electropositive or electronegative atom is replaced by a group of atoms, known as a radical. If the radical is an electronegative group (an anion), it usually has the suffix *-ate*, such as in $NaNO_3$ (sodium nitrate), K_2SO_4 (potassium sulfate), $NaClO_3$ (sodium chlorate). Anions derived from the same central atom but with different numbers of oxygen atoms are distinguished by the suffix *-ite* and prefixes *hypo-* and *per-*, as in the series: NaClO (sodium hypochlorite), $NaClO_2$ (sodium chlorite), $NaClO_3$ (sodium chlorate), $NaClO_4$ (sodium perchlorate). In naming the acids corresponding to these salts, the ending *-ate* is replaced by *-ic*, and *-ite* by *-ous*, as in HClO (hypochlorous acid) and $HClO_4$ (perchloric acid).

In the series of chlorine compounds above, chlorine is said to exist in four different oxidation states, each characterized by an oxidation number. There is some arbitrariness in the definition of oxidation number, but it is generally the charge, in electronic units, on an atom if all the electron pairs used in chemical bonds are given to the more electronegative atom in each bond. Some simple rules conforming to this definition are as follows:

(1) The algebraic sum of the oxidation numbers of the atoms of a molecule or ion must equal the charge on the molecule or ion. (Thus the oxidation number of a chemically free element is always zero, and the oxidation number of a monatomic ion is the ionic charge; *e.g.*, for Fe^{2+} the oxidation number is 2+.)

(2) The oxidation number of fluorine in compounds is always 1−.

(3) The oxidation number of oxygen is 2−, except when bonded to fluorine (as in OF_2, when its oxidation number is 2+) or another atom of oxygen (as in H_2O_2, in which case its oxidation number is 1−).

(4) The oxidation number of hydrogen is 1+, except in hydrides of more electropositive elements (as in LiH), where it is 1−.

Then the following oxidation numbers can be assigned to the chlorine atom in the above-mentioned compounds: NaClO 1+, $NaClO_2$ 3+, $NaClO_3$ 5+, $NaClO_4$ 7+. Many metals produce cations (electropositive radicals) in more than one oxidation state. In naming these compounds, the oxidation state of the metal is shown by a Roman numeral in parentheses following the name of the metal. This system replaced an older one in which the suffixes *-ous* and *-ic* were used to designate the lower and higher oxidation states, respectively, for elements having two oxidation states. The older system is ambiguous when several oxidation states are known for an element. Examples of the two types of nomenclature are: $Fe(OH)_2$, iron (II) hydroxide (or ferrous hydroxide); $Fe(OH)_3$, iron (III) hydroxide (or ferric hydroxide). Note the existence of iron compounds with higher oxidation states such as $BaFeO_4$ (barium ferrate [VI]) and $BaFeO_3$ (barium ferrate [IV]).

4. Inorganic Chemical Reactions.—A large fraction of the reactions in inorganic chemistry can be placed in one of two categories: acid-base reactions (*see* ACIDS AND BASES) and oxidation-reduction reactions (*see* OXIDATION AND REDUCTION). In acid-base reactions, a pair of electrons is completely or partially transferred from an electron donor atom or molecule (the base) to an electron acceptor atom or molecule (the acid). The following are examples of acid-base reactions:

$$\underset{\text{acid}_1}{H_3O^+} + \underset{\text{base}_1}{:\ddot{\underset{\cdot\cdot}{O}}:H^-} \rightleftharpoons \underset{\text{acid}_2}{H_2O} + \underset{\text{base}_2}{H_2O} \tag{1}$$

$$\underset{\text{acid}_1}{HClO} + \underset{\text{base}_1}{H_2O} \rightleftharpoons \underset{\text{acid}_2}{H_3O^+} + \underset{\text{base}_2}{ClO^-} \tag{2}$$

$$\underset{\text{acid}_1}{H_2O} + \underset{\text{base}_1}{:\ddot{\underset{\cdot\cdot}{Cl}}:\ddot{\underset{\cdot\cdot}{O}}:^-} \rightleftharpoons \underset{\text{acid}_2}{HClO} + \underset{\text{base}_2}{OH^-} \tag{3}$$

$$\underset{\text{acid}}{BF_3} + \underset{\text{base}}{:NH_3} \rightarrow BF_3NH_3 \tag{4}$$

$$\underset{\text{acid}_1}{Co(NH_3)_5Cl^{2+}} + \underset{\text{base}_1}{H_2O} \rightleftharpoons \underset{\text{acid}_2}{Co(NH_3)_5H_2O^{3+}} + \underset{\text{base}_2}{Cl^-} \tag{5}$$

These various acid-base reactions have more specific names. The first is called neutralization, as in the addition of an acid solution (such as hydrochloric acid) to a basic solution (such as sodium hydroxide) to produce a neutral solution of a salt (in this case sodium chloride). Since the sodium ions and chloride ions do not participate in the reaction, they are not shown in the equation.

Reaction 2 is the dissociation of a weak acid. Some acids such as nitric acid (HNO_3) and perchloric acid ($HClO_4$) dissociate completely in water to give hydrogen ions (H^+ or H_3O^+ cations) and anions (NO_3^- or ClO_4^-). These are called strong acids. Other acids such as hypochlorous acid (HClO) and nitrous acid (HNO_2) are only partly dissociated to hydrogen ions and anions, and most of the acid exists in solution as undissociated molecules of HClO or HNO_2. These are called weak acids and are characterized by a dissociation (ionization) constant K_A, which is a measure of the degree of dissociation. If the concentration of an acid in solution is represented by [HA] moles per liter, and the concentrations of hydrogen ion and anion by $[H^+]$ and $[A^-]$, respectively, then

$$K_A = \frac{[H^+]\,[A^-]}{[HA]}$$

Strong acids have large values of K_A, weak acids have small values. By the same method, bases are classified as strong and weak bases according to their basic dissociation constant K_B.

Reaction 3 is referred to as hydrolysis. If a salt of a strong base and a weak acid, such as sodium hypochlorite (Na^+ClO^-), is dissolved in water, the hydrolysis reaction takes place to produce some HClO molecules and some OH^- ions, which make the solution basic. Similarly, a salt of a weak base and a strong acid, such as ammonium chloride ($NH_4^+Cl^-$), will hydrolyze in water to give an excess of hydrogen ions that makes the solution acid.

Reaction 4 is the formation of an addition compound. The ammonia molecule has one unshared electron pair that can be partially accepted by the boron trifluoride to form a covalent bond.

Reaction 5 is a substitution, or displacement, reaction, in which one of the atoms or radicals in a co-ordination complex is replaced by another atom or radical from the solution. Reactions of this type are also important in organic chemistry.

Oxidation-reduction reactions are those in which the oxidation number of one or more elements is changed. An element is said to be oxidized in a reaction if its oxidation number increases. It loses a number of electrons equal to the change in oxidation number. An element is reduced if its oxidation number decreases by accepting electrons from the element that is oxidized. The element that is oxidized is called a reducing agent; the element that is reduced is called an oxidizing agent. The following are examples of oxidation-reduction reactions (the oxidation states of the oxidizing and reducing agents and of the oxidation and reduction products are shown in parentheses):

$$\underset{\text{reducing agent}}{Mg^{(0)}} + \underset{\text{oxidizing agent}}{Cu^{++(2+)}} \rightarrow Mg^{++(2+)} + Cu^{(0)} \qquad (6)$$

$$\underset{\text{reducing agent}}{C^{(0)}} + \underset{\text{oxidizing agent}}{O_2^{(0)}} \rightarrow C^{(4+)}O_2^{(2-)} \qquad (7)$$

$$\underset{\text{reducing agent}}{5H_2O_2^{(1-)}} + \underset{\text{oxidizing agent}}{2Mn^{(7+)}O_4^-} + 6H^+ \rightarrow 5O_2^{(0)} + 2Mn^{(2+)} + 8H_2O \qquad (8)$$

$$\underset{\text{reducing agent}}{Cl_2^{(0)}} + \underset{\text{oxidizing agent}}{Cl_2^{(0)}} + 4OH^- \rightarrow 2Cl^{(1-)} + 2Cl^{(1+)}O^- + 2H_2O \qquad (9)$$

In reaction 9, chlorine acts both as oxidizing and reducing agent; such a reaction is called disproportionation.

For each element that is known in two different oxidation states, a "half reaction" may be written, such as $Fe^{2+} \rightarrow Fe^{3+} + e^-$, where e^- represents an electron. If this half reaction has a large thermodynamic tendency to go from left to right, the species of lower oxidation number is called a strong reducing agent. If the half reaction has a large tendency to go from right to left, the species of higher oxidation number is called a strong oxidizing agent. Thus a series can be constructed in which an oxidizing agent can oxidize the reduced form of any element lower in the series.

It should be pointed out that many reactions that are energetically possible take place at rates that are too small to produce any observable change. This is particularly true for oxidation-reduction reactions. For example, hydrogen and oxygen can be kept together indefinitely at room temperature without measurable reaction, even though there is a very strong thermodynamic tendency for a reaction to form water. If there were chemical equilibrium between the oceans and the atmosphere, the nitrogen, oxygen and water would have combined to form nitric acid! So two questions must be answered for oxidation-reduction reactions: first, is a given reaction thermodynamically possible? and second, does it proceed at an appreciable rate?

B. CHEMICAL PROPERTIES OF THE ELEMENTS

The chemical properties of the elements must be discussed in relation to the periodic table (*see* PERIODIC LAW). In the table, the members of a vertical column all have the same configuration of outer electrons (valence electrons). Among the elements of one column, there are marked similarities in the formulas of compounds formed, and in chemical and physical properties of the elements and their compounds. There are variations, however, of properties within a column of the periodic table because of the increasing size of atoms or ions in successive periods. Therefore, for each column of the periodic table, it is appropriate to discuss the compounds and properties typical of the group of elements, and then the gradations of properties within the group.

In some parts of the periodic table, new electrons are added to underlying shells, rather than to the valence shell of electrons, so that the number of valence electrons remains constant for several elements in a row. In these cases, the properties of the elements are similar, and are best discussed together. The elements concerned are the transition metals (from scandium to zinc and the corresponding groups of the second and third long periods), and the rare earths (the lanthanide series, from cerium to lutetium, and the actinide series from thorium to lawrencium). (*See* ELEMENTS, CHEMICAL; VALENCE.)

1. Hydrogen.—Hydrogen is discussed separately because of its unique electronic structure, a single electron. This electronic configuration is given the symbol $1s^1$, indicating that the 1s orbital is occupied by one electron.

In the elemental form, two hydrogen atoms share their two electrons to form a covalent bond in the molecule H_2. Since this is the simplest possible molecule involving a two-electron bond, it has been of great importance in theoretical chemistry. It has been possible by the Heitler-London method and other quantum mechanical calculations to describe quantitatively the properties of the hydrogen molecule on a purely theoretical basis. Because of the enormous complexity of problems involving many particles, it has not been possible to make similar exact calculations of the properties of more complex molecules such as F_2, but the success of the treatment for hydrogen indicates that the fundamental nature of covalent bonding is understood.

Hydrogen can share its electron with more electronegative elements to form compounds of the 1+ oxidation state, such as H_2O and HCl. Most of these binary compounds are gases at room temperature. Binary compounds of hydrogen with the Group VI and VII elements dissolve in water to give acids; *i.e.*, they dissociate to give hydrogen ions and anions. The hydrogen ion does not exist in solution as a bare proton but is solvated (combined with solvent molecules) by one or more water molecules to give species such as H_3O^+ or $H_9O_4^+$. Since solvation takes place for all ions in solution, and often to an unknown extent, it is customary not to specify the degree of solvation in a chemical equation unless there is specific concern for reactions involving the solvent molecules. Hence the hydrogen ion in solution is usually written as H^+ or $H^+_{(aq)}$.

Hydrogen can accept an electron from an electropositive element to form a hydride ion H^-, which exists in salts such as NaH, sodium hydride. This contains hydrogen in the 1− oxidation state, analogous to halides. Hydrides of the alkali metals and alkaline earth metals are salts, forming ionic lattices similar to the corresponding halides. They react with water to liberate hydrogen.

2. Group I, the Alkali Metals.—The atoms of these elements (lithium, sodium, potassium, rubidium, cesium and francium) have only one valence electron outside the inner core of electrons of noble gas configuration (see *Noble Gases* below). The alkali metals are the most electropositive of all the elements; *i.e.*, they lose the valence electron very easily to give ions of charge 1+. For example, the metals reduce water to give hydrogen gas in the reaction:

$$2K + 2H_2O \rightarrow 2K^+ + 2OH^- + H_2$$

No other oxidation states are known besides 0 and 1+.

The metals are soft and easily cut; they react readily with oxygen of the air, and are usually kept under an inert liquid, such as kerosene. Within this group of elements, the reactivity increases from lithium to cesium. (Little is known about francium, since it is radioactive with a short half-life and exists only in very minute quantities in nature.)

The alkali metals form compounds with the electronegative elements, such as the halogens (Group VII) and the oxygen group (Group VI), as well as with hydrogen. In all cases, the alkali metal atom is in the 1+ oxidation state, and the compounds are held together by almost purely ionic forces. These compounds are usually very soluble in water, and only a few salts involving complex anions (*e.g.*, $K_3Co(NO_2)_6$) are sufficiently insoluble to be of use in gravimetric quantitative analysis.

The oxides of the alkali metals dissolve in water to give strongly basic solutions. Salts of the alkali metals and strong acids give neutral solutions (such as sodium chloride or sodium sulfate); salts from weak acids give basic solutions (such as sodium carbonate or sodium phosphate). It should be pointed out that the chemistry of the ammonium ion (NH_4^+) is similar in many ways to that of the alkali metal ions, differing primarily in that ammonium hydroxide is a weak base.

3. Group II, the Alkaline Earths.—The atoms of Group II elements (beryllium, magnesium, calcium, strontium, barium and radium) have two electrons in an s orbital outside a closed shell of inner electrons, giving a valence electron configuration s^2. With the exception of beryllium, these electrons are readily lost to an oxidizing agent to produce ions of charge $2+$. The more reactive members of the group, calcium, strontium, barium and radium, react with cold water like the alkali metals:

$$Ca + 2H_2O \rightarrow Ca^{2+} + 2OH^- + H_2$$

These metals are powerful reducing agents, but less so than the alkali metals of Group I.

As in the case of the Group I elements, the alkaline earth metals form binary compounds with the more electronegative nonmetals to give compounds such as calcium fluoride (CaF_2), calcium oxide (CaO), calcium nitride (Ca_3N_2) and calcium carbide (CaC_2). In all their compounds the alkaline earth elements have an oxidation state of $2+$.

Compounds of Group II elements are bound by principally ionic forces. Several compounds, especially with divalent anions, have very low solubility in water (*e.g.*, calcium carbonate, barium sulfate).

The oxides react with water to give the hydroxides, which are less soluble in water than the alkali metal hydroxides. The solutions are basic because of the dissociation:

$$Ca(OH)_2 \rightarrow Ca^{2+} + 2OH^-$$

The solubilities of the hydroxides increase in the series from beryllium to radium.

In each column of the periodic table, the elements are progressively more metallic from top to bottom; in each horizontal row, the elements are less metallic from left to right. As a result, the first member of a column often bears strong similarities to the elements in the next column to the right. For example, lithium resembles the alkaline earth metals more than the other alkali metals in its reactivity toward water; beryllium hydroxide is amphoteric, like aluminum hydroxide, while none of the other Group II hydroxides are amphoteric. (A hydroxide or oxide that can react with either acids or bases is said to be amphoteric.) (*See* ALKALINE EARTHS.)

4. Group III Elements.—These elements (boron, aluminum, gallium, indium and thallium) have three electrons in the valence shell, giving a configuration s^2p. The degree of metallic or electropositive character has a wide range in this group. Boron is a nonmetallic element: solid boron is a poor electrical conductor and its oxide, B_2O_3, is acidic. (It dissolves in water to give boric acid, a weak acid, and dissolves in bases to give borates.) Boron forms a remarkable series of compounds with hydrogen that are discussed in BORON.

Aluminum and the other Group III elements are metals. The hydroxides have very low solubility in water but dissolve in acids to give solutions containing the ion in the $3+$ oxidation state, such as Al^{3+}. The amphoteric hydroxides of aluminum and gallium also dissolve in strong bases to give solutions of aluminates and gallates, containing the ions $Al(OH)_4^-$ and GaO_3^{3-}.

Binary compounds formed in reactions between Group III elements and the halogens differ considerably in properties from the halides of Groups I and II. This does not represent a sudden change in the type of chemical bond between the metal and halogen but reflects the differences in structure of the molecular units. In the sodium chloride crystal, for example, each sodium is bound to six chlorines and each chlorine to six sodiums, so that the entire crystal is one large molecule. In order to melt or vaporize sodium chloride, it is necessary to break strong Na—Cl bonds. In boron trichloride, BCl_3, each boron atom is attached to only three chlorine atoms (because of the very small size of the B^{3+} ion) so that BCl_3 molecules exist as discrete units. In the solid state these molecules are attracted to one another only by weak van der Waals' forces, *i.e.*, the forces attracting the molecules to each other, so that they are easily separated in melting and vaporization. As a result, boron trichloride is a gas at room temperature (boiling point 13° C.). Similarly aluminum trichloride forms molecules, of the formula Al_2Cl_6, that remain as separate units in the solid. This solid melts at 194° C., much lower than sodium chloride or magnesium chloride.

In addition to the usual $3+$ oxidation state, compounds of thallium are known in which thallium is in the $1+$ state. These compounds resemble analogous Group I compounds in many properties: TlOH, for example, is a strong base.

5. Group IV Elements.—The elements of Group IV (carbon, silicon, germanium, tin and lead) have four electrons in their outermost shell, with configuration s^2p^2. As in the case of Group III, there is a marked trend from nonmetallic to metallic properties from top to bottom of the column. Carbon exists in two crystal modifications: graphite and diamond. In graphite each carbon atom is joined to three others in a plane, forming layers that give graphite its characteristic cleavage. In diamond, each carbon atom is surrounded by four others at the corners of a regular tetrahedron, producing a continuous three-dimensional network. Silicon, germanium and gray tin also have the diamond structure, and, like diamond, are poor electrical conductors when they are very pure. High temperatures or the presence of impurities makes these crystals into moderately good conductors: they are called semiconductors and are of great importance in electronics. Lead and white tin behave as metals.

The highest oxidation state of the Group IV elements is $4+$. The oxides of the $4+$ state range from acid in the case of CO_2 and SiO_2 to amphoteric for GeO_2, SnO_2 and PbO_2. The carbonate ion, CO_3^{2-}, has a planar triangular structure. There are many anions involving Si^{4+}, all built from a tetrahedral unit SiO_4. These units may be isolated as SiO_4^{4-} ions, joined in long chains to give SiO_3^{2-}, or joined in double chains, sheets or three-dimensional frameworks to give other more complex formulas. The chemistry and structure of silicates are important since these compounds constitute most of the mass of the earth.

Compounds are also known containing germanium, tin and lead in the $2+$ oxidation state. The $2+$ state is more stable relative to the $4+$ state in the heavier members of the group, so that the Sn^{2+} ion is a good reducing agent, being easily oxidized to Sn^{4+}, whereas PbO_2 is a strong oxidizing agent, being easily reduced to Pb^{2+}.

All the Group IV elements form hydrides: CH_4, SiH_4, GeH_4, SnH_4 and PbH_4, all of which are gases at room temperature. Carbon forms thousands of hydrides of more complicated structure in which there are carbon-carbon bonds. There is much less tendency for the other elements in this group to form long chains and rings. The largest known silicon hydride (silane) molecules contain a chain of six silicon atoms; germanium hydrides are known only up to Ge_3H_8, and none are known for tin and lead except SnH_4 and PbH_4. It is the extraordinary ability of carbon atoms to form carbon-carbon bonds that results in the fact that compounds containing carbon far outnumber compounds without carbon. This is the reason for treating carbon chemistry in the separate field of organic chemistry.

6. Group V Elements.—The Group V elements (nitrogen, phosphorous, arsenic, antimony and bismuth) have valence electron configuration s^2p^3. In the elemental form, nitrogen and phosphorus are nonmetallic, arsenic and antimony exist in both metallic and nonmetallic forms, and bismuth is a metal.

All the elements of this group have compounds involving the $3-$, $3+$ and $5+$ oxidation states. For nitrogen, compounds are known for every oxidation state from $3-$ to $5+$. In the $3-$ oxidation state, the three p electrons are shared with a more electropositive element, hydrogen, to give a series of hydrides: ammonia (NH_3), phosphine (PH_3), arsine (AsH_3), stibine (SbH_3) and bismuthine (BiH_3). These compounds are gases that decrease in stability and increase in acidity in the order shown. Ammonia dissolves in water to give the weak base, ammonium hydroxide; phosphine is almost insoluble in water and gives neutral solutions; stibine is slightly acidic and can form salts, such as Na_3Sb, sodium antimonide.

By sharing the three p electrons with a more electronegative atom, such as a halogen or oxygen, elements of Group V form compounds of the $3+$ oxidation state. These include a series of trihalides such as NF_3, PCl_3, AsF_3, etc. The molecules of these compounds are pyramidal in shape, with the Group V atom above a planar triangle of halogen atoms. They are gases, volatile liquids or solids at room temperature; all are reactive and strongly acidic.

For example, phosphorus trichloride reacts readily with water to give phosphorous acid and hydrochloric acid.

Except for N_2O_3, which is stable only at very low temperatures, the oxides, of empirical formula M_2O_3, are stable solids formed by burning the elements in air. They are anhydrides of the corresponding oxy-acids. For example, phosphorus (III) oxide dissolves in water to give phosphorous acid, H_3PO_3, which is a weak dibasic acid. (The suffix *-ous* distinguishes it from phosphoric acid, H_3PO_4, which contains phosphorus in the 5+ oxidation state.) The more electropositive nature of the heavier elements of the group is shown by the behaviour of the compounds H_3MO_3 or $M(OH)_3$. As mentioned above, phosphorous acid dissociates only as a weak acid and forms salts such as sodium phosphite, Na_2HPO_3; arsenious acid reacts with bases to give salts such as silver arsenite, Ag_3AsO_3; antimony forms both anions (antimonite, SbO_2^-) and cations (Sb^{3+} and SbO^+); bismuth forms only cations, Bi^{3+} and BiO^+.

The 5+ oxidation state is achieved by the sharing of all five valence electrons with a more electronegative element. Thus there exist pentahalides and pentoxides of all the elements of the group except nitrogen. In order to use all five electrons for covalent bonding, it is necessary to unpair the two electrons in the s orbital of the valence shell and promote one to a d orbital. This is possible only for elements beyond neon in the periodic table, since in the first horizontal row of eight elements there are no low-energy d orbitals available.

The pentahalides are reactive compounds, strong acids, strong halogenating agents and oxidizing agents. The common oxy-acids are nitric acid (HNO_3), phosphoric acid (H_3PO_4), arsenic acid (H_3AsO_4), etc.

The properties of nitrogen differ considerably from those of the rest of the group in several ways. First, because the atom is smaller, it tends to form compounds of lower co-ordination number for the same oxidation state. Whereas phosphorus and the heavier members form anions with formulas such as PO_4^{3-}, in which the phosphorus atom is surrounded tetrahedrally by four oxygen atoms, nitrogen has room for only three oxygen atoms, and forms the planar ion NO_3^-. Second, because only four bonds can be formed without using d orbitals, nitrogen has no pentahalides. Third, the tendency to form multiple bonds is much greater for elements of the first horizontal row of the periodic table than for elements below the first row, so that nitrogen forms very stable multiply bonded molecules such as N_2 and NO; this property has a large effect on the oxidation-reduction reactions involving nitrogen compounds.

7. Group VI Elements.—The Group VI elements (oxygen, sulfur, selenium, tellurium and polonium) have six electrons in the outer shell, giving configuration s^2p^4. Oxygen and sulfur are nonmetallic; elemental selenium exists in both nonmetallic and metallic forms; tellurium and polonium are metallic.

These elements can accept two electrons from an electropositive element to form an ion with the electronic structure of a noble gas: s^2p^6. This electronic configuration is particularly stable and inert. Two of the p electrons in the neutral atom are unpaired and available for the formation of two covalent bonds with more electropositive atoms, such as hydrogen. In each of these cases, the Group VI element is in the 2− oxidation state, and the binary compounds are oxides, sulfides, etc. This is the oxidation state of oxygen in almost all its compounds.

Compounds in which there is an oxygen-oxygen bond are called peroxides and contain oxygen in the 1− oxidation state. Their chemistry is particularly interesting in that they can be reduced to give oxides (2− oxidation state) or oxidized to give elemental oxygen (0 oxidation state). There are also analogous compounds with sulfur-sulfur bonds (compare hydrogen peroxide, H_2O_2, with hydrogen disulfide, H_2S_2).

The Group VI elements can share their two available p electrons with a more electronegative atom, such as a halogen, to give compounds of the 2+ oxidation state, such as oxygen fluoride (OF_2), sulfur dichloride (SCl_2), tellurium dibromide ($TeBr_2$), etc. Most of these are unstable gases or liquids.

For the members of the group heavier than oxygen, all four p electrons may be shared in covalent bonds with halogens or oxygen to give the tetrahalides such as SF_4, $TeBr_4$, the dioxides SO_2, SeO_2, TeO_2 and the oxy-acids such as H_2SO_3, all involving the 4+ oxidation state. Sulfur dioxide and sulfurous acid are good reducing agents. Selenium dioxide and tellurium dioxide are poor reducing agents but can act as oxidizing agents by being themselves reduced to elemental selenium and tellurium.

The highest oxidation state of the Group VI elements is 6+, attained by sharing all six of the valence electrons with halogens or oxygen. The only known hexahalides are SF_6, SeF_6, TeF_6. They are all gases at room temperature, and are unreactive. The trioxides SO_3, SeO_3, TeO_3 dissolve in water to give the acids: sulfuric acid (H_2SO_4), selenic acid (H_2SeO_4) and telluric acid (H_6TeO_6). Of these, the first two are strong dibasic acids, the third is a very weak dibasic acid. Selenic and telluric acids are good oxidizing agents.

Sulfur also forms a series of dibasic oxy-acids containing sulfur-sulfur bonds. These include thiosulfate ($S_2O_3^{2-}$), dithionate ($S_2O_6^{2-}$) and the polythionates ($S_nO_6^{2-}$, in which $n = 3, 4, 5, 6$).

8. Group VII, the Halogens.—The halogens (fluorine, chlorine, bromine, iodine and astatine) have seven electrons in the valence shell, with configuration s^2p^5. The elements are all nonmetallic and form diatomic molecules, such as F_2 and Cl_2. At room temperature fluorine and chlorine are gases, bromine is a volatile liquid and iodine and astatine are solids.

The halogens are the group most commonly chosen to illustrate the properties of the periodic table. They show a strong resemblance to one another in the formulas and properties of the compounds they form; the gradation of these properties within the group is usually clear.

The Group VII elements can acquire a noble gas electronic configuration by accepting one electron from an electropositive atom to give a halide ion (see *Noble Gases* below). The 1− oxidation state will also be produced by sharing the unpaired p electron with a more electropositive element, as in hydrogen bromide (HBr). Since fluorine is the most electronegative of all elements, all its compounds except F_2 involve the 1− oxidation state.

The halogens form binary compounds (halides) with all the elements except the noble gases. (Some of the properties of these compounds have been discussed in earlier sections.) In general, the electronegativity of atoms in a row of the periodic table increases from left to right, so that the halogens are the most electronegative elements in each row. The bond between two atoms can be considered intermediate between purely ionic and purely covalent, the amount of ionic character depending on the electronegativity difference between the two atoms. Thus for the fluorides of the second row of the periodic table, NaF has the most ionic bonds, ClF the least ionic and most covalent. The amount of ionic character decreases regularly along the row, and no sudden change in bond type is implied by the sudden change in properties from high melting solids (NaF, CaF_2, AlF_3) to the gases (SiF_4, PF_5, SF_6, ClF).

As was discussed in the section on Group III elements, this change in properties represents a change in co-ordination number due to the decreasing size of the central ion, so that the last four substances exist as discrete molecules in the solid state, whereas the first three form continuous crystals without separate molecule units.

The halogens beyond fluorine can share their unpaired p electron with oxygen to give the 1+ oxidation state, characterized by the hypohalites: hypochlorous acid (HClO), hypobromous acid (HBrO) and hypoiodous acid (HIO). These are weak acids and are formed by disproportionation (autooxidation and reduction) of the halogens in water by reactions such as:

$$Cl_2 + H_2O \rightarrow HClO + H^+ + Cl^-$$

The hypohalites themselves are unstable and disproportionate slowly to give halides and halates. The hypohalites are rapid, powerful oxidizing agents.

The 3+ oxidation state is known in the compounds ClF_3, BrF_3 and ICl_3 but the corresponding oxy-acid is known only for chlorine; *i.e.*, chlorous acid ($HClO_2$). Chlorous acid, a weak acid, is a strong oxidizing agent and decomposes readily to chlorine and chlorine dioxide (ClO_2).

Oxidation of halogens leads to halates: chlorate (ClO_3^-), bromate (BrO_3^-) and iodate (IO_3^-), where the halogen is in the 5+ oxidation state. The halic acids are strong acids and powerful oxidizing agents.

The highest state of oxidation for this group is 7+, found in the compounds iodine heptafluoride (IF_7), perchloric acid ($HClO_4$) and periodic acid (H_5IO_6 and HIO_4). Perchloric acid is a strong acid and thermodynamically a strong oxidizing agent. With most reducing agents, however, its rate of reaction is low, so that perchlorates remain unchanged in the presence of many powerful reducing agents. The perchlorate ion also has the property of being the poorest anion in forming co-ordination complexes with cations. (*See* Halogens.)

9. Group VIII, the Noble Gases.—These elements (helium, neon, argon, krypton, xenon and radon) have very little chemistry, forming compounds only with the most electronegative elements (fluorine, oxygen, chlorine). Their electronic configurations are: for helium $1s^2$, for the others s^2p^6, which constitutes a filled shell. That is, there are no empty orbitals available for low-energy chemical binding.

It was once believed that these elements were completely inert, but it was shown in 1962 that xenon (*q.v.*) reacted directly with platinum hexafluoride to give a solid, xenon platinum hexafluoride ($XePtF_6$). Subsequently several fluorides of xenon, radon and krypton were synthesized by reacting the elements under rather mild conditions. Reacting these fluorides with water produces unstable oxygen compounds of the noble gases.

At room temperature, all of these elements are monatomic gases with different melting and boiling points and with different adsorption characteristics.

10. The Transition Metals.—The 30 transition metals include scandium, titanium, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc and the corresponding series of the second and third long periods. They have many similarities in properties because of their similar valence electron configuration. With minor exceptions for chromium and copper, each atom has two electrons in the outer valence shell, in an s orbital (in the first transition series, the 4s orbital). Members of the series differ in the number of electrons in an inner subshell, the 3d orbitals. There are five of these orbitals, each of which can accommodate two electrons, thus accounting for the 10 members of the series. Scandium has an outer electron configuration $3d^14s^2$, titanium $3d^24s^2$, vanadium $3d^34s^2$, etc., until the 3d level is filled at zinc.

All the transition metals, except scandium, form stable compounds in the 2+ oxidation state by loss of the pair of 4s electrons. The 2+ cations formed differ only slightly from one another in size, the trend being toward smaller ions as more d electrons are added. Because there is no variation in charge, and little variation in size of these cations, their chemical properties are very similar. All form insoluble hydroxides and sulfides, soluble halides and sulfates, and crystals in which other transition metal ions can be substituted to form extensive solid solutions.

Most of the transition metals are also known in the 3+ oxidation state, forming another set of similar ions. An important property of the transition metals, particularly in the 2+ and 3+ oxidation states, is their ability to form co-ordination compounds. These are molecules or ions in which a transition metal ion is surrounded by several other atoms, molecules or ions known as ligands. The ligands are arranged in a simple geometrical manner around the central atom. For example, six ligands usually form a regular octahedron, and four ligands form either a tetrahedron or a plane square. Compounds of this sort exist also for nontransition metal ions, such as $Ca(H_2O)_6^{2+}$, the calcium ion in aqueous solution, but the presence of d electrons in the transition metals makes their complex ions more stable and often more inert to chemical reaction. Typical transition metal complexes are: $Fe(CN)_6^{3-}$, hexacyanoferrate (III); $Co(NH_3)_6^{3+}$, hexaammine cobalt (III); $Mn(H_2O)_6^{2+}$, hexaaquomanganese (II); $Cu(NH_3)_4^{2+}$, tetraammine copper (II). (*See* Co-ordination Compounds: *Some Important Types of Co-ordination Compounds*.)

All reactions of the transition metal ions in solution should be considered as reactions involving co-ordination complexes. The solid compounds of these elements are best described as complex ions linked together through sharing ligands. For instance, in solid CrF_2, the chromium ion is at the centre of an octahedron of fluoride ions, very similar to its environment in solution.

Lower valence states are also able to form co-ordination complexes with certain ligands, giving compounds such as $Ni(CO_4)$, tetracarbonyl nickel (0), and $Pd(PF_3)_3$, tris-trifluorophosphine palladium (0).

In their highest oxidation states, some of the transition metals form acid oxides and anions. Vanadium can share its three d electrons and two s electrons with oxygen to give vanadates containing the ion VO_4^{3-} or VO_3^- (compare with phosphate). Similarly, chromium in the 6+ oxidation state gives chromic acid and chromates (such as K_2CrO_4). Manganese is known in the 6+ state as the manganate ion MnO_4^{2-} and in the 7+ state as the permanganate ion MnO_4^-.

In the second transition series (yttrium through cadmium) and the third series (lanthanum, hafnium, tantalum, etc., to mercury), higher oxidation states tend to be more stable, and lower oxidation states less stable than in the first transition series. Compounds of the 2+ oxidation state are rare, and compounds of the maximum oxidation state reached by sharing all the d and s electrons are common. This can be illustrated by considering examples of elements of the same outer electron configuration from the three transition periods.

Vanadium, Niobium, Tantalum.—Vanadium exists as V^{2+}, V^{3+} and VO^{2+} in aqueous solution, the 2+ ion being readily oxidized to the 3+ state. In the 5+ state, vanadic acid is a good oxidizing agent. Niobium forms a trichloride, $NbCl_3$, but the 3+ state in aqueous solution is a strong reducing agent, being oxidized to the 5+ state. The only compounds of tantalum stable in aqueous solution are tantalates, involving the 5+ oxidation state.

Iron, Ruthenium, Osmium.—The common stable oxidation states of iron are 2+ and 3+. By electrolytic oxidation in strongly basic solution, iron may be oxidized to the ferrate (VI) ion, FeO_4^{2-}, which is a powerful oxidizing agent (better than permanganate). Ruthenium forms stable solutions containing complex ions of the 3+ and 4+ oxidation states. Also known are the ruthenate (VI) ion, RuO_4^{2-}, and the ruthenate (VII) ion, RuO_4^-. Continued oxidation produces a volatile compound, RuO_4, ruthenium tetroxide, in the 8+ oxidation state. The chemistry of osmium is similar to that of ruthenium, with the higher oxidation states being still more stable.

The stabilization of higher oxidation states in the second and third transition series decreases as the d shell fills up, so that there is not much difference in stability of the corresponding oxidation states of nickel, palladium and platinum.

Copper, Silver and Gold.—In this group only the 1+, 2+ and 3+ states are stable. For copper, Cu^{2+} is stable in most environments and the 3+ state, as in the cuprate (III) ion, CuO_2^-, is a strong oxidizing agent. Both the 2+ and 3+ states of silver are powerful oxidizing agents. Complex ions involving gold (III) are only moderate oxidizing agents. Both the 1+ and 2+ states are unstable with respect to disproportionation to gold (0) and gold (III). No compounds of gold (II) are known.

Zinc, Cadmium and Mercury.—In these elements the 3d subshell is full and only the two electrons in the 4s subshell are involved in chemical binding. The commonest oxidation states are 2+, but compounds of mercury (I), which contain the ion Hg_2^{2+}, are also known.

It is interesting to compare the chemistry of zinc, cadmium and mercury with that of magnesium, calcium and strontium of the alkaline earths. All give ions with a charge 2+ by loss of a pair of outer s electrons. The sizes of corresponding pairs of ions are comparable: the ionic radii are Zn^{2+}, 0.72 Å; Mg^{2+}, 0.66 Å; Cd^{2+}, 0.96 Å; Ca^{2+}, 0.99 Å; Hg^{2+}, 1.10 Å; Sr^{2+}, 1.15 Å. (The symbol Å is for angstrom unit, which equals 10^{-8} cm.) In all these cases the ions are spherical and differ therefore only in that those of the zinc group have a filled d subshell as their outermost electrons, whereas those of the alkaline earth group have a filled p subshell. For purely ionic chemical binding, the binding energy of a compound decreases as the separation between the centres of the ions increases, so that the binding energy of a series of ionic compounds of the alkaline earth elements decreases from magnesium to calcium to strontium. For example, the heats of hydration of these ions are as follows: Mg^{2+}, 464 kg.cal./mol.; Ca^{2+}, 382 kg.cal./mol.; Sr^{2+}, 350 kg.cal./mol. For purely ionic bonds, the heat of hydration of an ion of the zinc group should be very similar to that of the corresponding alkaline earth ion of the same size, since the charges and radii are alike. The observed values are Zn^{2+}, 492 kg.cal./mol.; Cd^{2+}, 437 kg.cal./mol.; Hg^{2+}, 441 kg.cal./mol. It is observed that the second group has larger binding energies and that these decrease much less for the heavier members. This is accounted for by an increase in the covalent nature of the bonds for ions with an 18-electron outer shell, such as the zinc group. The increase in amount of covalent character is the result of the poorer shielding of the nuclear charge provided by outer d electrons than by outer p electrons.

Because 18-electron shell ions form bonds that have considerable covalent character, structures of their compounds are generally more complicated than those of ions that have the electronic configuration of a noble gas. In the latter case, crystal structures are determined primarily by the efficiency of packing of spherical ions. In the former case, directed valence bonds are present, which lead to crystal structures other than the simple closest-packed structures. For example, magnesium oxide has a cubic structure of the sodium chloride type, but zinc oxide has a hexagonal structure of the wurtzite (a zinc sulfide ore) type in which each zinc ion is tetrahedrally surrounded by four oxygen atoms.

11. Rare-Earth or Lanthanide Elements.—These 14 elements, which have remarkably similar chemical properties, include cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium. In their electronic structures, they have the following in common: filled shells up to the 5s and 5p levels to give an electron core of the same configuration as the noble gas xenon, usually empty 5d orbitals (these become filled in the third transition series described above) and a pair of 6s electrons. The electronic structures of the rare earths differ from one another only in the number of electrons in the 4f subshell, ranging from 2 for cerium up to 14 for lutetium. The orbitals of the 4f electrons are buried so far inside the electron cloud of these atoms that they have very little influence on the chemical properties.

The characteristic oxidation state of the rare earths in aqueous solution is 3+. Besides this state, a few elements with electronic configurations near f^0, f^7 and f^{14} are found in 2+ or 4+ states, such as Ce (IV), Eu (II), Tb (IV).

The chemistry of the rare-earth elements is similar to that of the alkaline earth metals. The elements are metallic, dissolve readily in acids and react with hot water to form the hydroxides and liberate hydrogen. The oxides M_2O_3 are basic, and salts of M^{3+} cations with strong acids are only slightly hydrolyzed. The halides (except fluoride), nitrates and perchlorates are quite soluble in water, whereas the oxides, hydroxides, sulfates, phosphates and fluorides are insoluble. Because of their large ionic radii, the rare earths form very few complex ions.

Because of their strong similarities in properties, the rare-earth elements are not easily separated from one another by the classical chemical techniques of precipitation or extraction. Since differences in solubility of different rare-earth compounds are very slight, many tedious fractional crystallizations are necessary in the use of such techniques. However, the adaptation of ion exchange (*q.v.*) procedures on a large scale has made possible the preparation of large quantities of very pure rare-earth compounds. (*See* RARE EARTHS.)

12. Actinide Elements.—These 14 elements form a series, analogous to the lanthanide series, in which the 5f subshell is being filled. Members of the actinide series include thorium, protactinium, uranium, neptunium, plutonium, americium, curium, berkelium, californium, einsteinium, fermium, mendelevium, nobelium and lawrencium. In the first members of the series, thorium, protactinium and uranium, there is little energy difference between the 5f electrons and the 6d electrons so that these elements resemble in some ways the elements hafnium, tantalum and tungsten more than the first elements of the lanthanide series. For instance, the most stable oxidation states in aqueous solution are Th (IV), Pa (V) and U (VI). With increasing atomic number, the actinide elements resemble more closely the lanthanides, and the 3+ oxidation state is the most stable for the elements after plutonium.

All the actinide elements are radioactive, and beyond uranium are necessarily man-made since they are not found on the earth (*see* TRANSURANIUM ELEMENTS). For the higher atomic numbers, most of the isotopes have short half-lives and therefore high specific activities, so that it is not feasible to study their chemistry on large amounts of material. Special carrier techniques are used to study the properties of these elements.

The metallic element actinium is sometimes regarded as the prototype of the actinide series and when it is considered part of this group the series is called the actinium series. The chemical properties of actinium, however, resemble those of the rare-earth (lanthanide) elements. (*See* ACTINIUM.)

C. EXPERIMENTAL PROCEDURES IN INORGANIC CHEMISTRY

1. Structural Chemistry.—In order to understand the properties and reactions of any compound it is necessary to know the structure of its molecular or crystal units. This requires a knowledge first of the spatial arrangement of the constituent atoms in terms of distances between atoms (bond lengths) and angles between bonds. It also requires information on the distribution of electrons in the compound so that distinction can be made between single and multiple bonds, between more ionic and more covalent bonds, etc.

Several experimental methods are used in determining molecular structures, and these tend to complement one another. The most widely used technique is the determination of the structures of crystals by X-ray diffraction (*see* CRYSTALLOGRAPHY: *Diffraction by Crystals*). In this way, a three-dimensional map of the molecule can be obtained, with the locations of each atom known to an accuracy of about .01 Å.

The structures of gaseous molecules can be studied by means of electron diffraction (*q.v.*), a technique in which a beam of electrons is scattered by the molecules of the gas.

The dimensions of simple molecules can be measured with great accuracy (to .001 Å) by determining the rotational energy levels of a molecule in the gas phase. The experimental method used is absorption spectroscopy in the infrared and microwave regions. (*See* SPECTROSCOPY: *Applications;* SPECTROCHEMICAL ANALYSIS.)

The procedures listed above are used to determine the positions of the atoms in a molecule and do not directly give much information on the electronic configuration. However, relationships are known between structural properties and electronic properties. For example, it is known that a double bond between two atoms is shorter than a single bond between the same two atoms, so that the measured bond length gives information on the electronic distribution in that bond. Further information on the electronic structure is given by measurement of the electric dipole moment of the molecule (*see* DIPOLE MOMENTS) and of its paramagnetic moment (*see* below).

The magnetic properties of a molecule depend on its electronic configuration. Most molecules have their orbitals filled with electrons in pairs with spins opposed. Such substances, said to be diamagnetic, move away from a magnetic pole in a nonuniform field. Some molecules have one or more electrons that are not paired with electrons of opposite spin. These electrons behave as small magnets and can be lined up by an external magnetic field. Substances of this sort are described as paramagnetic and are attracted by a magnetic pole in a nonuniform field. Common examples of paramagnetic substances are: oxygen, nitric oxide, free radicals and most compounds of the transition metals and rare earths. A study of the magnetic properties of matter therefore gives information on the number of electrons with unpaired spins and on the distribution of electrons in the molecule. The experimental techniques include measurement of the magnetic susceptibility and electron spin resonance.

2. Reaction Mechanisms.—In a chemical reaction, molecules of the reacting species are destroyed, and molecules of the products are formed. This requires breaking of some chemical bonds and formation of new bonds. Information can be derived from the details of this process in terms of the sequence of events, and the geometrical and electronic structure of intermediate and transitional molecular units. One approach to this problem is through the study of the rates of chemical reaction, and the dependence of these rates on the concentrations of the reacting substances (*see* REACTION KINETICS: *"Order" of Reaction*). By this means it was shown, for example, that the reaction between hydrogen gas and iodine gas to give hydrogen iodide

$$H_2 + I_2 \rightarrow 2HI$$

takes place by a simple collision of one hydrogen molecule with one iodine molecule. On the other hand, the similar reaction between hydrogen and bromine

$$H_2 + Br_2 \rightarrow 2HBr$$

proceeds primarily by a chain reaction mechanism, in which a bromine molecule is dissociated into two atoms, each of which then attacks a hydrogen molecule, producing HBr and a hydrogen atom. Each hydrogen atom then reacts with another bromine molecule to give HBr and a bromine atom. This whole process is repeated many times.

Another important method of studying mechanisms of reactions is with isotopic tracers. By substituting a radioactive isotope for a stable element in a particular atom of a molecule, the course of the reaction can be followed and the final position of the labeled atom determined.

3. Synthetic Inorganic Chemistry.—Besides the conventional studies of reactions and properties of substances in their pure states and in aqueous solutions, modern inorganic chemistry also deals with reactions and properties in unusual solvents and environments. Many interesting reactions that cannot be carried out in the presence of water can be observed in solvents such as liquid ammonia, liquid sulfur dioxide or liquid hydrogen fluoride.

Also important are reactions in systems of molten salts. A large area of study is concerned with the behaviour of inorganic substances at very high pressures.

A large number of new co-ordination complexes were being made in aqueous solutions in the early 1960s, in many cases with organic ligands. Since complexes related to these are known in biological systems, this area is a link between inorganic chemistry and biochemistry. (R. N. CL.)

III. ORGANIC CHEMISTRY

A. DEFINITION AND INTRODUCTION

Although the term organic chemistry was introduced at the beginning of the 19th century, the development of the subject on a rational basis did not occur until about 1860. The decision to call a branch of chemistry organic chemistry was made because of the tendency of chemists to classify substances in terms of their origin. Thus organic chemical compounds were regarded as substances derivable either from plants or animals.

This led to the suggestion that there was some "vital force" associated with organic compounds and that this intrinsic quality made their synthesis in the laboratory impossible. It is now known, of course, that this was not correct, but during the initial development of organic chemistry this opinion was widely held.

Friedrich Wöhler is usually given the credit for disposing of the vital force theory, although other researches in progress at that time caused some chemists to be rather skeptical about it. Wöhler's classical experiment (1828) was the thermal conversion of ammonium cyanate into urea

$$NH_4 \cdot CNO \xrightarrow{\text{heat}} H_2N \cdot CO \cdot NH_2$$

From this experiment Wöhler concluded that heat had transformed ammonium cyanate, a typical inorganic compound, into the organic compound urea. His reaction to this result is shown by the following statement, which he made in a letter to Berzelius in 1828: "I must tell you that I can prepare urea without requiring a kidney of an animal, either man or dog."

This laboratory synthesis of an organic compound was not accepted by all chemists as proof that the vital force theory was incorrect. Some argued that because urea was isolated from urine it should be regarded as an end product of a metabolic process. The view was taken that as the formation of urea involved the degradation of a more complex organic precursor it was therefore not structurally characteristic of a synthetic process taking place in a living organism. The significance of the synthesis (1845) by (Adolph Wilhelm) Hermann Kolbe of acetic acid, CH_3CO_2H, was not universally accepted either, but it certainly helped to develop a climate of opinion among chemists that led them to reject the notion that a "vital force" was essential for the synthesis of an organic compound. The final blow to this theory was delivered (1860) by Berthelot in his famous treatise entitled *La Chimie organique fondée sur la synthèse;* the development of organic chemistry as a rational science proceeded from that date.

Even when it became evident that substances derived from plant or animal sources were not chemically distinguishable from inorganic compounds, it was still desirable to maintain this division into organic chemistry and inorganic chemistry.

Organic compounds contain carbon as a constituent element and organic chemistry may be briefly defined as the chemistry of compounds of carbon. There are some substances containing carbon that are nevertheless classified as inorganic because their behaviour is much more typical of inorganic substances. This is an artificial distinction that is acceptable because it is convenient. Substances that are usually considered to be inorganic include metal salts such as the carbonates, cyanides, carbides, cyanates and thiocyanates. It should be emphasized, however, that the border line between all branches of chemistry is diffuse.

At first sight it may cause surprise that the extent of the study of derivatives of a single element, carbon, should be sufficient to constitute a separate subject. However, the number of known derivatives of carbon that have been discovered as a result of researches in organic chemistry now far exceeds the total number of compounds derived from all the other elements. The total number of known organic compounds is not easily assessed, but it certainly exceeds 1,000,000. In 1880 the number was approximately 12,000; in 1910 it was 150,000; and in 1940 about 500,000.

It is also convenient to distinguish between organic and inorganic compounds because structurally related organic substances usually show very similar properties. A corresponding pattern of information also exists in inorganic chemistry and some of the aspects of behaviour that at one time were considered to be characteristic of organic chemistry are now known to have their counterparts in inorganic chemistry.

B. THE DEVELOPMENT OF THE THEORY OF MOLECULAR STRUCTURE

1. The Early Theories of Chemical Combination.—The establishment of chemistry as a science has been achieved through the recognition and experimental verification of the following concepts: (1) the conservation of matter in most chemical reactions; (2) the existence of chemical elements; (3) the derivation of compounds from elements and the interpretation of this process at a molecular and atomic level; (4) the existence of stable molecules and ions and the relationship between their stability and atomic constituents; (5) the nature of the chemical bond and valency; and (6) the arrangement in space of the atoms in molecules and in ions. The evolution of these concepts was directly related to the experimental approach, which required: (1) the study of reactions between substances; (2) the characterization of pure elements and compounds; (3) the determination of the composition of compounds by qualitative and quantitative analytical processes; and (4) the recognition of mass relationships between atoms and molecules by the precise determination of their atomic and molecular weights. By these processes it was possible to determine the type and number of atoms in molecules. The next step was to find a system of chemical notation. This nomenclature had to be acceptable for the description not only of molecular composition but also of chemical reactions. It will be appreciated that many chemists contributed to the solution of this problem, but the system of chemical notation that came to be generally adopted owes much to Berzelius.

Organic chemistry provided an important contribution to the development of chemical nomenclature and related structural theory. Lavoisier (1743–94), who emphasized the importance of the quantitative aspect of experimentation, showed that oxidative combustion of organic substances yielded carbon dioxide and water. In principle, Lavoisier's experiment could have established the composition of the organic substances that he investigated, but in fact they were impure; the ethyl alcohol that he isolated by distillation of wine certainly contained some water. Furthermore, the compositions of water and carbon dioxide were not known when these experiments were being carried out. However, in spite of the fact that Lavoisier's results were quantitatively in error, they were nevertheless extremely important in showing that organic substances were usually derived from carbon and hydrogen. The presence of other elements became clear from more accurate experimental study.

Louis Jacques Thénard and Gay-Lussac (1811) conducted some remarkably accurate investigations of the elementary composition of organic substances. If the primitive nature of the equipment that they used is taken into consideration, their approach must be ranked as a model of accurate experimentation. By examining a variety of organic compounds they were able to show a surprising relationship between oxygen content and the physical properties of substances of plant origin. Substances containing a high proportion of oxygen were often acidic whereas those containing a lower proportion of oxygen were frequently oily, resinous or alcohollike in behaviour. Some substances such as sugars, plant gums and starch were shown to contain hydrogen and oxygen in the same relative proportions as water. They were regarded as "hydrated carbon" and for this reason were later called carbohydrates.

At this time Berzelius was conducting his classical investigations of the composition of chemical substances by quantitative analytical methods. He was able to provide experimental verification (1818) of the laws of constant and multiple proportions, which Dalton (1766–1844) had deduced theoretically from his atomic theory. These studies at the beginning of the 19th century by Berzelius also included the analytical investigation of the composition of many organic compounds. He showed that many of these substances contained carbon, hydrogen, oxygen and nitrogen and in this respect corresponded with inorganic substances, but he was quite unable to produce evidence to support the "vital force" component of organic molecules; in spite of this, however, he still believed in its existence.

It is obvious that Wöhler was excited by the prospect of structural investigation of organic substances but it was not immediately clear to him how (using the language of modern organic chemistry) the arrangement of atoms in molecules might be established. Wöhler in a letter to Berzelius in 1835 said, "Organic chemistry just now is enough to drive one mad. It gives one an impression of a primeval tropical forest, full of the most remarkable things, a monstrous and boundless thicket, with no way of escape, into which one may well dread to enter."

2. The Radical Theory of Structure (Wöhler and Liebig).—At about this time (1820) the concept of radicals was beginning to be recognized, although this approach did not immediately find general favour among chemists and about 20 years elapsed before it was generally accepted. Lavoisier may be credited with the idea that certain types of compound were associated with particular types of radical and he published a list of radicals associated with acidic properties. In 1815 Gay-Lussac isolated cyanogen, which he believed to be the radical CN, corresponding to hydrogen cyanide, HCN. (It is now known that cyanogen is C_2N_2.) Berzelius called attention to the similarity between ammonium salts and alkali metal salts and interpreted this in terms of an ammonium radical. The relation of this proposal to the modern interpretation involving, for example, the ammonium cation, NH_4^+, and the sodium ion, Na^+, emphasizes the remarkable insight that Berzelius showed when considering these matters.

The next step forward was a consequence of the discovery of analytical methods by Liebig for the determination of carbon and hydrogen (1831), and by Jean Baptiste André Dumas for the direct determination of nitrogen (1833) (see *Analytical Chemistry* below). These methods provided precise information regarding the carbon, hydrogen and nitrogen content of organic molecules, and, when other elements were shown to be absent, the oxygen content could be determined by difference.

The determination of the elemental composition, coupled with early studies of organic chemical reactions, led to a resurgence of interest in the radical theory of structure and in 1832 Wöhler and Liebig published their important paper on "the radical of benzoic acid." Because of the misunderstanding that existed at that time about atomic weights, they deduced that the benzoyl radical contained 14 carbon atoms, 10 hydrogen atoms and 2 oxygen atoms. Their view may now be reinterpreted in terms of the correct atomic weights and the benzoyl radical becomes C_7H_5O or, more specifically, C_6H_5CO. In organic chemistry, C_6H_5 is often written as Ph, and the benzoyl radical may be written PhCO.

It should be mentioned that this group is no longer referred to as a benzoyl radical in organic chemistry because the term radical is reserved for free radicals (*q.v.*). It is called a benzoyl group. Wöhler and Liebig made the suggestion, which now forms one of the foundations of organic chemical theory, that the benzoyl group preserved its identity in a large number of reactions shown by derivatives of benzoic acid. If their proposals are interpreted in terms of current knowledge, the following molecular formulas may be given to these compounds:

Benzoic acid	$C_6H_5CO\cdot OH$	Benzoyl chloride	$C_6H_5CO\cdot Cl$
Benzaldehyde	$C_6H_5CO\cdot H$	Benzamide	$C_6H_5CO\cdot NH_2$
Benzoic anhydride	$C_6H_5CO\cdot O\cdot CO\cdot C_6H_5$		

Benzoyl chloride reacts with ammonia to give benzamide

$$C_6H_6CO\cdot Cl + 2NH_3 \rightarrow C_6H_5CO\cdot NH_2 + NH_4Cl$$

This involves the replacement of the chlorine atom (Cl) in benzoyl chloride by an amino group (NH_2). Inspection of this reaction shows the importance of the proposals made by Wöhler and Liebig. The benzoyl group was unchanged while the group to which it was attached was replaced by another.

A pattern was beginning to emerge that correlated the chemical behaviour of organic compounds. Organic chemists were also encouraged to make predictions of the way in which "radicals" would participate in chemical reactions. These predictions could be subjected to experimental scrutiny and it was this situation that stimulated considerable research. Several years after the first proposal was made regarding the nature of the benzoyl radical, Liebig (1834) published a memoir that became a point of departure toward the discovery of a modern organic structural theory and knowledge.

It is interesting to note that during 1837–43 Robert Wilhelm Bunsen carried out an elaborate investigation of various organoarsenic compounds as part of a study of the radical theory. This led to the recognition of the cacodyl radical, $(CH_3)_2As$—, which corresponds in some ways to the benzoyl radical PhCO—. It may be noted that this was the first investigation of organometallic compounds and it is only since about 1930 that there has been a tremendous renewal of interest in the chemistry of organometallic compounds—a field of research that lies on the border between inorganic and organic chemistry.

3. The Theory of Chemical Type and the Overthrow of the Electro-Dualistic Theory.—The revival and elaboration of the radical theory of structure was mainly because of Dumas, Auguste Laurent and Charles Frédéric Gerhardt. This development led eventually to the theory of chemical types (Dumas, 1840), which is best illustrated by an example. The hydroxyl (OH) group in benzoic acid ($C_6H_5CO{\cdot}OH$) may by suitable chemical reactions be replaced by various other groups as shown in the following compounds:

$C_6H_5CO\cdot Cl$	$C_6H_5CO\cdot Br$	$C_6H_5CO\cdot NH_2$
Benzoyl chloride	Benzoyl bromide	Benzamide

These compounds may be represented by the general formula $C_6H_5CO{\cdot}X$ where $X = Cl$, Br and NH_2 respectively. All three can be made to react with water to give benzoic acid as one of the products, and the three reactions are of exactly the same type. They may be represented by a single equation:

$$C_6H_5CO\cdot X + H_2O \rightarrow C_6H_5CO\cdot OH + HX$$

Dumas also detected what he called "the persistence of chemical type" in a large number of other compounds. This is illustrated by the following chlorine derivatives of acetaldehyde.

	Type Formula	Molecular Formula
Acetaldehyde	CH_3CHO	C_2H_4O
Monochloroacetaldehyde	$ClCH_2CHO$	C_2H_3OCl
Dichloroacetaldehyde	Cl_2CHCHO	$C_2H_2OCl_2$
Trichloroacetaldehyde	Cl_3CCHO	C_2HOCl_3

Comparison of the molecular formula of these four compounds showed that it was possible to replace only three of the four hydrogen atoms in acetaldehyde, indicating that one of the hydrogen atoms was unlike the other three. Dumas also noticed a preservation of the CO group in the members of this series and he associated the unique hydrogen atom with the CO group, as shown in the type formulas.

At this stage further development of organic structural theory was impossible because of an apparent conflict with the electro-dualistic theory of chemical combination proposed by Berzelius (1814). This conflict resulted from a more detailed consideration of the chemical properties of the chlorine derivatives of acetaldehyde listed above. Dumas argued that although comparison of the molecular formulas C_2H_4O, C_2H_3OCl, $C_2H_2OCl_2$ and C_2HOCl_3 suggested that the chlorine atoms were replacing the hydrogen atoms, they could not in fact be occupying the same position in the molecules. This conclusion, based on Dumas' belief that electropositive hydrogen could not be replaced by highly electronegative chlorine without causing a considerable alteration in the chemical behaviour of the substances, led directly from the electro-dualistic theory of chemical combination suggested by Davy in 1807. This theory involved the doctrine that some atoms (and radicals that behave like atoms in the preservation of their identity) are either positively or negatively electrically charged and Berzelius developed this by saying that only bodies of opposite electrical charge could exist in stable combination.

Laurent, however, was not concerned about the difficulty of reconciling the electro-dualistic theory with the consequences of an organic reaction involving the direct replacement of one atom by another. He regarded these organic substitution reactions as mechanical displacement processes and although initially Dumas accused Laurent of allowing his intuition to carry him beyond experimental fact, he was later persuaded by the accumulating experimental evidence that Laurent was right: Dumas abandoned the Davy-Berzelius theory and became an ardent supporter of Laurent's theories.

Meanwhile Gerhardt was able to effect a synthesis of the substitution (Dumas-Laurent) theory and the chemical type (Dumas) theory. This was a direct consequence of the possibility of determining the molecular formulas of organic compounds using the hypotheses of Avogadro and André Marie Ampère.

Gerhardt regarded organic compounds as being derived structurally from either hydrogen (H—H), halogen acids (H—X), water (H—O—H) or ammonia (H—NH_2); his approach is illustrated by the following compounds, whose structures are depicted according to the "rational" chemical formulas suggested by Gerhardt to represent chemical compounds.

Derivatives of H—H		Derivatives of H—O—H	
Ethane	C_2H_5—H	Ethyl alcohol	C_2H_5—O—H
Acetaldehyde	CH_3CO—H	Acetic acid	CH_3CO—O—H
Benzaldehyde	C_6H_5CO—H	Benzoic acid	C_6H_5CO—O—H
Butane	C_2H_5—C_2H_5	Ethyl ether	C_2H_5—O—C_2H_5
Acetone	CH_3CO—CH_3	Methyl acetate	CH_3CO—O—CH_3

Corresponding formulations of ethylamine (C_2H_5—NH_2) as a derivative of ammonia (H—NH_2) and ethyl bromide (C_2H_5—Br) as a derivative of hydrogen bromide (H—Br) are obviously possible.

It was clear that Gerhardt's theory was not applicable to all the evidence available within the scope of organic chemistry and the search for a more satisfactory unifying concept was continued.

It might be thought that the period from 1830 to 1850 was characterized by groping in semidarkness for theoretical interpretations, but nevertheless a considerable body of information was being accumulated by the study of the reactions of organic compounds. This not only directed attention toward the chemical type theory but also showed that some atoms or groups of atoms were equivalent.

4. The Structure of Organic Molecules (Kekulé-Couper).—In 1858 two of the most important contributions to the literature of organic chemistry were published by Kekulé and Couper. Although Couper's paper was the first of the two to be submitted for publication, Kekulé's was the first to appear. From that time Couper's interest in chemistry lapsed and he took no further part in the development of his theories. Kekulé, however, continued to play a dominant role in the growth of his subject and he is now generally regarded as the founder of organic structural theory.

The 1858 papers of Kekulé and Couper may be regarded as two independent but complementary contributions. Couper rejected the type theory of chemical structure and replaced it by a thesis that molecular structure was a consequence of the valency of the component atoms. From this he was able to write structural formulas for organic molecules that indicated the way in which the constituent atoms were bonded together. If allowance is made for the misunderstanding about atomic and molecular weights then current, it is clear that Couper's formulas were much more closely related than Kekulé's to the structural formulas now used by organic chemists. Couper was the first to designate bonds in formulas by dashes.

Kekulé (1858) recognized that Gerhardt's classification was too restricting and showed that it was possible to combine some of the features of the chemical type theory with implications regarding chemical behaviour that were provided by the radical theory. He emphasized that as the behaviour of a compound was dependent upon the conditions of the reaction, it was possible for a compound to belong to more than one type in the Gerhardt classification. He also recognized the fundamental importance of the valency of the atoms in molecules and showed that atoms or groups were either monovalent, divalent, trivalent or tetravalent. Thus carbon, with its valency of four, provided CH_4, which could join NH_3, H_2O and H_2 in the Gerhardt classification.

Kekulé's ideas led eventually to the transformation of Gerhardt's type formulas into the structural formulas that are still widely and successfully used. The significance of the "revolution" in organic structural theory that was promoted by Kekulé is obvious, but at the time he proposed his "rational formulas" he did not regard them as "representing the arrangement of groupings of atoms in existing compounds." Instead he thought of them as "expressions of certain relations in metamorphoses," that is, in chemical reactions. Some years elapsed before these formulas were considered to be structural formulas; in fact Adolf von Baeyer in 1890 said that the Kekulé molecular models were "even cleverer than their inventor." It is interesting to recall that Kekulé started his studies as a student of architecture at the University of Giessen in 1847, and it was there as a result of his contact with Liebig, who was professor of chemistry, that he took an interest in chemistry. He obviously continued to use an architectural approach when considering the structure of molecules.

So, during a period of 15 years, the situation regarding molecular structure was completely transformed and Gerhardt's original opinion that formulas represented the way in which a molecule could react gave place to the concept of representing structures by graphic formulas. The idea of structural formulas still required development in a three-dimensional sense and also interpretation in terms of the electronic theory of atomic structure, but these further advances occurred much later.

Couper's 1858 paper contained analogous ideas about the tetravalency of carbon and the suggestion that chains of carbon atoms could exist in organic molecules. Seven years later Kekulé proposed a constitutional formula for benzene (C_6H_6) that contained a closed chain of six carbon atoms and in 1866 he suggested that the four valency bonds of carbon were tetrahedrally disposed. He made it clear that the tetrahedral model for carbon was not to be taken literally but subsequent developments in organic chemistry showed that this appreciation of the way in which a carbon atom could be joined to other atoms was remarkably close to reality.

5. Optical Activity and the Tetrahedral Carbon Atom.—The theories of Kekulé and Couper did not account for the fact that in some cases more compounds were known than could be expected when two-dimensional graphic formulas were used. In 1848 Pasteur was studying the optical activity of the tartaric acids and showed that there were dextrorotatory, levorotatory and optically inactive forms and he realized that this ability to rotate the plane of polarized light must be associated in some way with molecular structure. It is unquestionably the influence of Pasteur's work that led to the interpretation (van't Hoff and Le Bel, 1874) of optical activity in terms of the tetrahedral disposition of the four valencies around carbon. This provided a satisfactory interpretation of Pasteur's results and a basis for all subsequent development regarding the structure of molecules. Thus it became clear that there was a geometrical aspect associated with chemical binding that had not previously been appreciated (*see* also STEREOCHEMISTRY: *The Stereochemistry of Carbon*).

6. The Strain Theory (Baeyer) and Structure of Cyclic Molecules.—The geometry of organic molecules is a subject that has been investigated from various standpoints since the van't Hoff-Le Bel theory was first proposed. In particular, Baeyer (1885) proposed his famous strain theory, which related the ease of formation and reactivity of cyclic organic compounds to the number of atoms in the ring. This theory implied that five-membered rings with an intervalency angle of 108°, which is close to the tetrahedral angle of 109°28′, would be easily formed, whereas larger or smaller rings would be less stable. The studies by the younger Perkin of the synthesis and properties of small ring compounds coupled with later work on the many-membered (macrocyclic) ring compounds showed that Baeyer's original hypothesis was not entirely correct because he had assumed that cyclic compounds were planar. This difficulty was resolved by H. Sachse (1890) and his theory was considerably elaborated by Ernst Mohr about 30 years (1918) later. The Sachse-Mohr theory suggested that six- and larger-membered rings could have a puckered multiplanar arrangement and it was this idea that formed the basis of the theory of conformational analysis (Derek H. R. Barton, 1950). Conformational analysis (*q.v.*) is concerned with the modern stereochemical treatment of organic structure.

7. Developments Since 1900.—Many of the developments of organic structural theory that followed the Kekulé-Couper proposals were empirically based on information acquired by the study of the synthesis of organic molecules and the determination of their structure by degradation. Much of this work was stimulated by the determination of the structure of natural products, and this marked the beginning of the return of organic chemistry to its original objective—the study of compounds isolated from plants and animals. Outstanding among these were the important studies on alkaloids (the younger Perkin and Sir Robert Robinson), plant colouring matters (Richard Willstätter) and terpenes, amino acids and proteins (Emil Fischer). Work in the natural product chemistry field also includes the later studies of the structures of vitamins, hormones and antibiotics.

At the time of these discoveries, ideas were being developed regarding the electronic theory of chemical bonding, which had a considerable impact on organic chemistry. Organic chemists quickly realized the significance of the progress that was being made concurrently in physics and in physical chemistry. Following the elucidation of the structure of the atom by Rutherford (1911), theories regarding the electronic nature of the chemical bond were proposed (G. N. Lewis, 1916). These ideas were initially applied by Arthur Lapworth to describe chemical reactions as processes involving movement of electrons. This interpretation of the structure and reactions of organic molecules was considerably extended (1920–30) by Robinson and Ingold and eventually formed the basis of theoretical organic chemistry. This rapidly expanding branch of the subject attracted many investigators and it was possible by the 1950s to correlate and interpret in detail the mechanism of many organic reactions.

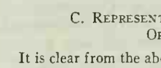
Another major 20th-century development was the application of quantum mechanics (Max Planck, 1900) to the description of the detailed structure of organic molecules. This provided a physical interpretation of covalent bonding and an understanding of the details of valency and stereochemistry. Pauling has reviewed (1938) in *The Nature of the Chemical Bond and the Structure of Molecules and Crystals* his mathematical interpretation of the structure of organic molecules that led to the proposal (1931–33) of the theory of resonance (*q.v.*) and the description of molecular structure by mathematical methods.

Although the early proposals regarding the structure of molecules were empirical, they later received dramatic support by completely independent physical methods. These methods, although of many different types, give results that agree with the three-dimensional structures deduced by using the "classical" methods of degradation and synthesis. The methods of X-ray crystallography and electron diffraction should be particularly mentioned. By X-ray crystallographic examination of crystals of organic substances it is often possible to determine the relative positions of the heavier atoms in the structure; the positions of hydrogen atoms are placed deductively. Electron diffraction by compounds in the vapour state provides similar information, and the confirmation of structures by these various physical techniques is convincing support for the methods and logic of organic chemistry.

C. REPRESENTATION OF THE STRUCTURE OF ORGANIC COMPOUNDS

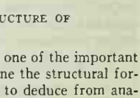
It is clear from the above information that one of the important objectives in organic chemistry is to determine the structural formulas of organic compounds. It is possible to deduce from analytical data an empirical formula that shows the relative number of constituent atoms in a molecule, and then from a knowledge of the molecular weight to deduce the molecular formula of the compound. The molecular formula shows the numbers of each type of atom that are present in the molecule and the elucidation of the structural formula involves the determination of the positions of each of these atoms.

1. Aliphatic Compounds.—The methods used to represent the structure of aliphatic compounds are best illustrated by an example. Carbon and hydrogen analysis shows that a compound has the empirical formula $C_4H_{10}O$, and a vapour density determination corresponds with the molecular formula $C_4H_{10}O$ (calculated molecular weight $= 4 \times 12 + 10 \times 1 + 1 \times 16 = 74$). It is possible to write seven structural formulas corresponding with the molecular formula $C_4H_{10}O$, in which the normal valencies of the constituent atoms (carbon = 4, oxygen = 2, hydrogen = 1) are observed. These formulas are:



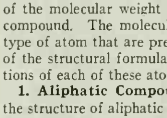
$$\begin{array}{ccccccccccccc} & & H & & H & & H & & H & & & & \\ & & | & & | & & | & & | & & & & \\ H & - & C & - & C & - & C & - & C & - & O & - & H \\ & & | & & | & & | & & | & & & & \\ & & H & & H & & H & & H & & & & \end{array}$$

I

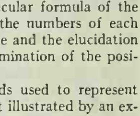


$$\begin{array}{ccccccccccc} & & H & & H & & H & & H & & \\ & & | & & | & & | & & | & & \\ H & - & C & - & C & - & C & - & C & - & H \\ & & | & & | & & | & & | & & \\ & & H & & H & & O & & H & & \\ & & & & & & | & & & & \\ & & & & & & H & & & & \end{array}$$

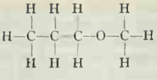
II



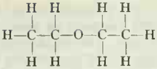
III



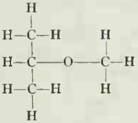
IV



V



VI

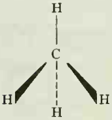


VII

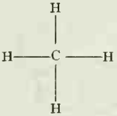
Thus there are seven possible ways of joining together four carbon atoms, ten hydrogen atoms and one oxygen atom when the conditions imposed by the valencies of these atoms are observed. It may be mentioned that, in fact, eight compounds can exist with the molecular formula $C_4H_{10}O$, and the reasons for this will become clear later.

The formulas I–VII are said to represent the structures of isomers, that is, substances with the same molecular formula, $C_4H_{10}O$, but with different structural formulas. These substances display different physical properties and different chemical reactions and it is these facts that permit the allocation of a particular structure to a compound (*see* ISOMERISM: *Assignment of Structures to Isomers*).

It should be emphasized that the formulas I–VII are only approximate, two-dimensional representations of structures that are in fact three-dimensional. This three-dimensional shape of the actual structure of the molecules is a consequence of the tetrahedral disposition of the four valencies around each carbon atom. Thus the molecule methane, CH_4, has a tetrahedral structure in which the intervalency angle between the C—H bonds is 109°28′. There are various ways of representing the three-dimensional structure of methane, but the perspective illustration VIIIa is probably the most easily understood.



VIIIa



VIIIb

In formula VIIIa, the continuous thin line represents a bond in the plane of the paper, the thickened lines represent bonds projecting toward the observer and the dotted line a bond directed away from the observer. It would, however, be very time-consuming always to use a formula such as VIIIa to represent organic structure, so unless it is necessary to emphasize a stereochemical situation a projection formula (VIIIb) is used. It must be realized that VIIIb is just a two-dimensional representation of a molecule that is in fact three-dimensional. Thus planar projection formulas must always be interpreted three-dimensionally.

The projection formulas I–VII are often abbreviated further as indicated in the formulas shown in Table I. Further abbreviation is also indicated in which a methyl (CH_3) group is replaced by the symbol Me, an ethyl (C_2H_5) group by Et, and so on. The valence bonds are indicated by dots.

The methods used for the representation of structural formulas indicated by the examples in Table I may be readily applied to more complex structures (*see* Table II). These examples include olefins, which contain double bonds (C=C); aldehydes and ketones, which contain carbonyl groups (CO); and acetylenes, which contain triple bonds (C≡C).

TABLE I

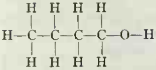
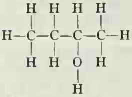
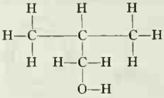
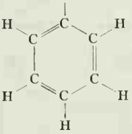
Projection Formula	Abbreviated Projection Formula	
	$CH_3\cdot CH_2\cdot CH_2\cdot CH_2\cdot OH$	$Me\cdot (CH_2)_3\cdot OH$
	$CH_3\cdot CH_2\cdot \underset{\displaystyle OH}{CH}\cdot CH_3$	$Et\cdot CH(OH)\cdot Me$
	$CH_3\cdot \underset{\underset{\displaystyle OH}{\displaystyle CH_2}}{CH}\cdot CH_3$	$Me_2CH\cdot CH_2\cdot OH$

TABLE II

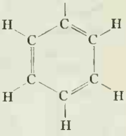
Name	Molecular Formula	Structural Formula
1-Butene	C_4H_8	$CH_3\ CH_2\ CH=CH_2$
2-Butene	C_4H_8	$CH_3\cdot CH=CH\ CH_3$
Allyl alcohol	C_3H_6O	$CH_2=CH-CH_2OH$
Acetaldehyde	C_2H_4O	$CH_3-\underset{\displaystyle H}{C}=O$
Acetic acid	$C_2H_4O_2$	$CH_3-\underset{\displaystyle OH}{C}=O$
Acetone	C_3H_6O	$CH_3-\underset{\displaystyle O}{\overset{}{C}}-CH_3$
Acetylene	C_2H_2	$HC\equiv CH$
1-Butyne	C_4H_6	$CH_3\cdot CH_2\cdot C\equiv CH$
2-Butyne	C_4H_6	$CH_3\cdot C\equiv C\cdot CH_3$

2. Aromatic Compounds.—The examples given in Tables I and II illustrate the structural formulas that may be drawn for aliphatic compounds. Structural formulas can also be written for aromatic compounds, which are most easily defined as derivatives of benzene. The problem presented by the structure of benzene is made clear if the structure of this molecule is considered.

Kekulé (1865) suggested that benzene (C_6H_6) had a structural formula that oscillated between the structures IXa and IXb, but this suggestion, which involves a dynamic equilibrium between structures IXa and IXb, is not now considered correct. A more accurate description of the structure of benzene is given by the application of the theories of resonance (Pauling) or mesomerism (Ingold).



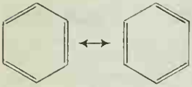
IXa

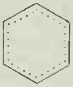


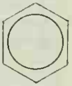
IXb

Ingold's view was that benzene had a mesomeric structure (mesomer = "between state") intermediate between IXa and IXb. This idea, which was developed intuitively, was given a mathematical treatment by Pauling (1933), who showed that benzene had a resonance hybrid structure to which IXa and IXb were the major contributors; IXa and IXb are called contributing structures or canonical forms. Similar views regarding the structure of aromatic compounds were proposed by Robinson and were extended by him to include other organic compounds.

It would clearly be time-consuming to have to write a detailed structure (*e.g.*, IXa) for benzene, so neater methods of representation are usually employed. The resonance hybrid structure for benzene is represented by the X, and it is customary to select either one or the other of the Kekulé structures shown in X to represent benzene. Although these structures contain indicated double bonds, it is not implied that there is any degree of double-bond fixation in the structure. The use of a Kekulé structure to represent benzene is just a convenient symbol summarizing the situation shown in X.

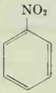

X


XI

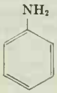

XII

Because of the equivalence of the six carbon-carbon bonds in benzene, the suggestion has been made from time to time that the representation of benzene by a Kekulé structure is somewhat misleading. This is not true if the condition cited above is observed, but it is, nevertheless, the reason why alternative forms of representation for benzene have been proposed. These have included formula XI, which is a type of structural formula very similar to the formula proposed by Johannes Thiele for benzene in his theory of partial valencies (1899). The dotted line in XI represents partial bonding. The relationship of XI to the mathematical description of the structure of benzene using the molecular orbital theory is very close. The molecular orbital theory may be briefly (and somewhat inaccurately) described as follows. In benzene there are six normal covalent C—C bonds and six normal covalent C—H bonds. Of the valence electrons supplied by the constituent atoms this leaves six valence electrons that are not involved in normal covalent bonding. These are called π electrons and it may be shown that six π electrons when associated with atoms in a cyclic system form a particularly stable electronic situation. This arrangement of six π electrons is responsible for aromatic stability and the association of six π electrons with aromatic stability was first recognized and elaborated by Robinson. Some chemists have suggested that this view of the structure of benzene is satisfactorily indicated by XII where the full circle represents six π electrons. A Kekulé-type formula for benzene is still often used.

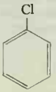
For monosubstituted benzenes it is customary to indicate only the substituents and not the hydrogen atoms attached to the aromatic nucleus. Typical formulas of various benzene derivatives are given below.



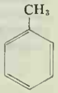
Nitrobenzene



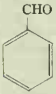
Aniline



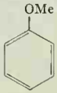
Chlorobenzene



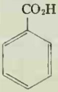
Toluene



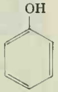
Benzaldehyde



Anisole

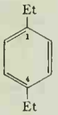


Benzoic acid

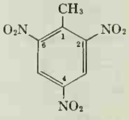


Phenol

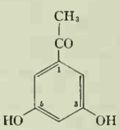
For polysubstituted benzenes it is necessary to indicate the relative positions of substituents by numbering the nuclear carbon atoms. One of the substituents is conventionally placed in position 1 and by selecting the appropriate numbers the positions of other substituents are determined. Examples of this method of naming compounds are shown below.



1,4-Diethylbenzene

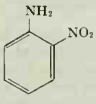


2,4,6-Trinitrotoluene

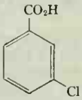


3,5-Dihydroxyacetophenone

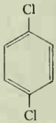
For disubstituted benzenes it should be noted that *o-* (*ortho*), *m-* (*meta*) and *p-* (*para*) may be used in place of 1,2-, 1,3- and 1,4- respectively.



2-nitroaniline
or
o-nitroaniline

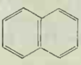


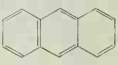
3-chlorobenzoic acid
or
m-chlorobenzoic acid

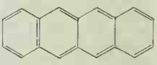


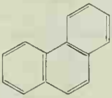
1,4-dichlorobenzene
or
p-dichlorobenzene

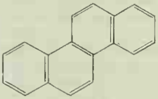
Large numbers of polycyclic compounds have been synthesized and the structural formulas of some of the better-known hydrocarbons are given below.

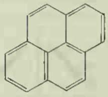

Naphthalene


Anthracene


Naphthacene


Phenanthrene


Chrysene


Pyrene

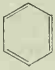
The names of many of these polycyclic hydrocarbons have not been determined by the nomenclature rules of organic chemistry. Derivatives of these more complex molecules are given names chosen according to rules that correspond to the rules for naming benzene derivatives.

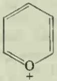
3. Heterocyclic Compounds.—This is a vast field and it can only be surveyed rather superficially here. It will be clear from a valence standpoint that the following groups are equivalent

$$>CH_2 \equiv >O \equiv >NH \equiv >S$$

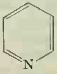
$$\geqslant CH \equiv N \equiv \geqslant O^+$$

It is therefore possible in principle to replace $> CH_2$ or $\geqslant CH$ in a cyclic hydrocarbon structure with their structurally equivalent groups and so produce structures that have been shown to be those of the following heterocyclic compounds.

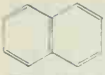

Benzene

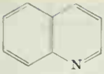


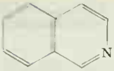
Pyrylium

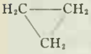


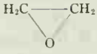
Pyridine

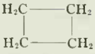

Naphthalene

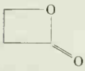

Quinoline

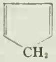

Isoquinoline

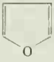

Cyclopropane

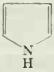

Ethylene oxide

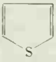

Cyclobutane

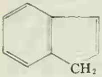

β-Propiolactone

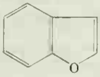

Cyclopentadiene

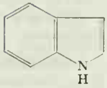

Furan


Pyrrole

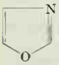

Thiophene

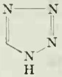

Indene

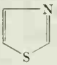

Benzfuran

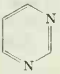

Indole

Heterocyclic compounds can also have more than one heteroatom, as shown below


Oxazole

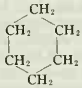

Tetrazole

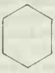

Thiazole


Pyrimidine

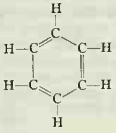
4. Representation of Complex Structures.—As has already been indicated, it is often customary not to indicate hydrogen atoms in organic structural formulas but it follows that it is imperative to indicate unsaturation as, for example, in C=C bonds. In the past there has been a tendency to represent benzene and cyclohexane by regular hexagons but it is important to differentiate between them by using appropriate structures, as in XIII and XIV.

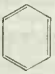
Cyclohexane (C_6H_{12})



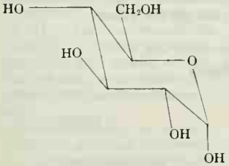

XIII

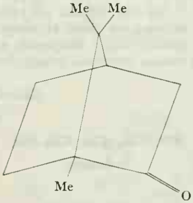
Benzene (C_6H_6)




XIV

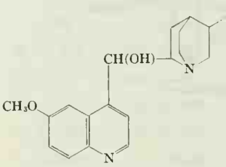
It is often customary not to designate carbon atoms by C in complicated organic structures. In many cases projection formulas do not show the detailed arrangements of the atoms in the molecules and in these cases formulas are used to indicate their three-dimensional structure. These formulas are sometimes called stereo formulas, and examples of these are provided by the structural formulas of glucose and camphor (XV and XVI).

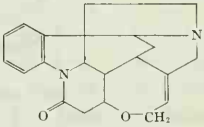

α-D-Glucopyranose
XV

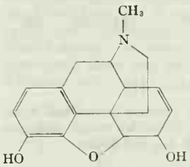

Camphor
XVI

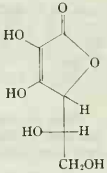
Natural products are often characterized by quite complex arrangements of their component atoms and many of the triumphs of 20th-century organic chemistry have been concerned with their structural elucidation. A selection of illustrative examples is given and includes alkaloids (quinine, strychnine and morphine), vitamins (vitamin C and vitamin E), plant-colouring matters (chlorophyll *a*), hormones (cortisone), antibiotics (penicillin and oxytetracycline) and the important coenzyme adenosine triphosphate.

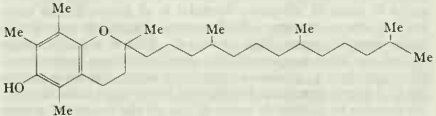
Even a cursory inspection of these structural formulas shows the complexity of molecular structure that can now be unraveled. In all the cases quoted above the substances were first obtained as natural products and were then, with the exception of oxytetracycline, synthesized in the laboratory.

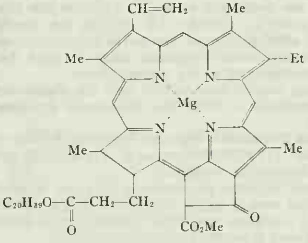

Quinine

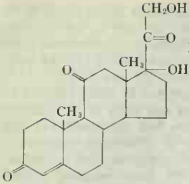

Strychnine

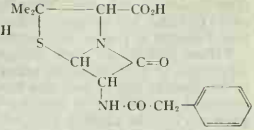

Morphine

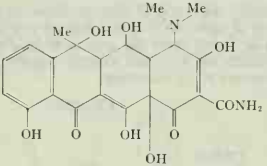

Vitamin C
(L-ascorbic acid)

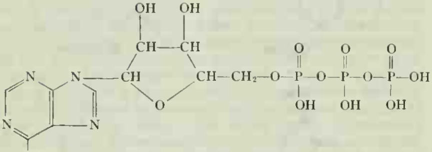

Vitamin E


Chlorophyll *a*


Cortisone


Penicillin


Oxytetracycline


Adenosine triphosphate (ATP)

These structures are not the most complex known and recent examples of highly complex organic molecules whose structures have been determined include vitamin B_{12} and insulin.

D. Classification of Organic Compounds

The variety of structures reviewed above indicates that any classification of the 1,000,000 or so known organic compounds will have to be somewhat arbitrary. Clearly any separation into categories in terms of molecular formulas is of practically no value and it is now customary to divide organic compounds into various types depending upon their structure. This is a fairly simple process for those compounds that contain only one or two functional groups (*e.g.*, alcohols or carboxylic acids), but when a number of different functional groups exist in the same molecule then the decision to classify in terms of one of the functional groups has to be made.

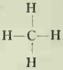
This problem of classification is also made extremely complicated by the tremendous variety of structures that exists among natural products. Consider, for example, the classification of alkaloids; although many of them can be placed in various families of structurally related compounds, there are some that are not easily accommodated in any general scheme.

It is not possible here to deal with the classification of organic compounds in detail, but the broader principles will be indicated.

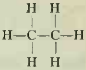
1. Main Divisions.—There are three main divisions of organic compounds: (1) aliphatic compounds; (2) aromatic compounds; and (3) heterocyclic compounds.

The term aliphatic was originally proposed to describe substances that were of a fatty nature, but later it was shown that many such substances were in fact derived from the alkanes, which are also known as paraffin hydrocarbons (*q.v.*).

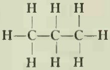
The alkanes form a homologous series with the general formula C_nH_{2n+2} and the lower members of this series have the following names and structural formulas.

Methane (CH_4)


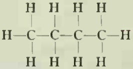
$$\begin{array}{ccc} & H & \\ & | & \\ H- & C & -H \\ & | & \\ & H & \end{array}$$

Ethane (C_2H_6)


$$\begin{array}{cccc} & H & H & \\ & | & | & \\ H- & C- & C & -H \\ & | & | & \\ & H & H & \end{array}$$

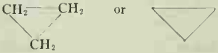
Propane (C_3H_8)


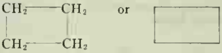
$$\begin{array}{ccccc} & H & H & H & \\ & | & | & | & \\ H- & C- & C- & C & -H \\ & | & | & | & \\ & H & H & H & \end{array}$$

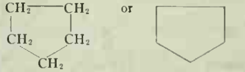
n-Butane (C_4H_{10})


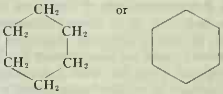
$$\begin{array}{cccccc} & H & H & H & H & \\ & | & | & | & | & \\ H- & C- & C- & C- & C & -H \\ & | & | & | & | & \\ & H & H & H & H & \end{array}$$

There is a corresponding series of alicyclic compounds, the cycloalkanes.

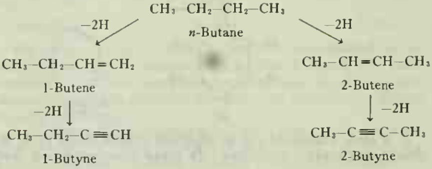
Cyclopropane (C_3H_6)


Cyclobutane (C_4H_8)


Cyclopentane (C_5H_{10})


Cyclohexane (C_6H_{12})


Aliphatic compounds may be regarded as derivatives of these compounds; the processes involved are either removal of hydrogen, leading to unsaturated compounds, or the replacement of hydrogen atoms by various functional groups. The first process is illustrated by the formation of the hydrocarbons derived from *n*-butane (the prefix *n* is an abbreviation for normal, meaning that the carbon atoms are in a straight chain).



The two butenes are called alkenes or olefins (*q.v.*) and the butynes are called alkynes or acetylenes. It is also possible to consider other compounds as derivatives by the introduction of various functional groups; for example, in *n*-butane.

$CH_3-CH_2-CH_2-CH_3$

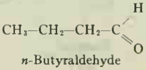
n-Butane

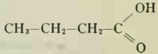
$CH_3-CH_2-CH_2-CH_2-OH$

n-Butanol

$CH_3-CH_2-CH(OH)-CH_3$

iso-Butanol


n-Butyraldehyde


n-Butyric acid

$CH_3{-}CH_2{-}CO{-}CH_3$

Ethylmethyl ketone

$CH_3{-}CH_2{-}O{-}CH_3$

Ethylmethyl ether

$HO{-}\overset{\beta}{C}H_2{-}\overset{\alpha}{C}H_2{-}CO{-}CH_3$

(β-Hydroxyethyl)-methyl ketone

$HO_2C{-}CH_2{-}CH_2{-}CO_2H$

Succinic acid

$CH_3{-}CH_2{-}NH{-}CH_3$

Ethylmethylamine

$CH_3{-}CH_2{-}CH_2{-}CH_2{-}Br$

n-Butyl bromide

These derivatives of *n*-butane can be related to other compounds that contain the same functional groups. The alcohols, for example, form a homologous series that is analogous to the homologous series formed by the alkanes; *n*-butanol is a member of the series that includes methanol ($CH_3{\cdot}OH$), ethanol ($CH_3{\cdot}CH_2{\cdot}OH$), *n*-propanol ($CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}OH$), *n*-butanol ($CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}OH$), *n*-pentanol ($CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}OH$) and so on. The aldehydes also form a homologous series: formaldehyde ($H{\cdot}CHO$), acetaldehyde ($CH_3{\cdot}CHO$), propionaldehyde ($CH_3{\cdot}CH_2{\cdot}CHO$), *n*-butyraldehyde ($CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CHO$), etc.

It will be clear that more than one functional group may be present in a molecule as in (β-hydroxyethyl)-methyl ketone, where there are alcoholic (OH) and ketonic (C=O) functional groups. Succinic acid contains two carboxyl (CO_2H) groups.

From these considerations it follows that many compounds in the aliphatic group can be classified into various families or types. The more important classes with their type formula are listed below. The general representation of an alkyl group such as methyl or ethyl is R.

Hydrocarbons	$R{\cdot}H$
Alcohols	$R{\cdot}OH$
Esters	$R{\cdot}CO_2R'$
Ethers	$R{\cdot}O{\cdot}R'$
Aldehydes	$R{\cdot}CHO$
Ketones	$R{\cdot}CO{\cdot}R'$
Carboxylic acids	$R{\cdot}CO_2H$; Acid chloride $R{\cdot}CO{\cdot}Cl$; [Acid] Amide $R{\cdot}CO{\cdot}NH_2$
Amines	$R{\cdot}NH_2$, R_2NH, R_3N
Alkyl halides	$R{\cdot}X$ (X = Cl, Br, I, F)

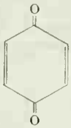
The term aromatic, which has been discussed above in *Aromatic Compounds*, is usually used to describe derivatives of benzene or polynuclear aromatic hydrocarbons such as naphthalene, anthracene, phenanthrene, etc. The more important types of aromatic compounds are listed below; the indicated functional group is attached directly to the benzene ring or aromatic system.

Nitro compounds ($-NO_2$)
Sulfonic acids ($-SO_3H$)
Aromatic amines ($-NH_2$)
Phenols ($-OH$)
Aromatic aldehydes ($-CHO$)
Aromatic ketones ($-COR$)
Aromatic carboxylic acids ($-CO_2H$)
Aromatic halides ($-F, -Cl, -Br, -I$)

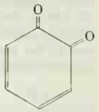
It is also customary to regard quinones as aromatic compounds. There are two types of quinone, represented by *p*-benzoquinone (XVII) and *o*-benzoquinone (XVIII). Quinones are characterized by their striking colours: for example, *p*-benzoquinone is yellow and *o*-benzoquinone is red.

The derivation of heterocyclic structures and their relationship to alicyclic or aromatic structures are discussed under *Heterocyclic Compounds* above.

2. Classification by Functional Groups.—The classification of aliphatic and aromatic compounds is mainly based upon the functional groups that are present, but in some cases there are considerable differences in the reactions shown by aliphatic and aromatic compounds containing the same functional group. This is particularly striking in the case of substances that contain the hydroxyl (OH) group; alcohols and phenols show important differences in many of their reactions. There are also important differences in the chemical behaviour of primary aliphatic and aromatic amines.

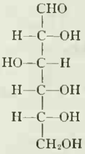


XVII

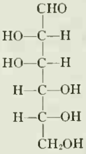


XVIII

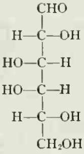
3. Natural Product Types.—Some classes of natural products such as carbohydrates, terpenes, steroids, fats, waxes, amino acids and proteins show a remarkable similarity of structure between the members of each class. This is illustrated by the structures of some representatives of carbohydrates.



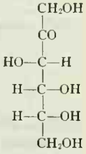
D-Glucose



D-Mannose

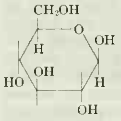


D-Galactose

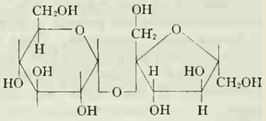


D-Fructose

Carbohydrates.—These sugars have been represented by open-chain structures, but in many natural products they exist in a cyclic form. Comparison of the cyclic structure of D-glucose with that of sucrose (the name usually used by organic chemists for cane sugar) shows their relation. Sucrose contains a glucose and a fructose unit.

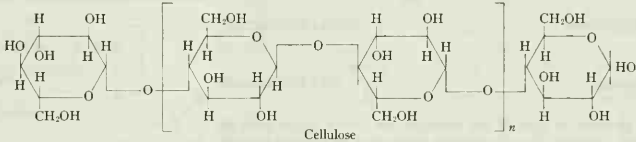


D-Glucose

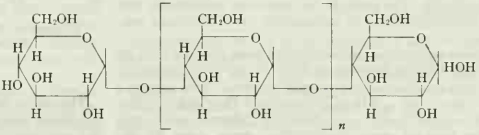


Sucrose

D-glucose is called a monosaccharide and sucrose, since it contains two sugar residues, is called a disaccharide. Their relation to two well-known and important polysaccharides, starch and cellulose, is shown by the following structural formulas. The glucose unit is repeated many times in both starch and cellulose.

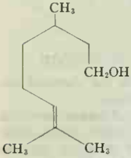


Cellulose

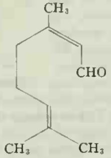


Starch (simplified structure)

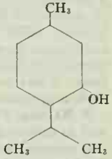
The structural formulas of carbohydrates show a remarkable variety of structure, but there is nevertheless a degree of similarity among them that makes it very desirable to classify them in one class. The study of this relationship between the structures of the sugars was initiated by Emil Fischer and is one of the high lights of scientific research. Carbohydrate chemistry now forms one of the more important branches of organic chemistry (*see* CARBOHYDRATES).



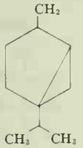
Citronellol



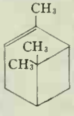
Citral



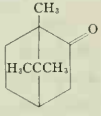
Menthol



Sabinene



α-Pinene

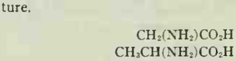
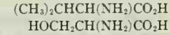
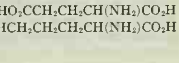


Camphor

Terpenes.—It will be noticed that all these compounds contain identical C_{10} skeletons that are folded in various ways. The close relationship between their structures is a good reason for placing them in the same group. They are called monoterpenes.

Similar structural features can be detected in the higher terpenes, which include the sesquiterpenes (C_{15} skeleton), diterpenes (C_{20} skeleton), triterpenes (C_{30} skeleton) and tetraterpenes (C_{40} skeleton).

α-Amino Acids and Proteins.—The classical investigations by Fischer established that proteins on acid hydrolysis give mixtures of closely related substances. These are called α-amino acids (the α symbol is used to show that the —NH_2 group is attached to the carbon atom adjacent to the —CO_2H group) and they show a remarkable variety of structure.

Glycine	$CH_2(NH_2)CO_2H$
Alanine	$CH_3CH(NH_2)CO_2H$
Valine	$(CH_3)_2CHCH(NH_2)CO_2H$
Serine	$HOCH_2CH(NH_2)CO_2H$
Cysteine	$HSCH_2CH(NH_2)CO_2H$
Glutamic acid	$HO_2CCH_2CH_2CH(NH_2)CO_2H$
Arginine	 $H_2N\underset{\underset{NH}{\Vert}}{C}NHCH_2CH_2CH_2CH(NH_2)CO_2H$
Phenylalanine	
Histidine	

However, in spite of this variation, the natural amino acids do have a common type of structure represented by the type formula $RCH(NH_2)CO_2H$. The group R may represent an aliphatic, aromatic (as in phenylalanine) or heterocyclic (as in histidine) residue.

The proteins are macromolecules derived from α-amino acids by a process equivalent to dehydration between the —NH_2 group of one amino acid and the —CO_2H group of another. This leads to a structure of the type . . . NH—CHR′—CO—NH—CHR″—CO—NH—CHR″—CHR‴—CO . . . in which different amino acid residues are repeated many times. Thus, from about 20 different amino acids, the colossal array of different proteins required by different forms of life is constructed.

The determination of the sequence of amino acids in proteins has represented a major challenge to the ingenuity and technical skill of organic chemists since the polypeptide nature of proteins was first recognized. Tremendous progress was made in this field during 1955–60; the complete structure of insulin was elucidated and considerable progress made toward the determination of the complete structure of other important hormones such as the corticotrophins and enzymes such as ribonuclease.

Vitamins.—There is a close relationship between the representatives of terpenes, carbohydrates and amino acids, and it is therefore logical to classify them together. This is not true of all natural products; for example, the vitamins are classified together because they have the same type of activity. Vitamins are essential constituents of food and their absence from animal diet causes disease. For example, lack of vitamin C causes scurvy.

Since the vitamins exist in natural substances in very low concentration, their isolation and identification of structure presented a formidable task. The structure of vitamin C was the first to be determined (1933) and since that time many others have been characterized. As might be expected, the vitamins show a wide variety of structure. (*See* VITAMINS.)

Antibiotics.—Like the vitamins, there is very little similarity between the structures of the many known antibiotics. (*See* ANTIBIOTICS.)

E. REACTIONS OF ORGANIC COMPOUNDS

This subject may be considered from two points of view: (1) the reactions of particular functional groups and the way in which these reactions are modified by interaction between the groups when they are present in the same molecule, and (2) the interpretation of reactions of organic compounds in terms of reaction mechanism.

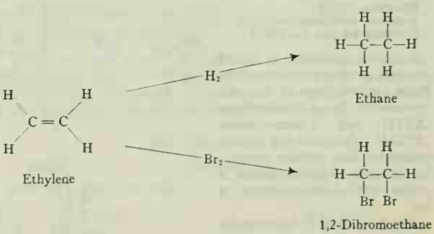
1. Functional Group Chemistry.—Although the aliphatic hydrocarbons (alkanes) are usually considered to have no functional groups, it is customary to begin discussions of organic functional group chemistry with a discussion of the alkanes.

Hydrocarbons.—The alkanes, which contain only carbon and hydrogen atoms, have the general formula C_nH_{2n+2}, in which all the valencies of the constituent atoms are satisfied. The characteristic reactions are therefore substitution reactions in which hydrogen atoms are replaced by other atoms or groups.

A typical substitution reaction of alkanes is the reaction with chlorine to give alkyl chlorides. Further replacement of hydrogen by chlorine leads to polychloro derivatives. The products obtained by the light-induced chlorination of methane are given below.

$$CH_4 \xrightarrow[\text{light}]{Cl_2} \underset{\substack{\text{Methyl}\\\text{chloride}}}{CH_3Cl} + \underset{\substack{\text{Methylene}\\\text{chloride}}}{CH_2Cl_2} + \underset{\text{Chloroform}}{CHCl_3} + \underset{\substack{\text{Carbon}\\\text{tetrachloride}}}{CCl_4}$$

Aliphatic hydrocarbons undergo a substitution reaction by treatment with nitric acid vapour ($RH \rightarrow RNO_2$) at high temperatures.



The olefins (alkenes) contain a carbon-carbon double bond as a functional group and this results in addition rather than substitution reactions. Thus ethylene may be catalytically hydrogenated to ethane and it can be made to undergo an addition reaction with bromine, giving 1,2-dibromoethane.

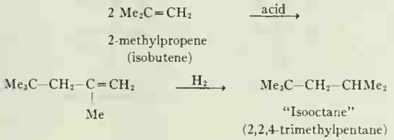
The transformation of alkanes into alkenes is a very important industrial process because alkenes show a much greater number of reactions as a consequence of their carbon-carbon double bond. Alkenes are extremely versatile in their reactions and may be used as starting materials in a large number of industrial processes. The cracking of saturated hydrocarbons is achieved thermally, often with catalysts. The pyrolysis products from the simpler hydrocarbons illustrate the various products that are obtainable.

$$\mathrm{CH_3{-}CH_3} \longrightarrow \mathrm{CH_2{=}CH_2 + H_2}$$

$$\mathrm{CH_3{-}CH_2{-}CH_3} \longrightarrow \left\{\begin{array}{l}\mathrm{CH_3{-}CH{=}CH_2 + H_2}\\ \mathrm{CH_2{=}CH_2 + CH_4}\end{array}\right.$$

$$\mathrm{CH_3{-}CH_2{-}CH_2{-}CH_3} \longrightarrow \left\{\begin{array}{l}\mathrm{CH_3{-}CH_2{-}CH{=}CH_2\ +}\\ \quad\mathrm{CH_3{-}CH{=}CH{-}CH_3 + H_2}\\ \mathrm{CH_3{-}CH{=}CH_2 + CH_4}\\ \mathrm{CH_2{=}CH_2 + C_2H_6}\end{array}\right.$$

"Isooctane" (2,2,4-trimethylpentane) is an important constituent of high-quality gasoline; its industrial synthesis from 2-methylpropene (isobutene), a product from the cracking process, illustrates the acid-catalyzed dimerization (combining of two molecules) of alkenes, which is one of their characteristic reactions. (*See* GASOLINE.)



$$2\ \mathrm{Me_2C{=}CH_2} \xrightarrow{\text{acid}}$$

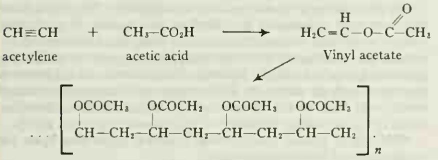
2-methylpropene
(isobutene)

$$\mathrm{Me_3C{-}CH_2{-}\underset{\displaystyle Me}{\underset{|}{C}}{=}CH_2} \xrightarrow{\mathrm{H_2}} \mathrm{Me_3C{-}CH_2{-}CHMe_2}$$

"Isooctane"
(2,2,4-trimethylpentane)

Hydration of ethylene ($C_2H_4 + H_2O \rightarrow C_2H_5OH$) is acid-catalyzed and is one of the methods used in industry to prepare ethanol.

Acetylene ($H{-}C{\equiv}C{-}H$) contains a triple bond. It shows many reactions characteristic of this type of unsaturation and such reactions are used widely for the industrial synthesis of a large range of compounds. Hydration of acetylene to acetaldehyde ($C_2H_2 + H_2O \rightarrow CH_3CHO$) is easily achieved with dilute sulfuric acid and mercuric sulfate as catalysts. The acetaldehyde so produced is used in vast quantities for the industrial preparation of acetic acid. The addition reaction between acetic acid and acetylene gives vinyl acetate, which on polymerization by various catalysts gives the polymer polyvinyl acetate (PVA).



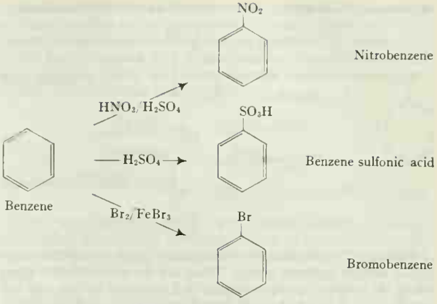
$$\mathrm{CH{\equiv}CH} + \mathrm{CH_3{-}CO_2H} \longrightarrow \mathrm{H_2C{=}\overset{H}{C}{-}O{-}\overset{O}{\overset{\|}{C}}{-}CH_3}$$

$$\ldots\left[\begin{array}{cccccccc}\mathrm{OCOCH_3} & & \mathrm{OCOCH_3} & & \mathrm{OCOCH_3} & & \mathrm{OCOCH_3} & \\ | & & | & & | & & | & \\ \mathrm{CH} & \mathrm{{-}CH_2{-}} & \mathrm{CH} & \mathrm{{-}CH_2{-}} & \mathrm{CH} & \mathrm{{-}CH_2{-}} & \mathrm{CH} & \mathrm{{-}CH_2}\end{array}\right]_n$$

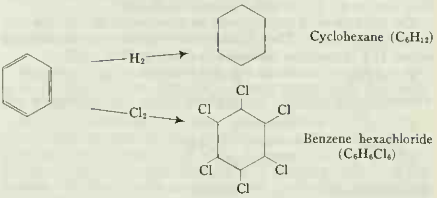
Polyvinyl acetate

The molecular formula of benzene (C_6H_6) is such that it would be expected to behave as an unsaturated compound, but in fact in many of its reactions it shows substitution rather than addition reactions. Substitution reactions of benzene include nitration, giving nitrobenzene; sulfonation, giving benzene sulfonic acid; and halogenation.

Benzene also shows reactions of the addition type. These include the formation of cyclohexane by catalytic reduction and the light-induced reaction with chlorine that yields benzene hexachloride.



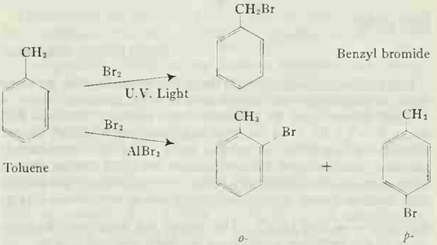
Substitution reactions of benzene



Addition reactions of benzene

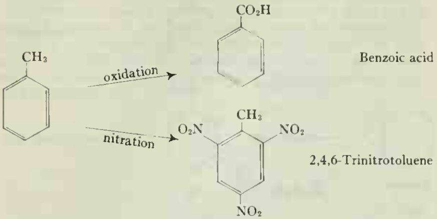
This duality of reaction type shown by benzene is compatible with its aromatic structure. The unsaturation indicated by the molecular formula explains the addition reactions, and the substitution reactions are in accord with the stability characteristic of aromatic systems. The polynuclear aromatic hydrocarbons such as naphthalene and anthracene also show substitution and addition reactions.

The alkylbenzenes (*e.g.*, toluene and the xylenes) contain alkyl and aryl groups and, as might be expected, show properties characteristic of both groups. Thus, bromination of toluene in the presence of ultraviolet light gives benzyl bromide, but in the presence of aluminum bromide nuclear bromination occurs, giving a mixture containing *o*-bromotoluene and *p*-bromotoluene as the main constituents.



Bromotoluene

An interesting feature of the reactions of alkylbenzenes is that both the methyl and the phenyl groups show a higher degree of reactivity than is shown by methane or benzene. For example, oxidation of toluene by potassium permanganate gives benzoic acid, whereas methane is unaffected under these conditions. Thus one group activates the other. Nitration of toluene, to cite another example, gives 2,4,6-trinitrotoluene (TNT) whereas the nitration of benzene yields only a dinitro derivative (1,3-dinitrobenzene).



Benzoic acid

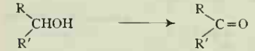
2,4,6-Trinitrotoluene

Hydroxy Compounds.—Two important types of organic compound contain hydroxyl groups. They are the alcohol (*q.v.*) type, where the hydroxyl group is bonded to a saturated carbon, and the phenols (*q.v.*), in which the hydroxyl group is attached directly to a benzene ring or aromatic system. The latter are called phenols after the parent of the series, phenol (C_6H_5OH).

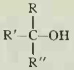
The three kinds of alcohols may be represented by the type formulas shown below. They differ in their reaction toward oxidizing agents (*e.g.*, potassium chromate in dilute sulfuric acid).

$$R{-}CH_2OH \longrightarrow R{-}CHO \longrightarrow R{-}CO_2H$$

Primary alcohol — Aldehyde — Carboxylic acid



Secondary alcohol — Ketone



$$R'{-}\overset{\overset{R}{|}}{\underset{\underset{R''}{|}}{C}}{-}OH$$

Tertiary alcohol (resistant to oxidation)

Mild oxidation of ethanol (C_2H_5OH), for example, gives acetaldehyde (CH_3CHO) and more vigorous oxidation gives acetic acid (CH_3CO_2H). Oxidation of isopropanol [$(CH_3)_2CHOH$] gives the ketone, acetone (CH_3COCH_3). Oxidation of a tertiary alcohol, such as *t*-butyl alcohol, either produces no change or results in oxidative degradation. Dehydration of alcohols may give either olefins (alkenes) or ethers, depending on the structure of the molecule and the conditions of the reaction.

$$CH_3CH_2OH \longrightarrow CH_2{=}CH_2 \quad \text{Ethylene}$$

$$CH_3CH_2OH \longrightarrow C_2H_5OC_2H_5 \quad \text{Ethyl ether}$$

Ethyl ether (ethoxyethane), the ether often used as an anesthetic, is prepared by the dehydration of ethyl alcohol.

Alkyl halides may be prepared from alcohols ($ROH \rightarrow RX$, where $X = Cl, Br, I$) by reaction with phosphorus halides, thionyl chloride (giving RCl) or halogen acids. This is a particularly valuable reaction synthetically because the alkyl halides show a large number of different reactions. When alcohols are treated with sodium metal, the corresponding alkoxide is formed (*e.g.*, $C_2H_5OH \xrightarrow{Na} C_2H_5ONa$). This shows the weakly acidic character of the hydrogen atom in an alcoholic hydroxyl group.

$$R{-}OH \xrightarrow{R'CO_2H} R{-}O{-}CO{-}R' \quad \text{Ester}$$

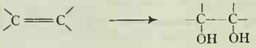
$$R{-}OH \xrightarrow{HNO_3} R{-}O{-}NO_2 \quad \text{Alkyl nitrate}$$

$$R{-}OH \xrightarrow{H_2SO_4} R{-}O{-}SO_3H + R_2SO_4$$

Alcohol — Alkyl hydrogen sulfate — Dialkyl sulfate

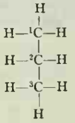
A reaction that is characteristic of alcohols is the formation of esters. Reaction between alcohols and carboxylic acids gives organic esters; and inorganic acids, such as nitric or sulfuric acids, give inorganic esters when they react with alcohols.

The preparation and reactions of polyhydroxy compounds (*i.e.*, compounds containing more than one hydroxyl group) are of interest. The 1,2-diols, which contain the part structure $-\overset{|}{C}(OH){-}\overset{|}{C}(OH){-}$, may be prepared by oxidation of alkenes with alkaline permanganate or osmium tetroxide. The general reaction may be represented as follows:

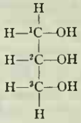


Alkene — 1,2-Diol

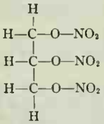
Glycerol, which is often produced by the alkaline hydrolysis (saponification) of animal oils and fats, contains three hydroxyl groups in each molecule. It is called 1,2,3-propanetriol or trihydroxypropane. It is so named because glycerol is a derivative of propane in which hydrogen atoms attached to the carbon atoms numbered 1, 2 and 3 are replaced by hydroxyl groups.



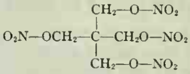
Propane



Glycerol (1,2,3-propanetriol)



Nitroglycerine



P.E.T.N.

Treatment of glycerol with a mixture of concentrated nitric and sulfuric acids gives the powerful explosive nitroglycerine, which, when absorbed on kieselguhr (diatomaceous earth), is used as dynamite. A related explosive is pentaerythritol tetranitrate (PETN), which is prepared from the tetrahydroxy compound pentaerythritol [$C(CH_2OH)_4$].

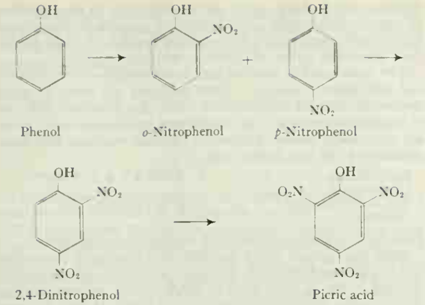
The phenols are aromatic hydroxy compounds. They show some reactions that correspond to reactions of alcohols (*e.g.*, formation of esters and others), but most of their more interesting reactions are associated with the aromatic nucleus, to which the hydroxyl group is bonded. Phenols undergo aromatic substitution reactions such as nitration, sulfonation and halogenation much more easily than do the corresponding aromatic hydrocarbons because of the activating influence of the phenolic hydroxyl group.

Nitration of phenol gives various products depending upon the conditions and the nitrating agent.

In these substitution reactions the substituent is located either ortho or para to the phenolic group. The phenolic group is said to be an ortho-para directing group since it activates the ortho and para positions.

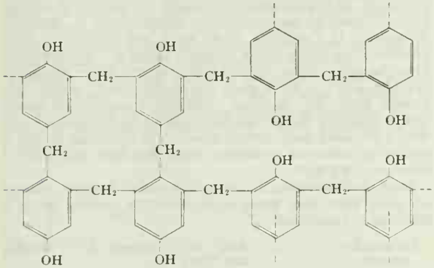
Phenols are more strongly acidic than alcohols and are soluble in sodium hydroxide because the phenolate anion is more stable than an alkoxide anion.

Phenols react with aldehydes to give condensation products, a reaction that is employed in the technical preparation of the phenol-formaldehyde resins, which are plastics of the thermosetting type. The industrial process was discovered by Leo Hendrik Baekeland and the plastics are called Bakelite. The structure of



Phenol
o-Nitrophenol
p-Nitrophenol
2,4-Dinitrophenol
Picric acid

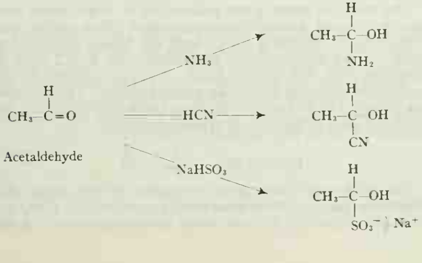
the bakelite-type resins produced from phenol and formaldehyde is macromolecular and contains phenol residues cross-linked via methylene groups supplied by the formaldehyde precursor. Examination of the part structure shown below indicates how the cross-linkages involve the ortho and para positions of the phenolic residues.



Many substances that occur naturally are phenolic. Lignin, for example, a major constituent of wood, has a macromolecular structure containing phenolic residues, but its detailed structure was not known in the early 1960s.

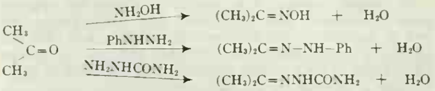
Aldehydes and Ketones.—These are compounds represented by the type formulas, R—CHO (aldehydes) and R—CO—R′ (ketones). They contain a carbonyl ($>C{=}O$) group; the chemical reactions that they show may be associated either with the $>C{=}O$ group directly or with the way in which the $>C{=}O$ group modifies the groups to which it is attached.

The $>C{=}O$ group is unsaturated like the $>C{=}C<$ group and, as could be expected, aldehydes and ketones (*q.v.*) show addition reactions. The reactions of acetaldehyde, as shown below, are typical; they include additions with ammonia, hydrogen cyanide and sodium bisulfite.

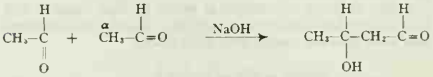


Acetaldehyde

Aldehydes and ketones also react with a variety of reagents in a process leading to the elimination of water. These reactions, termed condensation reactions, may be illustrated by the reaction of the ketone acetone with hydroxylamine, phenylhydrazine and semicarbazide, giving acetoxime, acetone phenylhydrazone and acetone semicarbazone respectively.



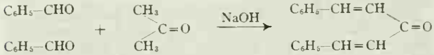
When acetaldehyde is treated with a small quantity of sodium hydroxide it forms aldol; this reaction may be regarded as involving the addition of one molecule of acetaldehyde to the carbonyl group of another.



Aldol

The methyl group designated as α in the above equation is said to be activated by the adjacent carbonyl group, with the result that it may undergo addition to another carbonyl group.

Aldol is dehydrated to give crotonaldehyde ($CH_3-CH{=}CH-CHO$) by heating, and this reaction takes place particularly easily in the presence of acid. In some reactions the intermediate of the aldol type, although it is certainly formed, is not isolated. In these cases a condensation product is obtained directly; thus benzaldehyde and acetone in the presence of aqueous sodium hydroxide give dibenzylidene-acetone (dibenzalacetone, or styryl ketone).



Benzaldehyde
Acetone
Dibenzylidene-acetone

The reaction of aliphatic aldehydes with bases differs from that of aromatic aldehydes. Acetaldehyde yields aldol, whereas benzaldehyde undergoes an unexpected reaction, giving sodium benzoate and benzyl alcohol.

$$2C_6H_5CHO \xrightarrow{NaOH} C_6H_5CO_2Na + C_6H_5CH_2OH$$

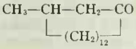
Benzaldehyde
Sodium benzoate
Benzyl alcohol

This reaction was discovered by Cannizzaro (1853) and is called the Cannizzaro reaction. It may be regarded as an internal oxidation-reduction reaction.

It is possible to differentiate between aldehydes and ketones by using tests that depend upon the ability of aldehydes to act as reducing agents. They are easily oxidized to carboxylic acids and it is this property that is involved in the silver mirror test and in Fehling's test for aldehydes.

Carboxylic Acids and Their Derivatives.—Most of the properties of carboxylic acids are attributable to reactions involving the carboxyl ($-CO_2H$) group. Carboxylic acids are acidic, though usually less so than most inorganic acids. The carboxylic acids are represented by the type formula $R-CO_2H$; decarboxylation by heating with soda lime gives the alkane ($R-H$). Electrolysis of aqueous solutions of sodium salts ($R-CO_2Na$) gives alkanes ($R-H$), a reaction (discovered by Kolbe) that involves free radical intermediates. When the calcium salts of carboxylic acids are heated they yield ketones (*e.g.*, calcium acetate gives acetone).

This reaction formed the basis of Leopold Ruzicka's classical studies (1934) on the synthesis of ketones with large-membered rings. By heating the thorium salts of dicarboxylic acids he showed that it was possible to obtain cyclic ketones with structures similar to muscone, the odiferous principle of musk perfume.



$$CH_3-CH-CH_2-CO \quad (CH_2)_{12}$$

Muscone

By suitable reactions it is possible to change the carboxyl group of carboxylic acids ($R-CO_2H$) into various groups that lead to derivatives such as esters ($R-CO_2R'$), acid chlorides ($R-COCl$), acid amides ($R-CONH_2$) and acid anhydrides ($R-CO-O-COR$). These derivatives are important as intermediates in synthetic organic chemistry.

Amines.—Amines (*q.v.*) are of three types: primary amines ($R-NH_2$), secondary amines ($R-NHR'$) and tertiary amines ($R-NR'R''$). When the NH_2 group is attached to an aromatic ring the compounds often show different properties than do aliphatic primary amines.

Amines are basic compounds, as shown by their reaction with acids to form salts and by the formation of quaternary ammonium salts when they are treated with alkyl halides.

$$MeNH_2 + HCl \rightarrow [Me\overset{+}{N}H_3]Cl^-$$

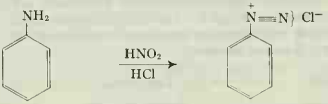
Methylammonium chloride

$$Me_3N + MeCl \rightarrow [Me_4\overset{+}{N}]Cl^-$$

Tetramethylammonium chloride

The reaction of aliphatic amines with nitrous acid may be used to differentiate between primary, secondary and tertiary amines. Primary amines often give the alcohol and nitrogen ($R-NH_2 + HNO_2 \rightarrow R-OH + N_2 + H_2O$), secondary amines give nitrosamines ($RR'NH + HNO_2 \rightarrow RR'N-NO + H_2O$) and tertiary amines form only a nitrite salt.

In this respect primary aliphatic amines differ from primary aromatic amines, since the latter react with nitrous acid under controlled conditions to give diazonium salts. For example, aniline and sodium nitrite in aqueous hydrochloric acid at 0°–5° C. give benzenediazonium chloride.



Aniline

Benzenediazonium chloride

The diazonium salts show a remarkable variety of reactions and may be transformed into phenols, aryl halides (Sandmeyer reaction), aryl hydrazines and azo compounds by coupling with phenols or aromatic amines. The coupling reaction of diazonium salts was discovered by Johann Peter Griess (1858) while he was working in Kolbe's laboratory, and this observation led to the large industry now associated with the manufacture of azo dyes.

2. Mechanisms of Organic Reactions.—During the 1920s the first attempts were made by organic chemists to describe the reactions of organic compounds in terms of the electronic theory of atomic structure. It had already been recognized that single covalent bonds involved the interaction between two electrons (Lewis, 1916) and it was reasonable to expect that chemical reactions, which involve the formation and cleavage of chemical bonds, might be treated as processes involving the movement of electrons. These newer electronic concepts were successfully applied to organic phenomena by several organic chemists including Lapworth, Robinson and Ingold. Their approach developed into a branch of the subject that is termed theoretical organic chemistry and made it possible to provide rationalizations for many organic reactions and to detect many subtle similarities in the behaviour of organic compounds. The theory of reaction mechanisms is now so well based that it is frequently possible to make predictions about the course of chemical reactions.

Two main types of reaction may be recognized—ionic reactions and free radical reactions. Ionic reactions are those in which electrically charged intermediates (ions) are involved; this type of reaction intermediate can be produced by the heterolytic cleavage of covalent bonds. Homolytic cleavage reactions give intermediates of the free radical type.

Ionic reaction (Heterolytic)	$A:B \longrightarrow A^+ + B:^-$
Free radical reaction (Homolytic)	$A:B \longrightarrow A. + B.$

Each dot in equations of this kind represents one electron.

Since free radicals (*q.v.*) are dealt with elsewhere, this section will be concerned primarily with ionic reactions. The heterolytic cleavage of the covalent bond in A—B is often represented by a curved arrow, which symbolizes the movement of two electrons. Thus the ionic reaction shown above can also be represented in the following way:

$$A \overset{\frown}{-} B \rightarrow A^+ + B^-$$

Electrophilic and Nucleophilic Reagents.—Reagents can be divided into at least two types, electrophilic (cationoid, or electron-accepting) and nucleophilic (anionoid, or electron-donating). During a reaction an electrophilic reagent seeks a negatively charged site in a molecule, or an anion, and it therefore often provides a less stable (more reactive) cation A^+ on heterolysis. Thus bromine is an electrophilic reagent since heterolysis ($Br-Br \rightarrow Br^+ + Br^-$) gives the reactive Br^+ cation. The bromide anion, Br^-, is stable. Similarly, a nucleophilic reagent seeks a positively charged site in a molecule since heterolysis provides a relatively more reactive anion. The equivalent process is possible in molecules containing atoms that have lone pairs of electrons (*e.g.*, $R_3N:$).

Some simple examples of electrophilic and nucleophilic reagents are given below and, where appropriate, the reactive entity is indicated in parentheses:

Electrophilic reagents	Acids (H^+); halogens (X^+); nitrating acid (NO_2^+);
Nucleophilic reagents	Hydroxides (OH^-); cyanides (CN^-); alkoxides (OR^-); enolate anions; amines ($R_3N:$)

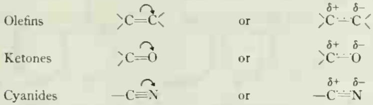
Reactions are classified according to the types of reagent involved. The alkaline hydrolysis of an alkyl halide giving an alcohol ($R-Br + OH^- \rightarrow R-OH + Br^-$) is described as a nucleophilic substitution since it is a substitution reaction involving a nucleophilic reagent that provides OH^-. The addition of halogen acid to an olefin (*e.g.*, $CH_3-CH=CH_2 + HBr \rightarrow CH_3CHBrCH_3$) is an electrophilic addition since it involves an attack by H^+ and Br^- upon the $> C=C <$ double bond.

Structure of Molecules.—Although it is usual to represent molecules as not containing atoms bearing formal positive or negative charges, electron displacements can occur within molecules by the operation of inductive (electrostatic) and electromeric (tautomeric, mesomeric or resonance) effects.

The inductive effect is the polarization of single bonds connecting atoms of different electronegativities. Thus methyl chloride (CH_3Cl) contains a C—Cl bond and because the chlorine atom is more electronegative than carbon, the C—Cl bond is polarized. The carbon atom bears a fractional positive charge and the chlorine atom a fractional negative charge. These charges are presented by δ^+ and δ^-. There are two ways of indicating the inductive effect in the formula of methyl chloride:

$$H_3C \rightarrow\!- Cl \qquad \overset{\delta^+}{H_3C} - \overset{\delta^-}{Cl}$$

The electromeric effect is a consequence of the charge displacement that can occur in unsaturated systems (*e.g.*, $> C=C <$; $> C=O$; $-C\equiv N$). It is not, unlike the inductive effect, necessarily an intrinsic property of the molecule, but it may be brought about only by the presence of an attacking reagent. The polarization can be represented in two ways as in, for example, the olefins, ketones and cyanides.



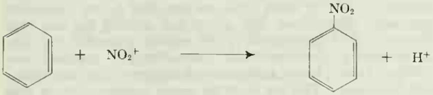
These charge displacements can, so to speak, encourage reactions with either electrophilic or nucleophilic reagents.

Organic Reaction Mechanisms.—In a brief account it is not possible to survey all aspects of organic reaction mechanisms. In some cases a simplified treatment is given, but no reference is made to the detailed approach to the subject that is now possible when use is made of the principles of modern physical chemistry. (*See Physical Chemistry* below; *see* also REACTION KINETICS: *Reaction Mechanism.*)

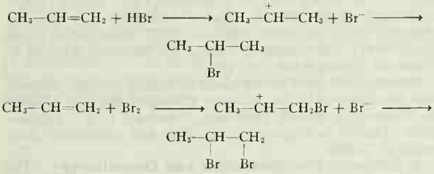
Reactions in organic chemistry may be classified into four main groups: substitution; addition; elimination; and rearrangement reactions.

1. Substitution reactions may be represented by the general expression ($X + A—B \rightarrow X—A + B$) in which the group X is replacing the group B. A typical reaction is the alkaline hydrolysis of an alkyl bromide ($OH^- + R—Br \rightarrow HO—R + Br^-$). This reaction is called a nucleophilic aliphatic substitution reaction; reactions of this type were closely examined by Ingold.

Aromatic substitution reactions are often reactions of the electrophilic type as exemplified by the nitration of benzene to nitrobenzene. It has been shown that the active entity in this process is the nitronium cation (NO_2^+), which displaces the hydrogen as H^+.



2. Addition reactions can also involve electrophilic or nucleophilic reagents. The addition reactions of olefins involve the former type of reagent. The similarity between the addition of hydrogen bromide and bromine to an olefinic group is indicated in the following addition reactions of propene.

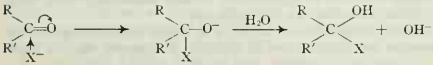


$$CH_3—CH=CH_2 + HBr \longrightarrow CH_3—\overset{+}{C}H—CH_3 + Br^- \longrightarrow CH_3—\underset{\underset{Br}{|}}{C}H—CH_3$$

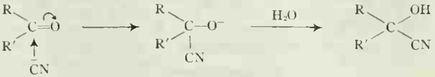
$$CH_3—CH=CH_2 + Br_2 \longrightarrow CH_3—\overset{+}{C}H—CH_2Br + Br^- \longrightarrow CH_3—\underset{\underset{Br}{|}}{C}H—\underset{\underset{Br}{|}}{C}H_2$$

The cations ($CH_3\overset{+}{C}HCH_3$ and $CH_3\overset{+}{C}HCH_2Br$), represented as intermediates in these reactions, are called carbonium ions. Many aspects of the behaviour of carbonium ions were investigated by the American chemists Frank C. Whitmore and Saul Winstein.

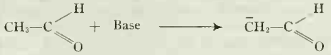
The electromeric effect in the carbonyl group ($>C=O$) of aldehydes and ketones is responsible for the electrophilic addition reactions shown by them. These reactions can be represented generally by

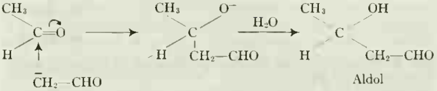


The addition reactions of ketones with hydrogen cyanide, sodium bisulfite and ammonia may be represented mechanistically in this way. The hydrogen cyanide reaction, for example, may be shown as follows:

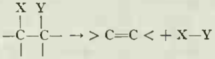


It is also possible to represent related reactions by similar mechanisms. Thus the base-catalyzed formation of aldol involves the addition of the anion derived from acetaldehyde to the carbonyl group of another acetaldehyde molecule.



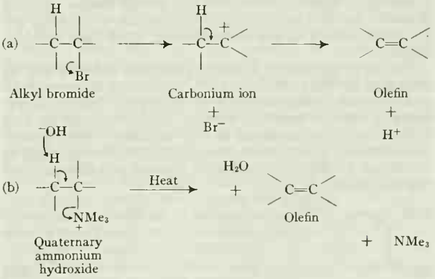


3. Elimination reactions are of various types; olefin formation may be represented by the general expression



$$—\underset{|}{\overset{\overset{X}{|}}{C}}—\underset{|}{\overset{\overset{Y}{|}}{C}}— \rightarrow\ >C=C<\ + X—Y$$

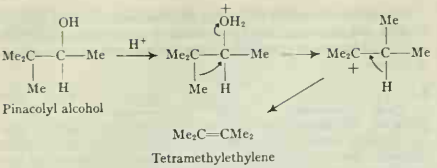
The two reactions that are often used for the preparation of olefins are (a) the reaction of alkyl halides with strong alkali and (b) the Hofmann degradation, which is achieved by the pyrolysis of quaternary ammonium hydroxides. The mechanisms of these reactions may be represented as follows:



The diagrams shown above for reactions (a) and (b) illustrate the symbols that are used by organic chemists to indicate the mechanisms of the reactions. Partial structures are used to indicate the generality of the reactions and the curved arrows are used to indicate the shift of two electrons (*i.e.*, the sbift of one bond).

4. Molecular rearrangements (*q.v.*) are those reactions that are associated with an alteration in the relative positions of the skeletal atoms of a molecule. Numerous reactions of this type are known; they can be illustrated by (1) the Wagner-Meerwein rearrangement; and (2) the Beckmann rearrangement. Examples of these rearrangements are given below:

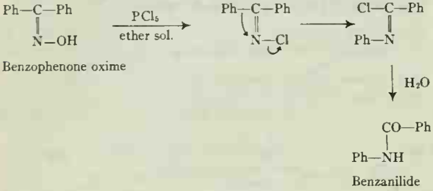
(1) Acid-catalyzed dehydration of pinacolyl alcohol gives tetramethylethylene by the following mechanism



Pinacolyl alcohol

Tetramethylethylene

(2) Benzophenone oxime and phosphorus pentachloride in an ether solution give benzanilide by the Beckmann rearrangement.



Benzophenone oxime

Benzanilide

The Beckmann reaction involves a migration of a phenyl group from carbon to nitrogen.

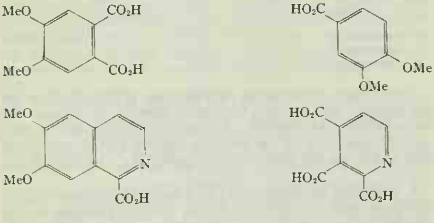
F. Proof of Structure

One of the major activities of organic chemists has been the determination of the structures of organic compounds. Natural products and also products of unexpected constitution resulting from synthetic reactions have been examined.

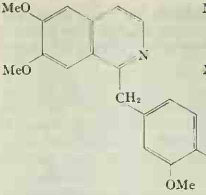
The classical methods for the establishment of structure involve elucidation by degradation followed by confirmation of the structural proposal by a rational synthesis. In determining the structure by degradation a study is made of the reactions of the compound with various reagents, including acids, bases, oxidizing agents and reducing agents. This eventually leads to the recognition of functional groups.

Successful degradation reactions also provide simpler products of known structure and from these it is possible to determine the structural formula of the molecule from which they could be derived.

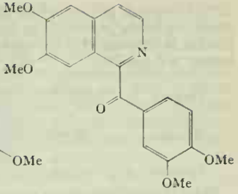
The use of degradative methods to elucidate structure may be illustrated by brief reference to G. Goldschmiedt's studies on papaverine, an alkaloid isolated from the poppy. Papaverine was shown to have the molecular formula $C_{20}H_{21}NO_4$ with the four oxygen atoms accommodated in four methoxy (OMe) groups. Mild oxidation gave papaveraldine, $C_{20}H_{19}NO_5$, corresponding to the change $> CH_2 \rightarrow CO$, and more vigorous oxidation gave the four compounds:



By comparing these structures it is possible to deduce which carbon atoms are common to the degradation products; from this deduction follows the proposed structure for papaverine. Its relationship to papaveraldine, as indicated by their structural formulas, is acceptable.



Papaverine



Papaveraldine

This argument illustrates the approach used by organic chemists in tackling structural problems. Experiments are carried out and a structure is eventually proposed that is compatible with the degradative evidence. It should be pointed out, however, that the determination of the structure of papaverine was fairly straightforward; other determinations have required very lengthy study for their solution. It will be clear from the discussion in earlier sections that many structural problems presented by molecules of great complexity were soluble by the early 1960s. The remarkable progress that was made in this field during the 1950s was to some extent due to the wide use of physical methods by organic chemists; these methods include ultraviolet, infrared and nuclear magnetic resonance spectroscopy.

G. Synthesis of Organic Compounds

A great deal of effort has been devoted to the synthesis of organic compounds. This has included, for example, the synthesis of natural products in order to make them artificially and to verify the structure that had previously been established by degradation. Other studies have been motivated by the desire to discover or exploit new organic reactions, to synthesize new compounds in order to study their reactions and to test theoretical proposals. Since about 1900 tremendous activity has also been directed toward the synthesis of new organic compounds that may be valuable as pharmaceuticals (chemotherapy), synthetic substitutes (fibres, plastics and resins), dyes, insecticides, anesthetics and hormones. This list is by no means complete, but it does show the wide range of substances that fall within the province of synthetic organic chemistry.

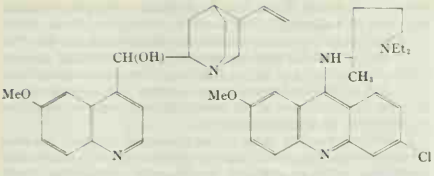
1. Synthesis of Natural Products.—Many of the milestones in the history of organic chemistry have been provided by the synthesis of natural products. Important achievements include the syntheses of urea (Wöhler, 1828), acetic acid (Kolbe, 1845), alizarin (Carl Graebe and Carl Liebermann, 1868), coniine (Albert Ladenburg, 1886), glucose (Fischer, 1890), camphor (Gustav Komppa, 1903), tropinone (Robinson, 1917), anthocyanins (Robinson, 1931) and vitamin C (Walter N. Haworth, Edmund L. Hirst and Tadeus Reichstein, 1933).

Between 1950 and 1960 the power of modern synthetic methods was demonstrated by the syntheses of complex alkaloids (Robert B. Woodward), steroids (Robinson, Woodward *et al.*), polypeptides (Vincent du Vigneaud), nucleotides and coenzymes (Alexander R. Todd).

2. Synthetic Pharmaceuticals and Chemotherapy.—The synthesis of molecules that are structurally related to natural products and have pharmaceutical activity has led to extensive inquiry. A good example of this approach is the search for synthetic antimalarials (as substitutes for quinine) that led to the discovery of quinacrine hydrochloride (Atabrine; Atebrine) (W. Kikuth, H. Mauss and F. Mietzsch, 1930). (*See* QUININE.)

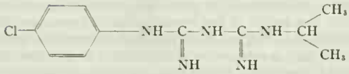
Comparison of the structure of quinacrine hydrochloride with that of quinine indicates relationships between molecular structure and biological activity. However, the effective antimalarial chlorguanide hydrochloride (Paludrine), which was discovered during World War II, is rather remote structurally from both quinine and quinacrine hydrochloride.

Chlorguanide hydrochloride is in many respects superior to quinine for the treatment of malaria. Discoveries such as those



Quinine

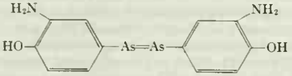
Quinacrine (Atabrine)



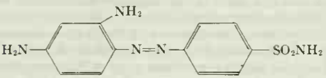
Chlorguanide (Paludrine)

of chlorguanide hydrochloride are made only as a result of research on a very broad front; during World War II more than 14,000 compounds were screened in the United States, Great Britain and Canada as possible antimalarials.

Interest in chemotherapy was stimulated by the remarkable researches carried out by Paul Ehrlich in his search for chemical agents that might selectively destroy pathogenic organisms without seriously damaging the host. In 1909 Ehrlich discovered that arsphenamine (Salvarsan) had an ameliorative effect upon syphilis; he also discovered that various dyes had certain curative effects on other diseases. Many dyes were examined and in 1935 Gerhard Domagk discovered that the dye Prontosil, the first sulfonamide drug, was spectacularly effective against certain streptococcal infections.

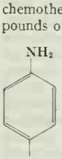


Arsphenamine (Salvarsan)

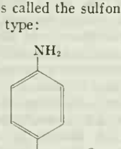


4′-Sulfamyl-2,4-diaminoazobenzene (Prontosil)

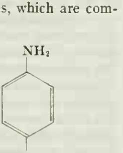
In 1936 J. Tréfoël discovered that Prontosil is transformed *in vivo* into *p*-aminobenzenesulfonamide (sulfanilamide) and this led to the synthesis and examination of a large number of derivatives of sulfanilamide, and to the discovery of the important group of chemotherapeutic agents called the sulfonamides, which are compounds of the following type:



Sulfanilamide



Sulfapyridine



Sulfathiazole

The discovery of antibiotics had a tremendous impact on methods of treatment of disease, but it has not reduced the effort devoted to the synthesis and examination of organic compounds as possible pharmaceuticals (*see* also PHARMACOLOGY).

3. Man-made Fibres, Plastics and Resins.—Many types of organic chemicals of high molecular weight are synthesized on a large scale for use as fibres and plastics. These include substances such as nylon, Dacron (Terylene), polyethylene and polyvinyl chloride; their production forms a very important part of the chemical industry. Synthetic polymers are structurally related to various natural products such as cotton or rubber and in some cases the qualities of the synthetic products are superior to those of the substances they are designed to replace. *See* FIBRE, MAN-MADE; PLASTICS; RESINS. (W. D. Os.)

IV. PHYSICAL CHEMISTRY

The easiest definition of physical chemistry is that which describes it as the borderline subject between physics and chemistry, but this definition is not necessarily the most accurate. No greater clarity results by adopting the name "chemical physics." In fact, physical chemistry, since the first issue of the *Zeitschrift für physikalische Chemie* appeared in 1887, can claim to be a science in its own right. It certainly covers the ill-defined territory between physics and chemistry, as biochemistry does between chemistry and biology, and mathematical physics between mathematics and physics, but it can also stake a claim to quite a sizable piece of land, as extensive and as cultivated as the regions conventionally allocated to the so-called pure sciences of physics and chemistry. A definition of physical chemistry is difficult to formulate because, properly regarded, it is less a circumscription of subject matter than a method of approach, applicable equally to the problems of physics, chemistry and biology. There can be no harm, however, in attempting to describe the physical chemist: he is a man who observes natural phenomena and records his observations but maintains a judicious balance between the material changes themselves, the physical effects that accompany them and the mathematical machinery by which the whole can be most compactly condensed.

The three ordinary states of matter—solid, liquid and gaseous—fall within the province of physical chemistry, as do the metallic state, the interfacial state, the colloidal state and, most important of all, the dissolved state of matter. The influence of heat, light and mechanical and electrical forces on the various states of matter forms the subjects of thermochemistry, photochemistry, piezochemistry and electrochemistry, which rank among the most important subdivisions of physical chemistry. In this article various problems that have been solved, particularly during the 20th century, or are still being investigated will be discussed.

1. Adsorption.—When ethylene gas at atmospheric pressure is sealed in a vessel containing copper turnings, the pressure within the vessel gradually diminishes until it reaches a constant value. Similarly, when a solution of iodine is kept in contact with charcoal, the concentration of iodine diminishes until it reaches a constant value. Gas molecules in the first case and solute molecules in the second case have adhered to the surface of the solid. The phenomenon is known as adsorption and occurs in varying degrees for all solutes and all gases kept in contact with the surface of solids. Argon gas, for example, is adsorbed on the surface of potassium chloride crystals, and enzymes are adsorbed on diatomite (kieselguhr). The extent of adsorption depends on specific properties of the adsorbed and the adsorbing molecules, on the temperature and on the concentration or pressure. The familiar facts have been utilized practically without being understood theoretically. The fairly general adsorbing power of charcoal, for example, explains its use in decolorizing solutions in the course of organic preparations, in protection against toxic vapours and in the treatment of digestive ailments. The reverse process, desorption, has been utilized in the isolation of pure enzymes. While attempts were being made to understand the mechanism of adsorption, many empirical relations appeared connecting the amount adsorbed with temperature and concentration, the principal variables. Curves showing fractional adsorption as a function of the concentration at constant temperature are termed adsorption isotherms, and the empirical formulas advanced to account for these were numerous but unenlightening.

In 1916 Langmuir proposed a theory of adsorption that was not only sufficient to explain the phenomenon but also had extensive applications in other fields, including statistical physics. His theory was simple. The surface of the solid, of area O cm.^{2}, is likened to a chess board, on which solute or gas molecules impinge. Some adhere to the unitary areas; others fly back to the bulk of the solution or the gas phase. When equilibrium is attained, a certain fraction, θ_s, of the area of the solid remains covered with adsorbed molecules. The fraction of free surface is then $(1-\theta_s)$. In deriving the theoretical expression for the adsorption isotherm, the terminology of solutions will be used though the formulas are applicable, with certain changes, to gaseous systems. Let the total number of sites per unit area of surface, on which solute molecules can be adsorbed, be n_0 and the probability per second that an adsorbed molecule may become desorbed be v_s. Then the total number of molecules escaping per second from a surface of area, O cm.^{2}, is $On_0v_s\theta_s$. The total number of solute molecules reaching the surface from the solution in one second is proportional to the surface area, O, and to the concentration, n_s, of solute molecules. Denoting the proportionality factor by k_s, the number is thus k_sOn_s molecules per second. But only those that hit vacant sites are adsorbed. Hence the rate of adsorption is $k_sOn_s(1-\theta_s)$. At equilibrium, the rates of adsorption and desorption are equal. On solving for θ_s it is found that $\theta_s = k_sn_s/(k_sn_s+v_sn_0)$, which is Langmuir's adsorption isotherm. From the form of this equation, it will be noted that at low concentrations the fraction of the surface that is covered is proportional to the concentration of the supernatant solution, and is, in fact, $(k_s/v_sn_0)n_s$. At high concentrations, θ_s tends toward unity. The whole surface is then covered with adsorbed molecules, and the extent of adsorption becomes independent of the concentration. It is generally possible, by quite simple experiments, to measure the concentration, $n_0^{\bullet}$, which corresponds to a surface that is only one-half covered. This concentration, from the isotherm equation, is seen to be $v_sn_0k_s$.

Among the many applications of Langmuir's theory is the experimental determination of the number of catalytically active sites on the surface of a single enzyme. It has been shown that $n_0 = k_sn_s^{\bullet}/v_s$. The proportionality factor, k_s, is given by classical theory in terms of the mass, m, of the solute molecule, the absolute temperature, T, and Boltzmann's constant, k, which is numerically 1.38044×10^{-16} erg/degree: $k_s = (kT/2\pi m)^{\frac{1}{2}}$. The probability per second, v_s, that an adsorbed molecule will escape is given by quantal theory in terms of the energy, E, of adsorption, and Planck's constant, h, which is numerically 6.62517×10^{-27} erg-second: $v_s = (kT/h)e^{-E/kT}$. Thus $n_0 = hn_s^{\bullet}(2\pi mkT)^{-\frac{1}{2}} \cdot e^{-E/kT}$. The application of this formula to experimental results on the inversion of cane sugar by invertase shows that there are only a few active sites, probably eight, on the not inconsiderable surface of one enzyme.

Systems of greater complexity and interest are those in which the surface can simultaneously adsorb more than one kind of solute. Let the second solute be denoted by the subscript I. The fraction of the surface that, under equilibrium conditions, is covered by solute molecules of the first type is now $\theta_s = k_sn_s/[k_sn_s+v_sn_0+k_In_I(v_s/v_I)]$. This formula, as Langmuir showed, can explain a number of the idiosyncrasies of catalyzed reactions in solution. Inhibition of chemical reactions and the poisoning of catalysts by substances such as mercuric chloride are readily understood as a preferential adsorption of these compounds and a consequent exclusion of the reactants from the active centres. Similarly, many reactions proceed at rates that are inversely proportional to the concentration of products. These rates were discovered by Emil Schuetz in 1900 and include the digestion of proteins; they indicate that the greater the extent of reaction, the smaller the rate of the persisting reaction. Clearly, in such cases, the products are more firmly adsorbed than the reactants. There can be little doubt that the condition of satiety finds its mechanistic basis here; so also does the protective effect so often exerted by the products of hydrolysis on the enzyme responsible for their appearance.

The energy that an adsorbed molecule must acquire before it can become dislodged must, in general, depend on how many of its neighbouring sites are occupied. The experimental dependence of the heat of adsorption on the extent of adsorption was established experimentally by J. K. Roberts a few years before his untimely death during World War II. It ranks as the greatest single extension of Langmuir's theory and is proving to be one of the most fruitful fields for the investigation of surface catalysis. The discovery has had far-reaching applications in theoretical physics, which, in attempting to derive statistical laws for condensed systems, had previously been at a loss to know how to make allowance for the dependence of the molecular energy on the probability of occupation of neighbouring sites.

2. Diffusion.—The sugar at the bottom of a cup of tea soon dissolves into a sirup, but, if the tea were not stirred, considerably more time would be required for the sugar to distribute itself throughout the whole volume of the beverage. The process whereby a quiescent solute at a high concentration moves isothermally to a region of low concentration is known as diffusion. It is analogous to thermal conduction and viscous flow, and differs from them only in that matter is transported in diffusion, whereas energy and momentum, respectively, are transported in the others. The exact mathematical theory of all three phenomena is difficult, but new laws of great beauty and simplicity were, nevertheless, discovered by Einstein during the first decade of the 20th century and have had much to do with elucidating the nature of diffusion. They have been applied to determine the Avogadro number; *i.e.*, the number of molecules in one gram-molecule, to estimate the size of colloid particles, to evaluate the time taken by a given molecule in the gas phase or in solution to reach the walls of its container and to develop the modern theory of liquids.

The number, dN, of molecules transported in a time interval, dt, across an area, O, is, according to Fick's law, proportional to both dt and O, and to the concentration gradient, dn/dx, at the plane crossed: $dN = -DO(dn/dx)dt$. The proportionality factor, D, is termed the coefficient of diffusion. Molecules are transported in the direction of increasing x only when the concentration gradient in that direction is negative. By subtracting from dN_1, the number of molecules crossing a given plane, the number dN_2 crossing a neighbouring and parallel plane at a distance, dx, from it, the net transport is obtained. Since dN/Odx is the increase in concentration between the planes, it may be denoted by dn, so that $dn/dt = D(d^2n/dx^2)$, which is a more general expression for the coefficient, D, of diffusion. When molecules at a concentration, n, move with an average velocity, v, the number that in one second cross unit area of a plane at right angles to the direction of motion is nv. The rate of transport of molecules across an area O cm.^{2} is thus $dN/dt = Onv$. Comparison with Fick's law indicates that the coefficient of diffusion is $D = -nv/(dn/dx)$. According to van't Hoff's laws, the osmotic pressure, π, of a solution containing n molecules per cubic centimetre is $\pi = kTn$. Any isothermal change in the osmotic pressure must therefore be the result of a change in the concentration, so that $d\pi = kTdn$. The additional force exerted in the direction of increasing x on an area, O, caused by a difference in concentration is thus $-Od\pi = -OkTdn$. The number of molecules exerting the force is the number contained in the volume element, Odx, which is $nOdx$. Hence the force exerted by each molecule is, on an average, $X = -(kT/n)(dn/dx)$. The uniform velocity, v, is the ratio of this force to the resistance factor, s. Thus $v = X/s$. Sir George G. Stokes's expression for the resistance factor in the case of a spherical molecule of radius, r, moving in a medium of viscosity, η, is $6\pi\eta r$. Hence $vn/(dn/dx) = -kT/6\pi\eta r$. According to the previous equation, the expression on the left side is simply the coefficient of diffusion with the sign reversed. It follows that $D = kT/6\pi\eta r$, which is Einstein's equation. The coefficients of diffusion and viscosity are not difficult to measure at a constant temperature, T, and the radii of particles diffusing in solution thus become directly measurable.

Diffusion has hitherto been regarded as a property of molecules in systems of uneven concentration and as the mechanism whereby uniformity of concentration is established. The process, however, must persist, though without a net transfer of matter, even in systems of uniform molecular concentration. The laws of diffusion can be applied, for example, to determine the fate of an arbitrarily selected group of molecules from one part of an equilibrated system to another. By solving the differential form of Fick's equation in the case of linear motion, it can readily be shown that the uniform velocity at the distance x is $v = D/x$. But $v = dx/dt$; hence $dx/dt = D/x$, which gives on integration: $x^2/2 = Dt +$ a constant. The system of reference chosen for the selected migrating molecules was that corresponding to $x = 0$ when $t = 0$, so that the square of the net displacement suffered by the selected molecules in time t, and measured along the x axis, is $x^2 = 2Dt$, which is the second of Einstein's diffusion laws. This law was verified by Jean Perrin in a series of experiments in which he used colloidal particles that were made visible in the ultramicroscope and were followed at time intervals of a few seconds. It is to be noted that, because the motion is a random one, the average distance traversed (or, more precisely, the square root of the average of the square of the distance) is proportional, not to the time, but to the square root of the time.

Einstein's treatment of diffusion did much to stimulate work in the physical chemistry of solutions. In particular, attempts have been made to extend the treatment to the movement of molecules under the influences of forces other than the thermal and viscous forces to which the early work was restricted. Only partial success has been achieved and that has been recorded in cases where the additional force is of a simple and well-known form. There is, however, no reason why the method should not ultimately prove helpful in the recognition of the type of force actually at work.

Perrin's experimental verification of Einstein's second law of diffusion afforded one of the most accurate estimates of the Avogadro number. It is 6.0248×10^{23} molecules per gram-mole. This fundamentally important constant has also been measured, with confirmatory results, in many other ways. It enables the physical chemists to compute, in all systems of interest, the actual number of molecules present. One drop of water, weighing 5 milligrams, is thus found to contain 167.2 million million million molecules.

3. Coagulation.—Colloid particles may be prepared, either in the gaseous phase or in solution, by a variety of methods. Aerosols, for example, may be made by mixing the vapour of the substance to be dispersed with a blast of air at a lower temperature, or by suddenly bursting a sample of liquid at great pressure into air at ordinary pressure. Liquid sols may be made by slow chemical reaction in dilute solution or, in the case of metals, by G. Bredig's method of sparking between electrodes immersed in the solvent. The chief characteristic of the dispersed phase in either system is its instability. The dispersed particles, when initially generated, are relatively small, but, with the passage of time, they become coarser, until they are large enough to come under the influence of gravity. The process of coarsening is termed coagulation, and it has been extensively studied. Experiment shows that the instantaneous rate at which the number of particles diminishes is proportional to the square of the concentration, n, of particles present at that instant. Therefore $-dn/dt = k_2n^2$, where k_2 is the coefficient of coagulation. On integrating—and noting that the initial condition of $t = 0$ corresponds to the initial concentration of $n = n_0$—we have $k_2 = (1/t) \times (1/n - 1/n_0)$. If we denote by $t_{\frac{1}{2}}$ the time required for the number of particles to be reduced to one-half of their original number, then clearly $k_2 = 1/t_{\frac{1}{2}}n_0$. These formulas are characteristic of bimolecular processes. The latter simply states that the product of the half life and the initial concentration for such processes is a constant, and that it is equal to the reciprocal of the bimolecular velocity coefficient. The formulas have been abundantly verified for the process of coagulation in solution and in the gaseous phase. When the latter equation is rearranged in logarithmic form, it becomes $\log_{10}t_{\frac{1}{2}} = -\log_{10}k_2 - \log_{10}n_o$. A plot of the logarithm of the half life against the logarithm of the initial concentration should thus be a linear one, with a gradient of -1, and it should intercept the abscissa at a concentration numerically equal to the reciprocal of the bimolecular velocity coefficient. These generalities are illustrated in fig. 1, which has been drawn from P. Tuorila's data on the rate of coagulation of colloidal gold in water at 20° C. It will be noted that the initial concentration has been varied by a factor of more than 10,000, and that k_2 becomes 6.8×10^{-12} ml./particle-second, which has a constant value over the whole range of concentrations. There can be no doubt that the coagulation of sols in aqueous solution takes place, as R. Zsigmondy first showed, as a result of binary encounters.

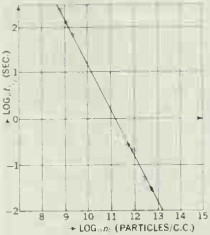


FIG. 1.—THE BIMOLECULARITY OF THE COAGULATION OF COLLOIDAL GOLD

Inquiry is next made, following M. von Smoluchowski, into the theoretical interpretation of the coefficient, k_2, and for this purpose the frequency of binary collisions must be determined. The number of molecules of type A that, in one second, cross a spherical surface of radius, r, surrounding a molecule of type B is the product of the concentration of the A molecules by their velocity and by the spherical area. It has been shown that the velocity is D/r, and, since the area is $4\pi r^2$, the number crossing per second is $4\pi Drn_A$. This equals the number of collisions, when r becomes the sum of the radii $(r_A + r_B)$ of the colliding partners. Hence ${}_1Z_A = 4\pi D(r_A + r_B)n_A$. The total number, ${}_AZ_B$, of collisions in unit volume is n_B times as great. Viewing the problem from the complementary angle of a stationary A molecule surrounded by approaching B molecules, and taking the mean, we obtain, for the number of binary collisions in unit volume and in unit time: ${}_AZ_B = 2\pi(D_A + D_B)(r_A + r_B)n_An_B$. If use is made of Einstein's first diffusion formula, this expression may be rewritten in terms of the viscosity, thus obtaining ${}_AZ_B = (kT/3\eta)$ $(r_A + r_B)^2 \; n_An_B/r_Ar_B$, which, for particles of equal radii, reduces to $(4kT/3\eta)n^2$. Now if a collision between two particles is a sufficient condition for their coalescence, the coagulation coefficient, k_2, should equal $4kT/3\eta$. Since the viscosity of water at 20° C. is 0.01005 gram/cm.-second, the theoretical estimate of k_2 is seen to be 5.33×10^{-12} ml. per particle-second, which is in good agreement with the experimental findings of Zsigmondy and of Tuorila. Moreover, the temperature dependence of the bimolecular velocity constant is correctly reflected by the ratio T/η. Smoluchowski's theory thus provides a fairly complete account of the kinetics of coagulation in solution and establishes the fact that the rate of this process is simply the rate at which particles collide with one another. Points of refinement deal with the uneven distribution of particle size and are relatively unimportant. There is also the possibility of preferential dissolution from the surface of the smaller particles.

Air at 20° C. is about 55 times less viscous than water at the same temperature. If, therefore, colloidal particles in air coagulate according to the same mechanism as colloidal particles in solution, the coagulation coefficient should be greater by about this factor, and should therefore be about 3×10^{-10} ml. per particle-second. Smokes made from a variety of substances, such as magnesium oxide, cadmium oxide, long-chain fatty acids and resinous materials, were examined by R. Whytlaw-Gray and H. S. Patterson, who found that k_2, though not exactly 3×10^{-10}, seldom varies beyond the limits of 5 and 8 in the same units. Vaporization from the particulate surface and the possible inadequacy of Stokes's expression for the frictional resistance factor are among the explanations offered for the slight discrepancy. Apart from points of detail, however, Smoluchowski's theory is as applicable to aerosols as to liquid sols. The point is an important one, as the work in the two phases has been carried out by different investigators in different countries and without liaison or much knowledge of one another's activities.

It is, perhaps, one of the most attractive features of 20th-century physical chemistry that theories, like that of Smoluchowski, sometimes emerge that, on being extensively applied, bring coherence to sets of phenomena that have been traditionally regarded as unrelated.

4. The Quenching of Resonance Radiation.—A substance that, while absorbing radiation of a given wave length, simultaneously emits radiation of a longer wave length, is said to fluoresce. Aqueous solutions of chlorophyll, fluorescein, uranine and quinine bisulfate are familiar examples. The phenomenon of fluorescence was interpreted at the end of the 19th century in terms of ionization; not until the advent of the quantum theory was the correct interpretation provided by O. Stern and M. Volmer and by O. Klein and S. Rosseland, who postulated the theory that electronically excited molecules or ions could loose their electronic energy either by spontaneous emission of radiation, as envisaged by Einstein in his theory of the distribution of thermal radiation, or in radiationless transfers of energy during collision. The theory was amply verified for the quenching of resonance radiation of thallium, mercury, sodium and cadmium atoms in the gas phase by Guenther Cario and J. Franck, and for the quenching of the fluorescence of numerous solutes in aqueous solution by S. J. Wawilow and by R. H. Mueller, E. R. Jette and W. West. Perrin, E. Gaviola and others employed the theory to determine the average lifetime of electronically excited structures. The theory can best be formulated in terms of a general procedure devised by J. A. Christiansen and H. A. Kramers and generally referred to as the stationary state procedure.

It is assumed that the electronically excited molecules are produced at a rate that is proportional to the concentration of normal molecules, say, n_A per ml. The rate of production may then be given as $k_3 n_A$, where the proportionality constant, k_3, depends in magnitude on the nature and intensity of the exciting radiation and on the dimensions and design of the reaction vessel. A threefold fate awaits these excited structures. They may, in the first place, emit radiation spontaneously, at a rate that is proportional to the concentration, a, of the excited structures. Let this rate of emission be denoted by $k_1 a$, where k_1 is the decay constant, or the reciprocal of the mean life. They may, in the second place, be robbed of energy in collisions with normal molecules of their own kind: this rate is a bimolecular one and may be denoted by $k_4 n_A a$. Finally, the excited molecules, atoms or ions may loose energy by transfer during collisions with molecules of another kind, which, let it be supposed, are present at a concentration n_B molecules per ml.: this rate again is a bimolecular one and may be expressed as $k_2 n_A a$. When a stationary concentration of excited molecules has been reached, the rate of production by absorption of light equals the sum of the three rates of destruction. We can thus solve for a, the concentration of excited molecules. But the rate of emission is known to be $k_1 a$. After a is eliminated from these two expressions, the rate, I, of emission becomes $k_1 k_3 n_A/(k_1 + k_2 n_B + k_4 n_A)$. Maximum emission, I_o, coincides with absence of the quenching molecules and is clearly $k_1 k_3 n_A/(k_1 + k_4 n_A)$. The ratio of the intensity of fluorescence in the absence of a quenching material to that in the presence of a quencher is $I_o/I = 1 + \frac{(k_2)}{(k_1 + k_4 n_A)} n_B$. If self-quenching is insignificant, the term $k_4 n_A$ can be ignored; the ratio I_o/I is then a linear function of the concentration of quenching molecules, and the gradient $d(I_o I)/dn_B$ is the ratio of two velocity coefficients, k_2/k_1. The decay constant, k_1, is known from other sources, and the velocity coefficient that governs the bimolecular process whereby excited molecules are deprived of their energy can thus be determined. When the magnitude of the velocity coefficient is compared with the number of collisions, as given by the formula in the section on coagulation, varying results are obtained, according to the quenching molecule. Collisions between electronically excited quinine ion and normal iodide ion in water almost invariably lead to a radiationless transfer of energy. Collisions of the same organic ions with other inorganic quenchers are never quite so efficient. Inorganic ions, in fact, range themselves in an order of quenching efficiency that is the same as the order of electronic polarizability, coagulation power and lyophilic activity. The constant k_2 for gaseous processes, such as the damping of resonance radiation of sodium atoms by nitrogen molecules, is usually greater than the number of collisions occurring per milliliter per second. This result has generally been interpreted as indicating that the electronically excited atom has a larger radius than the normal atom.

Perhaps the chief theoretical interest attaching to work on the quenching of resonance radiation in gases and of fluorescence in solution is that it brings to the fore the mechanism according to which, during collisions, energy of one kind is converted into energy of another kind. The present examples are confined to the conversion of electronic energy into some other form; *e.g.*, into kinetic energy, but the problem posed is a much more general one. When, for example, an atom of argon collides with a molecule of nitrogen, does the kinetic energy of the atom become exchanged for the kinetic energy of the molecule? Or does the atom during collision transmit its energy into vibrational energy of the molecule? In principle, these are questions that the quantum theory is able to answer but, in practice, little has yet been done in deriving the mathematical solution. A difficulty in the way is that complete information is required of the forces at work, and this is not always available. Assumptions as to the form of forces acting at short distances were made, for example, by C. Zener, who consequently arrived at a partial solution of the problem of conversion of energy from the kinetic to the vibrational kind. Arnold Eucken and his collaborators pursued the same problem experimentally, using acoustical methods. The limit of accumulation of vibrational energy in a diatomic molecule corresponds to its dissociation into atoms, a process that is known to happen in certain cases of resonance quenching. Moreover, the most efficient quenchers are diatomic molecules whose energy of dissociation lies near to the quantum of energy emitted by the electronically excited atom. The theory of energy transfer during collisions was, in the early 1960s, in its infancy, and many more experimental guides such as those enumerated here will probably have to be discovered before any considerable growth can ensue.

5. Spectroscopy.—Studies made after 1930 of the radiation absorbed and emitted by chemical compounds in the gaseous and dissolved states of matter have given the physical chemist a more penetrating insight into the structure of molecules than would have been thought possible at the beginning of the 20th century. The key to the interpretation of the multitudinous spectra exhibited was provided by Rutherford and Niels Bohr in their treatment of the spectrum of the hydrogen atom. According to their theory, the hydrogen atom can exist only in definite energy states; all conceivable energy states lying between these so-called "quantized" states are excluded from the realm of possibility. The energy levels are related to one another in the ratio of the inverse square of the integral ordinal numbers. To adopt an analogy effectively used by Bertrand Russell, it is as if the citizens of some fictitious town were allowed to possess curious sums of money, such as £100, £25 and £11 2s. 2⅔ d., but not sums intermediate between these. All transactions would then be in terms of equally curious sums, such as £75, £13 17s. 9⅓d., but not in intervening quantities. Analysis of the spectra of molecules shows that molecular electronic levels resemble atomic electronic levels. Vibrational energies in molecules are, however, almost directly proportional to integral ordinal numbers, and rotational energies are approximately proportional to the squares of integral numbers. If the translational energy is excluded, the total energy of molecules may be considered as made up of three components, *viz.*, the electronic energy, E_e, the vibrational energy, E_v, and the rotational energy, E_r. Then $E = E_e + E_v + E_r$. The difference between two neighbouring electronic energy levels in molecules is usually commensurable with the difference in the electronic levels in atoms. For every electronic energy level there exists a number of vibrational levels, which lie relatively near to one another. Associated, in turn, with each vibrational energy level are many rotational levels, which, generally, lie still nearer together. The rotational energy, E_r, of a molecule in any given state depends not only on the rotational quantum number, J, but also on the vibrational quantum number, v, as well as on the electronic quantum number necessary to define completely a given molecular state. The vibrational level is also to some extent dependent on E_e, but the latter is independent of either J or v. The transition of a molecule from a state with energy E to one with a higher energy, E', is accompanied by the absorption of a quantum of radiation, $h\nu$, where h is Planck's constant and ν is the frequency of the radiation absorbed. The frequency $\nu = (E' - E)h =$

$$\frac{E_e' + E_v' + E_r'}{h} - \frac{E_e + E_v + E_r}{h} = \frac{E_e' - E_e}{h} + \frac{E_v' - E_v}{h} + \frac{E_r' - E_r}{h} = \nu_e + \nu_v + \nu_r.$$

When both ν_e and ν_v are zero, all the absorption lines in the spectrum are the result of transitions between two states of the molecule with fixed electronic and vibrational quantum numbers; the lines of absorption are said to constitute a pure rotation band, and, since they occur between energy levels that lie very close together, the frequencies of the absorbed radiation are low, and therefore the wave lengths of the absorption lines are large. They are found in the infrared region of the spectrum. When only $\nu_e = 0$, the lines may be caused by transitions between molecular states differing in both their vibrational and rotational quantum numbers; the lines constitute vibration-rotation bands and often appear in the visible region of the spectrum. When ν_e, ν_v and ν_r all have positive values, the lines of absorption or emission correspond to transitions between molecules that have different electronic, vibrational and rotational energies. The whole band system may then extend right across from the far infrared to the far ultraviolet regions. Because of the inequality $\nu_e > \nu_v > \nu_r$, it follows that the general position of a nonelectronic band is governed by the vibrational quantum number, while the structure of the various bands is determined by the rotational quantum numbers.

Special apparatuses and techniques pertain to the various spectra, and, although many physical chemists have devoted their time to the investigation of molecular spectra, the subject is so vast and the experimental intricacies attached to the various spectral regions so specific, that few investigators, if any, can claim to be directly acquainted with more than one technique. Experimentally, the investigators are grouped as infrared, visible region and ultraviolet spectroscopists, and, as will be shown in the next section, as Raman spectroscopists. Details of the investigations will not be discussed here. It is, however, necessary to outline the theoretical sections of the quantum theory that have been advanced by spectroscopic knowledge and to indicate briefly what information of value to the physical chemist has emerged in very simple cases.

According to the quantum theory, the rotational energy of a diatomic molecule, with a moment of inertia, I, is $E_r = J(J+1) \times \frac{h^2}{8\pi^2 I}$ where $J = 0, 1, 2, 3 \ldots$. The difference in energy between two neighbouring states is thus $J(J+1)(h^2/4\pi^2 I)$. The greater the rotational quantum number, the farther apart are the energies of any two neighbouring states. The emission frequencies that form given states to those immediately below them are, by the Bohr frequency law, $(J+1)(h/4\pi^2 I)$. Transitions between systems performing simple harmonic motions, of which free rotation is an example, can take place only with unit change in the quantum number. The frequencies of the radiation absorbed or emitted by diatomic molecules in the infrared region of the spectrum should therefore be $\frac{h}{4\pi^2 I}$, $2\frac{h}{4\pi^2 I}$, $3\frac{h}{4\pi^2 I}$, etc. Except for a small correction, this conclusion has been verified in the case of the hydrogen halides. Karl Czerny found that the pure rotational frequencies (in reciprocal seconds) of hydrogen chloride and hydrogen bromide are, respectively, $6.034 \times 10^{11} \times M$ and $5.002 \times 10^{11} \times M$, where M is 1, 2, 3, 4, ... Now the moment of inertia is the product of the reduced mass of the rotator and the square of the distance apart of the nuclei. In this way it is possible to determine accurately the internuclear distances in simple molecules. The results for hydrogen fluoride, hydrogen chloride, hydrogen bromide and hydrogen iodide are, in angstrom units, 0.923, 1.281, 1.421 and 1.617 respectively.

A more detailed analysis takes into account the fact that ordinary hydrogen chloride, for example, is a mixture of two kinds of molecules, one of which contains the chlorine atom of atomic weight 35, and the other the chlorine atom of atomic weight 37. The internuclear distance is found to be the same for the two molecules.

If the nuclei in a diatomic molecule were to vibrate harmonically with a frequency ν, the total vibrational energy of the molecule characterized by a quantum number, v, would be $E_v = (v + \frac{1}{2})h\nu$, and, by the Bohr frequency relationship, the frequency of the radiation absorbed or emitted would be $\nu_v = \nu$. But, since transitions between harmonically vibrating systems must coincide with unit changes in the quantum number, there should be only one absorption or emission line, and its frequency should be identical with the vibration frequency of the molecule. H. Deslandres showed that the vibrational energy levels are more satisfactorily reproduced by the equation, $E_v = (v + \frac{1}{2})h\nu - x(v + \frac{1}{2})^2 h\nu$, in which the empirical factor, x, though numerically small, is never zero. It can be shown to be approximately equal to $h\nu/4D$, where D is the energy necessary to dissociate the molecule into atoms. The analysis of the vibrational spectra of simple molecules thus yields information on two important properties—the frequency of internuclear vibration, and the energy of dissociation. The vibration frequencies of the halogen molecules, in units of 10^{12} reciprocal seconds, are thus found to be 16.03 (Cl_2), 9.712 (Br_2) and 6.424 (I_2). The dissociation energies of the alkali metal diatoms, expressed in units of kilocalories per gram-molecule, are, by the same method, found to be 23.7 (Li_2), 16.8 (Na_2) and 11.85 (K_2).

The absorption or emission lines in the electronic spectra of simple molecules can be represented semiempirically by equations of the Ritz-Rydberg form, which include terms inversely dependent on the square of an integral number. The constant term in the formula affords an analytical means of estimating the limit of absorption of electronic energy, and thus of the energy required to eject the least firmly bound electron. Ionization potentials of simple molecules and electron affinities of simple ions thus come within the reach of experiment. Both are of fundamental importance in the description of the electronic structure of molecules, a subject that, from the purely theoretical aspect, is fraught with complications.

From these elementary beginnings, modern physicochemical spectroscopy bifurcates. One branch seeks, with only qualified success, to extend to more complicated molecules the dynamic principles on which the spectra of diatomic molecules have been interpreted. The more complicated the molecule, the greater is the number of electrons and nuclei contained in it, and the more numerous, for that reason, are the ionization potentials and the internuclear frequencies. The other branch is directed to the applications of the spectra to the problems of chemical analysis and has progressed further. Spectroscopic methods are now familiar not only for detecting impurities in suspect samples but also for estimating the composition of mixtures that could not be analyzed by ordinary physicochemical methods. The preparation of vitamins from fish oils and the rectification of high-grade aviation fuels from petroleum are but two of the important industrial spheres in which spectroscopic analyses have proved to be supreme.

6. The Raman Effect.—In absorption spectra, atoms and molecules assimilate only those quanta of radiation to which they are constitutionally adapted. In Raman absorption, incident light of an arbitrary frequency is used. Moreover, the experimental technique is relatively simple. Raman instruments now take their place among the most useful tools of the physicochemical workshop.

It has been known since John Tyndall's time that a faint blue colour becomes visible from all directions when a beam of white light is passed through a pure transparent medium. Light of short wave length is more readily scattered than light of long wave length, as Rayleigh emphasized in his explanation of the blueness of the sky. When, instead of white light, a beam of monochromatic radiation is allowed to pass through a homogeneous specimen of matter, light detected in a direction perpendicular to that of the incident beam is found to contain, in addition to the original radiation, light of other frequencies in numbers and intensities that depend on the scattering medium. The displaced lines, on analysis after resolution in the detecting spectroscope, are found to be much fainter than the line resulting from the original light; exposures of several days are often necessary for the measurement of their position and intensity. The scattering of homogeneous radiation by chemical compounds is termed the Raman effect (*q.v.*). It was experimentally established by Sir C. V. Raman and K. S. Krishnan in 1928, though its occurrence had been theoretically foreshadowed by A. Smekal in 1923. Since its discovery, tens of thousands of compounds have been investigated by its means, with important consequences.

Consider a head-on collision between a quantum, $h\nu_1$, of incident light and an atom or molecule of mass, m, which is supposed to be moving with velocity v_1 and to possess an internal energy, E_1, in addition to its kinetic energy, $\frac{1}{2}mv_1^2$. The energy of the incident photon is $h\nu_1$, and, according to an important quantal law discovered by Louis Broglie, its momentum is $h\nu_1/c$, where c is the velocity of light. The laws of the conservation of energy and momentum then give the relations $h\nu_1 + E_1 + \frac{1}{2}mv_1^2 = h\nu_2 + E_2 + \frac{1}{2}mv_2^2$ and $(h\nu_1/c) + mv_1 = (h\nu_2/c) + mv_2$. The maximum energy exchange clearly occurs when $\nu_1 = 0$ and $\nu_2 = 0$, *i.e.*, when the kinetic energy of the incident photon is completely converted into kinetic energy of the atom or molecule that was initially at rest. Only head-on collisions have been considered here, but it can be shown by classical dynamics that the conclusion is a true one in general. It follows that the maximum gain in kinetic energy is $\frac{1}{2}\,mv_2^2 = \frac{1}{2m}(mv_2)^2 = \frac{1}{2m}\left(\frac{h\nu_1}{c}\right)^2$. Under the most favourable conditions, therefore, the fraction of the incident energy, $h\nu_1$, that is convertible is $h\nu_1/2mc^2$. This is of a very small order of magnitude. When, for example, the 4358 Å line of the mercury spectrum is used as incident radiation, and carbon tetrachloride as the scattering medium, the fraction proves to be less than 10^{-11}. Any change in the frequency of the light caused by its passage through the medium must accordingly be the result of a change in the internal energy of the molecule. The first of Smekal's equations now becomes, effectively, $\nu_1 - \nu_2 = (E_2 - E_1)/h$. The difference between the frequencies of the incident and emergent radiation is termed the Raman frequency: it could with more logic be termed the Raman shift. We have, then, the relation $\nu_R = \nu_1 - \nu_2$ where ν_R can be greater than, equal to or less than zero, according to whether the light is displaced toward the red end of the spectrum, is unaffected or is displaced toward the ultraviolet end of the spectrum. The responsible collisions are said to be, respectively, inelastic, elastic or superelastic. The extent of the displacement in the two directions is the same, so that lines in the scattered radiation appear in pairs, equidistantly draping the undisplaced line. The intensities of the two displaced lines are, however, very different, and, by measuring the way in which the ratio of the two intensities varies with respect to the temperature, it has been possible to ascribe a numerical value to Planck's constant, h.

Although the occurrence of the Raman effect becomes intelligible in terms of Smekal's hypothesis, its true origin is to be traced to the fact that, on account of the vibratory motion executed by the atoms within a molecule, the molecular polarizability varies with the phase of intramolecular motion. The interplay between the variable internal field thus set up and the harmonic field caused by the electrical component of light results in the generation of three electromagnetic vibrations, of frequencies ν_L, $\nu_L + \nu_R$ and $\nu_L - \nu_R$, where ν_L is the frequency of the incident light and ν_R is the Raman frequency.

The commonest source of light used is that given by the mercury-vapour discharge tube, which emits strong radiation of wave lengths 5460.74, 4358.34 and 4046.56 angstrom units. These correspond to the reversal of the electronically excited mercury atom from the 2s state to the three 2p states. Two of these radiations may be cut out by suitable filters (such as quinine sulfate to eject the 4047 line), and as intense a beam of the monochromatic 4358 line as possible is used to irradiate the medium—generally in the pure liquid phase. The total light emitted is recorded on a photographic plate after the light is passed through a prism.

Experiment shows that the Raman shift, *i.e.*, the difference between the frequencies (or wave numbers) of the incident and scattered radiation, is (1) independent of the frequency of the incident light; and (2) to a first approximation is independent of the state of the scattering substance. By virtue of Smekal's equations, the quantum $h\nu_R$ equals the difference between two stationary energy levels of the scattering molecule. The Raman wave numbers, in reciprocal centimetres, of the chloride, bromide and iodide of hydrogen in the gaseous phase are, respectively, 2880, 2558 and 2233. Very often the evidence afforded by Raman spectroscopy is complementary to that given by infrared absorption spectroscopy, as lines missing in one may appear in the other. In the case of the three heteronuclear diatomic molecules mentioned here, the missing null lines in the infrared spectra of the gases have the wave numbers 2887, 2559 and 2240, respectively. Experiments show that the Raman wave numbers of these three compounds in the liquid state are about 80 less, and in the solid state about 130 less, than in the gaseous phase.

The Raman spectra of polyatomic molecules are naturally more complicated. An important guiding principle revealed by extensive experiments is that a given bond in a complicated molecule often gives rise to a Raman frequency that is but slightly affected by variations in the structure of the remaining portions of the molecule. All incompletely substituted aliphatic compounds, for example, exhibit a Raman shift in the neighbourhood of 2934 cm.$^{-1}$. A line near 1700 cm.$^{-1}$ is invariably found in the Raman spectra of carboxylic acids, aldehydes, ketones, acid chlorides and esters, and is naturally attributed to the presence of the carbonyl group, $=C=O$. The exact value found for the methyl, ethyl, propyl, butyl and amyl esters of formic acid is 1718 ± 3, and for the corresponding values for the esters of chloroformic and acetic acids the values are, respectively, 1775 ± 5 and 1738 ± 2 reciprocal centimetres. These variations, though genuine, are not great enough to invalidate, as a guiding rule, the principle of a virtual independence of group frequencies. In this way, characteristic Raman shifts may be allotted to atom pairs in polyatomic molecules, such as the wave number 3050 for the —C—H pair in aromatic hydrocarbons and that of 2924 for the same pair in aliphatic hydrocarbons. The spectra of amines, alcohols and mercaptans similarly yield 3370 for the —N—H group, 3650 for the —O—H group and 2572 for the —S—H group.

Higher values of the Raman frequencies are obtained when the two atoms are joined by divalent bonds, and still higher values when the same two atoms are united by the tervalent bond. Thus, when the carbon-carbon, the carbon-nitrogen and the carbon-oxygen bonds are examined, each in the three valency states, the ratio of the Raman shifts in 1:1.63:2.10. Now it can readily be shown that the average restoring force of a linear harmonic oscillator is proportional to the vibration frequency raised to the power of 3/2, and is in fact equal to $\pi(h\mu\nu^3)^{\frac{1}{2}}$, where μ is the reduced mass. It is thus shown, as A. Dadieu and F. W. G. Kohlrausch first pointed out, that, for univalent, divalent and tervalent bonds between the same pair of atoms, the average restoring forces stand in the ratio of 1 to 2.08 and 3.05. The classical theory of valency is thus quantitatively vindicated by the study of the Raman effect. It is, thus, a natural result to find that the average restoring force exerted in the carbon-nitrogen bond contained in oximes, ketimines and isocyanates is intermediate in strength between the average forces exerted, on the one hand, in amines, amides and pyrroles, and, on the other hand, in nitriles, ferrocyanides and cyanamides.

Only a few instances can be cited of the further application of the Raman technique to physicochemical problems. In the familiar conversion of the keto to the enol modification suffered by ketonic compounds, the characteristic ethylenic lines at 1632 and 1725 cm.$^{-1}$, which are present in the spectrum of ethyl acetoacetate (the ethyl ester of acetoacetic acid) are found to be absent from the spectrum of ethyl dimethyl acetoacetate, which shows, however, a doublet at 1707 and 1738, which is typical of the carbonyl group. In the polymerization of methyl methacrylate, the Raman line resulting from the $C=C$ bond gradually vanishes and is almost completely absent from the final polymer formed, which indicates that the double bond is obliterated during the linking up. The great similarity between the Raman spectra of the tertiary butane molecule and the tetra methyl-ammonium ion establishes a regular tetrahedral configuration for the latter. Finally, promising attempts have been made at computing, from a knowledge of the Raman frequencies, the specific heat of certain liquids and the latent heats of fusion of certain solids.

7. The Kinetic Theory of Gases.—With the exception of the atomic theory of matter, no theory has so powerfully influenced chemistry as the kinetic theory of gases. Its origin may be traced, through Gassendi in the 17th century, to the early speculations of the Greek philosophers, but its formulation as we now know it is due in equal measure to the German scientist Boltzmann and the British scientist Maxwell; their classical theorems on the distribution of energy and velocity appeared in 1859. It is worthy of note that many of the ideas essential to the theory, though inaccurately formulated, were expressed in 1845 by J. J. Waterston, whose celebrated communication was not published until 1892. The original postulates are that the molecules constituting a gas are hard, perfectly elastic spheres, endowed with incessant translatory motion, and occupy a volume that is negligible compared with the total volume of the gas. The velocities, momenta, energies and directions of motion are not the same for all the molecules in any specimen of gas but are distributed among them according to the formal laws of probability.

Few of the postulates underlying the original theory are now regarded as valid, but enormous advances have been made by accepting them as working propositions, and by inventing additional postulates to explain divergences between theory and practice.

The kinetic theory of gases gives a logical meaning to the well-known laws of Robert Boyle, J. A. C. Charles and Avogadro. Thomas Graham (1829) showed that the velocity of effusion of gases at a constant temperature should be independent of the pressure and inversely proportional to the square root of the molecular weight. He verified this theoretical deduction by measuring the rates of effusion of nitrogen and ethylene, which were found to be nearly equal, and the relative rates of effusion of hydrogen and oxygen, which were found to be 3.815:1.000, as compared with the anticipated value of 3.985. Atmolysis, the separation of gases by diffusion, was used by Sir William Ramsay and M. Travers to isolate helium from other gases, and by Rayleigh and Ramsay to effect a partial separation of argon from nitrogen with the aid of the celebrated churchwarden pipe technique. In this experiment, a mixture of gases of unequal molecular weight is made to flow through a tube that bifurcates into one tube of glass and one formed of two churchwarden pipes joined together. The lighter gas diffuses through the clay walls more readily than the heavier one, and partial separation can be effected. The formula (O_3) of ozone was first established as a result of diffusion experiments.

According to the kinetic theory, the specific heat of gases, and the ratio (γ) of the specific heat at constant pressure to that at constant volume, should be independent of the temperature and determined by the number of atoms in the molecule. The first of these conclusions has proved to be untrue, and the real effect, which is an increase in the specific heat with a rise in temperature, has been understood, in terms of the quantum theory, only comparatively recently. The second conclusion, though limited in validity, has been of direct value to chemistry in allowing an experimental determination of the number of atoms in molecules. Rayleigh and Ramsay (1894) found γ, from the velocity of sound in the gas, to be nearly 1.67 in the case of argon, and concluded that this molecule was therefore monatomic.

Ramsay (1879) gave the first kinetic interpretation of the Brownian movement as the motion of small particles resulting from molecular impacts with molecules of the surrounding medium. This interpretation led later (1905) to the kinetic theories of the effect by Einstein and by Smoluchowski (1906), and to the first reliable experimental value of the Avogadro number by Perrin (1909). The Brownian movement of smoke particles studied by E. N. da C. Andrade and R. C. Parker (1937) offers direct visual evidence of the effects of collisions by gas molecules on the movements of small particles of suspensoid.

The coefficients of viscosity, diffusion and thermal conduction are given by the kinetic theory in terms of the molecular diameters (P. G. Tait, 1886–92). The three methods afforded early values of molecular radii, which agree among themselves and with those obtained by numerous other methods, of which only two—both devised by Rayleigh—need be mentioned here. The first (1871) depends on the refraction of light by particles of molecular dimensions, and the second (1905) is based on the computed minimum thickness of an oil layer found necessary to stop the Brownian movement of camphor particles in the water-air interface. The value estimated by Rayleigh by the second method was 16×10^{-8} cm. His kinetic treatment of the effect forms the basis of the Langmuir-Adam-Rideal (Langmuir, N. K. Adam and E. K. Rideal) trough techniques for examining surface films.

The kinetic theory in its original form accounts only for the kinetic pressure exerted by a gas and ignores intermolecular cohesion. The second factor is necessary to explain the condensation of gases into liquids, a process that was investigated experimentally by T. Andrews (1862) in his work on critical phenomena and theoretically by James Thomson (1871) and van der Waals (1871) in their theories of the continuity of states. The existence of cohesive forces between molecules is manifested by the cooling that ordinarily occurs when a gas expands. By developing the porous plug experiment of J. P. Joule and James Thomson, both Sir James Dewar (1900) and M. W. Travers (1900) succeeded in liquefying hydrogen, which is one of the two gases that Michael Faraday was unable to liquefy by other means. It is the liquefaction of gases, and of helium in particular, that has enabled all the recent work to be done on physical and chemical properties of matter at low temperatures.

The classical work of Sir Joseph John Thomson on the conduction of electricity through gases followed the observation of Sir William Crookes (1881) that the viscosity of gases at low pressures is less than that predicted by the kinetic theory.

The fundamental ideas of the kinetic theory of gases have been extensively applied to systems other than the gaseous system. In particular, they have greatly influenced the development of the theories of solution, which stimulated the precise experimental work of E. G. J. Hartley and Lord Berkeley, and led to van't Hoff's hypothesis of osmosis.

The kinetic theory in its primitive form affords expressions for the number of collisions taking place in unit time between gas molecules and unit area of a surface and between gas molecules themselves in unit volume. The former of these expressions was compared by Rayleigh with the rate of oxidation of solid silver oxide by gaseous ozone (1912), and the latter was compared by Trautz (1916) and Lewis (1918) with the rate of decomposition of gaseous hydrogen iodide. The collision hypothesis, supplemented by the fundamental conception of a random distribution of energy, has since dominated the field of chemical kinetics and surface catalysis.

Extensions of the kinetic theory of gases to cover the repulsive and attractive forces exerted between the molecules were made by A. W. Chapman (1915) and by Sir John Lennard-Jones (1924). The theory has also been extended to the kinetics of solutions (1933).

To the experimental chemist, the kinetic theory has given a picture of how molecules behave and has made it possible for him to construct in his imagination the types of molecular interactions that constitute chemical change. It has given him a lively and interesting method of approach to many of his problems, a method that is neither as formal as that of thermodynamics nor as difficult as that of statistical mechanics.

8. The Maxwell-Boltzmann Law.—Reference has already been made to the theorems of Maxwell and of Boltzmann on the distribution, respectively, of momenta and energies among gaseous molecules. Boltzmann proved that the fractional number of molecules retained in a system at constant volume and temperature that possess an energy, E, per molecule, is proportional to the term $e^{-E/kT}$, where e is the base of the natural logarithms, T the temperature on the Kelvin scale and k a constant that is independent of the system; k is now recognized universally as Boltzmann's constant. As E increases, the Boltzmann factor $e^{-E/kT}$ decreases. Hence, the number of molecules that are energetically well-endowed is relatively small, while the number of molecules with lower energies is large. Energy among molecules is thus like money among men; the poor are numerous, the rich few. This law has proved to be one of the securest possessions of natural science and has survived the storms of quantal mechanics that overthrew so many of the stately edifices constructed in the placid days of classical mechanics. Salvador de Madariaga held that the derivation of the Maxwell-Boltzmann law offered the best example of pure logical deduction evinced since the middle of the 19th century. Its derivation will not be discussed here, but some indication must be given of its far-reaching effects on the development of many physicochemical themes.

When a liquid is kept in a closed vessel, like wine in a bottle, the molecules in the closed system distribute themselves between the condensed and vaporous phases in such a way that (except at the critical temperature) the molecular concentration in the vapour is considerably less than that in the liquid. The explanation, according to the Maxwell-Boltzmann law, is that only those molecules of the liquid that possess an energy L can vaporize. L is the latent heat of vaporization and is usually large; hence the number of liquid molecules that have sufficient energy to detach themselves from their neighbours in the condensed state is relatively small.

A very similar state of affairs prevails in the case of electrons in metals. It is known that the atmosphere above the surface of a cold metal is electrically neutral. At high temperatures, however, all metals emit a stream of electrons that constitutes the so-called "thermionic current" so extensively utilized in the construction of electronic tubes. O. W. Richardson discovered that the logarithm of the current is proportional to the reciprocal of the absolute temperature. In other words, the current itself has a strength that is proportional to $e^{-W/kT}$, where W is positive. In terms of the Maxwell-Boltzmann law, W can be identified as the work that must be expended to remove an electron from inside the metal. It is known as the thermionic work term and was shown by Einstein to be equal to the quantum, $h\nu$, of light necessary at the threshold frequency to emit electrons in the photoelectric effect.

It is well known that high-altitude aviators must carry their own supply of oxygen with them, because the concentration of this vital gas at great heights is too attenuated to support life. The distribution of concentration with height is again governed by the Maxwell-Boltzmann law. The concentration, n_1, at a height H_1, is proportional to $e^{-mgH_1/kT}$, where m is the mass of one molecule and g the gravitational constant. At the same temperature but at another height, H_2, the concentration, n_2, is proportional to $e^{-mgH_2/kT}$. The ratio of the concentrations at two heights differing by H is thus $n_1/n_2 = e^{mgH/kT}$. The earth's atmosphere is not the most suitable medium for testing this equation because the molecules are invisible, and because of the overwhelming complications due to meteorological factors. In work with colloid particles suspended in water at a constant temperature, however, the numbers may be counted by visible means and the difference in height measured microscopically. This Perrin did in his researches that both verified the law and afforded an experimental determination of the Boltzmann constant, k.

The Maxwell-Boltzmann law forms the basis of the modern theories of electrolytic solutions, which were first proposed by S. R. Milner in 1913 and were improved by P. Debye ten years later. The electrolyte is regarded as dissociated completely or partially into ions, in a medium of uniform dielectric capacity. The random distribution of ions in solution differs from the random distribution of molecules in a gas, because of the strong Coulombic forces exerted between them. When the Boltzmann law is applied to a determination of the ionic concentration in the neighbourhood of any selected ion, the selected ion will be surrounded by a relatively high concentration of ions of the opposite sign, and by a relatively low concentration of ions of the same sign as its own. This uneven distribution of electrical charges leads to the formation, around each ion, of a cloud of ions whose net charge is opposite that of the ion. The total electrostatic energy of ionic solutions is thus diminished and is less than the electrostatic energy of the same number of ions in an infinitely dilute solution. In extremely dilute solutions of electrolytes of low valency type, the Milner-Debye theory has been corroborated in various ways; for example, by measuring cryoscopically the activity coefficients of electrolytes, by determining the ionic mobility in electrical fields and by estimating the effect of dilution on the heat of dissolution. The assumption that the Maxwell-Boltzmann law applies to electrolytic solutions is one of its least debatable ones and is certainly less dubious than the law of the invariance of the dielectric capacity of the medium.

The intensity of a line in the Raman spectrum is proportional to the stationary concentration of excited molecules in that state; transition from that state causes the emission. If I_b and I_r stand, respectively, for the intensities of the lines displaced toward the blue and red ends of the spectrum from the central position of the undisplaced line, then the following expression holds, according to the Boltzmann law for the ratio of the intensities: $R = I_b/I_r = e^{-Eq/kT}/e^{-Ep/kT}$. But, from the discussion of the Raman effect, it is known that $E_p - E_q = 2h\nu_R$; hence $R = e^{2h\nu_R/kT}$. As the temperature rises, the ratio approaches unity. By plotting $\log_{10}R$ against $1/T$, this relation was verified independently by P. Daure and by L. S. Ornstein and J. Rekveld. The gradient determined from experiment yields the value of 4.79×10^{-11} degree-seconds for h/k. If k is taken as 1.372×10^{-16} erg per degree, h thus becomes 6.56×10^{-27} erg-second; this result satisfactorily confirms the more accurate estimates based on the photoelectric effect and the spectrum of atomic hydrogen.

Finally, it was shown by J. J. Hood (1878) and by Arrhenius (1889) that the logarithm of the velocity coefficient of a chemical reaction is linearly related to the reciprocal of the absolute temperature. The velocity itself is thus proportional to $e^{-E/kT}$, where E is termed the energy of activation. This relationship is the foundation of chemical dynamics.

In these instances of the application of the Maxwell-Boltzmann law, care has been taken to emphasize the proportionality between, rather than the identity of, the fractional number of energized molecules and the factor $e^{-E/kT}$. The ratio of the number of active molecules to the total number is equal to the exponential term only when the energy concerned can be expressed as the sum of two quadratic terms. A generalized form of the law was derived by A. Berthoud (1911).

9. Chemical Kinetics.—Instructions for the preparation of chemical compounds frequently contain such phrases as "heat substance A with substance B for two hours." The time element is important in the process; its inclusion aims at the most abundant yield of the desired commodity. The process of preparing chemical compounds is, of course, one of the principal activities of the chemist. Physical chemists have two guides to help them. One is thermodynamics, which can, in principle, tell them how far any reaction can go, given all the relevant thermal data; the other is chemical kinetics, which can, in most cases, tell them how fast the reactions can go. Chemical kinetics, since its inception by Wilhelmy in 1850, has proved to be one of the most popular branches of physical chemistry, and one which has shown the most consistent and continuous growth. It introduces time as an essential variable in chemical systems. The laws of chemical kinetics, rigidly formulated, all contain time as a factor, and reduce, when the time is extended to infinity, to the equilibrium laws of chemical thermodynamics. The formal side of chemical kinetics deals with the velocity of chemical change in all systems. In its development, however, a machinery has been created for handling a variety of problems outside its formal sphere and for solving problems that have proved too difficult for chemical thermodynamics or statistical physics. Adsorption, discussed in the first section of this article, provides a good example. Other problems that have been successfully approached by the method of chemical kinetics are the standard electrode process, overpotential, the conduction of electricity through gases, vaporization, enzyme structure, dissolution, the persistence of clouds and the disorderliness of simple binary systems in the condensed phases.

Clearly one condition that must be fulfilled before molecules can react is that they should meet. If an encounter between two molecules is a sufficient condition for reaction, the rate of chemical change should be equal to the rate of collisions. Two physical changes have already been discussed from this point of view, and it has been shown that the rate at which colloid particles in the gas phase and in solution coagulate and the rate at which electronically excited molecules in both systems are deprived of their energy are equal to the rate at which the molecules meet. Binary collisions are thus a necessary but not always a sufficient condition for the occurrence of these physical changes. When, however, the rate of chemical processes is examined in the light of the collision hypothesis, a wide disparity is found. Experiment shows that only a very small fraction of the total number of collisions is fruitful. Trautz, in 1916, and Lewis independently in 1918, argued that, since only molecules possessing exceptional energies can undergo chemical change, the rate of reaction should be compared not with the total rate of collisions but with the rate of activating collisions, which, according to the Maxwell-Boltzmann law, is less by the factor $e^{-E/RT}$, where E is the energy of activation. Experiment shows that the energies of activation for the decomposition of ozone into oxygen, of hydrogen iodide into hydrogen and iodine and of nitrous oxide into nitrogen and oxygen are, respectively, 26,365, 47,275 and 61,550 cal. per gram-mole. The Boltzmann factors are thus extremely small. Nevertheless, when multiplied by the total collision rate, they yield products that are experimentally indistinguishable from the rates of chemical reaction. This conclusion forms the basis of the collision theory of chemical change.

An application of the same reasoning by Christiansen in 1924 to reactions in solution met with less success, in that a considerable discrepancy appeared between the observed rates and those computed on the basis of the collision theory. It was, therefore, maintained for some years that the theory, though apparently applicable to gases, was not, without drastic modifications, applicable to solutions. In 1932, however, it was revealed that hundreds of reactions in solution, some of which had been examined with great accuracy during the 19th century, fitted in perfectly with the predictions of the collision theory. Thousands more have since been discovered, and there now remains no doubt that the theory of activating collisions, sometimes in revised forms, is fundamentally sound. Among these numerous reactions are to be found the etherifications of alkyl halides by organic bases such as sodium methoxide, potassium phenoxide and alkali β-naphthoxides, the replacements of halogen and hydroxyl from aliphatic compounds by anions in various solvents, the union of ethyl bromide with ethyl sulfide in hydrolytic media, and the formation of the bicarbonate ion from carbon dioxide and the hydroxyl ion in aqueous solution.

Occasionally when two chemical compounds interact, only one of them suffers chemical change, while the other, which is termed a catalyst, emerges from the reaction unchanged. These catalytic reactions are essentially bimolecular, and their rates, with few exceptions, are also in agreement with the prediction of the collision theory. The catalytic mutarotation of the reducing sugars by hydrogen ions, the catalytic decomposition of ethylene iodide by iodine atoms, the catalytic mutarotation of beryllium benzoylcamphor by cresol, the catalytic conversion of the picryl ethers of benzophenone oximes by acetone and nitromethane are all processes whose rates are given by the expression: number of molecules reacting in unit volume in one second equals the number of collisions between catalyst and reactant in unit volume in one second multiplied by $e^{-E/RT}$.

If only those molecules that possess considerable energies in excess of the average can react, on what is this energy expended? The answer was first given by W. Heitler and F. London in 1927. Chemical change involves first the loosening and finally the breaking of a chemical bond and usually the simultaneous formation of a new bond. To break a bond requires energy; and this, duly compensated by energy liberated in the formation of another bond, constitutes the energy of activation. Heitler and London showed how the energy of activation could be calculated from first principles for very simple chemical changes, such as the following reaction between an atom, A, and a diatomic molecule, BC; $A + B - C \rightarrow A \cdot B + C$. The initial system corresponds to a free atom, A, at an infinite distance from the stable molecule, BC, the atoms in which are at their normal, or equilibrium, distance apart. This state of affairs may be described by saying that r_{AB} is infinite, and $r_{BC} = r^0_{BC}$. The final state, after the completion of reaction, corresponds to a free atom, C, at an infinite distance from the stable molecule, AB. This state of affairs may be summarized by saying that $r_{AB} = r^0_{AB}$, and that r_{BC} is infinite. Between these stages, the internuclear distances, r_{AB} and r_{BC}, must have had comparable magnitudes, and this very nearly corresponds to the activated state, as D. S. Villars (1930) independently concluded. The difference between the energy of the complex $A \ldots B \ldots C$ in the activated state and the energy of the initial system is the energy of activation. The solution of the dynamic problem is somewhat tortuous and demands an exact knowledge of the forces exerted between the various atoms. The results of calculations on the energy of activation of the reaction between the bromine atom and the hydrogen molecule ($Br + H - H \rightarrow Br - H + H$) are shown graphically in fig. 2. From the energy contours, which are given in kilocalories per gram-mole, it is seen that the easiest of an infinite number of passages from the initial atomic configuration (top left-hand corner) to the final atomic configuration (bottom right-hand corner) requires an ascent of 22,000 cal., and that the two internuclear distances at this pass height are equal to 1.43×10^{-8} cm. The former value is in agreement, though not directly comparable, with the experimental values obtained by Max Bodenstein and H. Luetkemeyer, and later by F. Bach, K. F. Bonhoeffer and E. A. Moelwyn-Hughes, using both ordinary hydrogen and its heavy isotope.

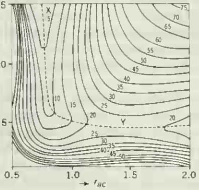


FIG. 2.—POTENTIAL ENERGY CURVES FOR THE SYSTEM BR . . . . . H . . . H

The first calculations of the energy of activation of triatomic reactions according to the Heitler-London method were made by Henry Eyring and Michael Polanyi on the ortho-para conversion of hydrogen, which, as Adalbert Farkas and Bonhoeffer have shown, proceeds by the same mechanism as that previously established for the hydrogen-bromine reaction. Attempts at computing the energies of activation of more complicated reactions have also been made.

If all chemical reactions conformed to the collision theory, chemical changes would proceed with wide ranges of velocities, from the fast reactions that require little energy to the slow reactions that require much, but the changes would, as a rule, be orderly, and would never get out of hand. It is well known that many chemical reactions run riot; they proceed with accelerative rates and lead to explosions. The explanation of the occurrence of thermal explosions and of numerous phenomena with which they are akin was given, principally by Bodenstein, R. Willstätter, Fritz Haber, Christiansen, Kramers and N. Semenoff, in terms of the chain theory of chemical change. The primary notion is one of "hot" molecules; *i.e.*, of chemically reactive molecules produced during the activation process and capable of retaining their energy until an opportunity affords of passing it on to fresh reactant molecules, which in turn become activated. One initial activation can thus lead to the conversion of many molecules. The average number so destroyed per unit activation is termed the chain length. This may amount to many thousands of molecules not only in gases but also in solution, where deactivations by solvent molecules, though possibly not entirely absent, are by no means as probable as they were at one time thought to be. It can readily be shown that, if, in a system containing n molecules per ml., the decomposition occurs by the mechanism under discussion, the rate of reaction becomes $-\dfrac{dn}{dt} = \dfrac{k_1 n^2}{(k_4/k_3)n + (1 - \alpha)}$, where k_1 governs the rate of formation of active reactants by collisions between normal molecules, k_4 governs the rate of destruction of active reactants in deactivating collisions with normal molecules, and k_3 is the unimolecular constant for the spontaneous decomposition of active reactants. The important term α takes account of the fact that not all of the collisions between normal molecules and active products that lead to deactivation are effective in regenerating active molecules of reactants. In all thermal, or "quiet" reactions, α is zero. Chain reactions are characterized by real values of α. In simple cases, the chain length is simply the reciprocal of $(1 - \alpha)$, which may be very large when α approaches unity. Branching chains are characterized by values of α exceeding unity, in which case the denominator in the general rate equation may become zero, and the rate itself may become infinite. This is what is generally meant by an explosion.

The chain theory has been employed to interpret numerous phenomena in the kinetics of chemical changes in gaseous and liquid systems. It can successfully account for the apparently unimolecular behaviour of molecules decomposing in systems of high concentration, though the rate of production of active molecules itself is a bimolecular process, and is therefore dependent on the square of the concentration, and for the distinction between the mechanism of hydrolytic and oxidative enzymic reactions.

The extensions of chemical kinetics resulting from the quantum theory are concerned with the more exact determination of the energy of activation, and with the possibility (precluded according to the classical theory) of the transit of a molecule over a potential barrier while not possessing sufficient energy to surmount it. The latter phenomenon is known as the tunnel effect, and is relevant only for light molecules that penetrate barriers at low temperatures.

10. Intermolecular Energy.—When molecules come near enough to influence one another, at least two forces are brought into play: one of attraction, and one of repulsion. If molecules did not exert forces of attraction, they would not cohere, as they manifestly do in the liquid and crystalline state. Were there no forces of repulsion, the forces of attraction would be supreme, and nothing would prevent molecules from annihilating one another. Much as human conduct is determined by a conflict of loyalties, molecular behaviour is, to a large extent, determined by the balance struck between the forces that tend to pull molecules together and those that tend to push them apart. The detection of the kind of intermolecular force at work in particular systems has been an important new feature of the physical chemistry of the 20th century.

More is generally known about attractive than about repulsive forces. When, for example, two ions, of valencies z_A and z_B, are held at a distance, a, apart, there exists between them, *in vacuo* an energy that C. A. de Coulomb showed experimentally to be inversely proportional to their separation. In fact, the energy is $u = z_A z_B \epsilon^2/a$, where ϵ is the electronic charge $(4.802 \times 10^{-10}$ electrostatic units). The force, X, is given by the general equation $X = -\frac{du}{da}$, which, in the present example, becomes $z_A z_B \epsilon^2/a^2$. Thus, when both ions have charges of the same sign, their mutual energy and the force acting between them are positive, denoting repulsion. When the ions have charges of opposite signs, their mutual energy and the force acting between them are negative, indicating attraction. It is this Coulombic force that, as Rutherford and Bohr first showed, accounts for the tenacity with which electrons in atoms are held to the positively charged nuclei. In crystalline salts, the units are positive and negative ions, such as the sodium and chlorine ions in common salt; and here also, the binding force is almost entirely due to the Coulombic attraction between the ions. It is thus easy to understand why the lattice energy (*i.e.*, the energy required to transform the crystalline salt into gaseous ions) is four times as great for a bi-bivalent salt as it is for a uni-univalent salt of the same molar volume. The Coulombic energy of a pair of ions separated by a medium of dielectric constant, D, is less than that *in vacuo* at the same separation by the ratio D:1. The dielectric constant of water at ordinary temperatures is about 80; hence the force attracting cations to anions in aqueous solution is relatively small and can be effectively combated by the kinetic energy that results from their motion.

The energy of interaction of an ion of charge $z_A\epsilon$ and a dipole of moment μ_B that is inclined at an angle of θ to the line joining their centres is given approximately by the equation $z_A \epsilon \mu_B \cos\theta/a^2$. The mutual energy may now be positive or negative even for a system containing the same ion, because $\cos\theta$ can be positive or negative. It is this term that explains the comparative stability of inorganic ions in solvents of high dielectric constant, such as water, alcohol and nitromethane. In solution, each ion attracts the solvent molecules and forms a shell around itself, with each solvent molecule oriented in the position of minimum energy. The exact number of solvent molecules that forms the first sheath had not been established in the early 1960s, although the co-ordination number of many ions in crystals of hydrated salts was known. When chemical reaction takes place between an ion and a polar molecule, the approach of the ion to the molecule is influenced by the position and magnitude of the dipolar groups that the latter contains. The interaction of the ion with all the dipoles constitutes an important component of the energy of activation and thus modifies the velocity of reaction. In the light of these considerations, it is now, for the first time, becoming clear why the substitution of a given group in the benzene ring may hasten or retard chemical reaction according to the position, relative to the point of attack, that it occupies.

When two dipoles interact, four angles, in addition to the distance apart of their centres, are required in order to express their mutual energy, which now varies inversely as the third power of the distance, as may easily be derived by applying Coulomb's law to the interaction due to each pole, or by carrying out experiments with bar magnets, which are the macroscopic and magnetic analogues of the microscopic and electric moments in molecules. The interaction of permanent dipoles probably explains most of the anomalous properties of binary liquid mixtures, such as those of acetone and chloroform.

The next force of physicochemical interest is that which comes into play when an ion approaches a nonpolar molecule. The field generated by the ion induces an electric moment in the molecule, and the net interaction energy that results is readily shown to be directly proportional to the square of the ionic charge and to the polarizability of the molecule, and inversely proportional to the fourth power of their distances apart. An example is afforded by the attraction of the highly polarizable iodine molecule for the iodide ion; iodine is very sparingly soluble in water but is readily soluble in aqueous iodides.

Many forces vary inversely as the seventh power of the intermolecular distance. The most important is the so-called "dispersion force," which London (1930) showed to be related to the frequency of vibration of the electrons in the molecules. This is the force that accounts for the cohesion of nonpolar molecules in the condensed state. In the case of the inert elements, and of symmetrical molecules such as chlorine, carbon tetrachloride and benzene, the dispersion force is the only attractive one; it also comes into play even in polar cases, where it is often dominant. Deviations of the behaviour of real gases from that of ideal gases are in large measure caused by the presence of London forces.

As stated above, rather less is known of the repulsion forces. These may, it is thought, be exponentially related to the intermolecular distance, or they may vary inversely with respect to the distance raised to some power that must be higher than the power governing the attractive forces. If the latter supposition is provisionally adopted, the total interaction energy of a molecular pair, at a distance a apart, may be expressed as the sum of the repulsive and the attractive energies: $u = Aa^{-n} - Ba^{-m}$, where n is greater than m. This relationship was applied by Gustav Mie in 1903 to a variety of chemical and physical problems. He showed how this equation, which represents the interaction energy of an isolated pair of molecules, can be extended to the evaluation of the interaction energy of a large number, mutually influencing one another, and derived, in terms of the constants, A, B, and the integers, m, n, illuminating expressions for the isotherms, the compressibilities and the expansivities of condensed systems. Mie's equation was later applied by Max Born to the study of solids and by Lennard-Jones to the study of gases.

Other types of forces that are only partially electrostatic in origin are exerted between the atoms in a molecule and give rise to the variety of chemical bonds. It has already been shown that the average interatomic force between two atoms varies linearly with respect to their valencies. How the interatomic forces vary with the distance apart of the nuclei is a problem that is, as yet, only dimly understood. Progress is being made on empirical lines. There is, however, no obscurity about certain conditions that experiment imposes on the general nature of the force laws. It is certain, for example, that the force tending to restore the atoms to their equilibrium positions after they have been slightly displaced therefrom must increase in proportion to the displacement, and thus obey Hooke's law. Only in terms of such an elastic force can the essential harmonicity of the interatomic vibrations, which is proved alike by infrared and Raman spectroscopy, be understood. If, however, only elastic forces were at work, the more the atoms were drawn apart the stronger would be the forces of restitution, and the less would be the likelihood of bond cleavage. Experiment shows that, with increasing separation, the atoms come under the influence of a very weak force, which eventually vanishes as the interatomic distance reaches infinity. Finally, the interatomic forces must be consistent with the thermal and spectroscopic evidence on the energy of dissociation, as well as on the known values of the equilibrium separation and the fundamental vibration frequencies. These guides suffice to indicate the general way in which the force varies with the distance, and several empirical expressions embodying these essential features have been advanced. The most widely used is one given by Philip M. Morse in 1929.

Rather special assumptions have to be made concerning the forces responsible for the properties of metals—their hardness, stability, lustre and high powers of conducting both heat and electricity. The essential features of the elementary model of metals are that the framework is provided by the nuclei, and that the whole of the volume of the metal is accessible to the valency electrons. High electrical conductivity is thus intelligible. The attractive energy is provided by the Coulomb forces between the cations and the mobile electrons, and the repulsive energy is provided by the kinetic energy of the electrons. The latter, according to the quantum theory, is much greater than would be expected on classical arguments, and was evaluated by Enrico Fermi. The energy required to expel an electron from a metal, which can be measured photoelectrically or thermionically, thus equals in magnitude the difference between the Fermi and Coulomb energies. Such a simple model of metals, is, however, deficient in many ways. It cannot, for example, give an explanation of the elastic constants, such as the compressibility and the fundamental vibration frequency, that is consistent with the specific heat. Other forces must come into play in metallic cohesion, and research on their nature was being actively carried out in the early 1960s by many investigators.

11. The Liquid State.—The liquid state has consistently been the most neglected of the various states of matter. Attention has been paid almost exclusively to the gaseous and crystalline states. Classical kinetic theory has been progressively applied for 100 years to the study of the gaseous state, and the quantum theory has been vigorously used for more than 50 years in the study of solids. It is only since the 1920s that either theory has been applied to liquids, except by a very small number of investigators, of whom Mie is the foremost. Two reasons may be advanced to explain the neglect. In the first place, the liquid state is the intermediate state of matter—the state that matter naturally assumes in passing from the solid to the vapour—and its properties are not so pronounced or sharp-edged as those of the extremes that flank it. In the second place, the classical theory appeared adequate to the knowledge of gases, and the quantum theory to the knowledge of solids. Neither suffices to explain what is known of liquids. The elucidation of their nature requires the full resources of both classical and quantal theories.

Solids are characterized by low potential energies that result from powerful cohesive forces and tie the molecules together, usually in an orderly pattern, and prohibit motion except an oscillation of small amplitude about the mean position of equilibrium. Gases are characterized by high potential energies, resulting from weak cohesive forces, that allow free motion and a completely random molecular distribution. A liquid, with its intermediate potential energies and moderate cohesive forces, has neither the orderliness of a crystal nor the randomness of a gas. Its molecules, though not constrained to vibrate about fixed positions in space, are, at the same time, not capable of unrestricted motion throughout the total volume.

The mean free path of a molecule in a crystal is less than, and of a molecule in a gas is greater than, the linear extension of the molecule. In a liquid, the mean free path is, under ordinary conditions, commensurate with the molecular dimensions. W. T. Kelvin once used a telling analogy of molecules with ships. In gases, the molecules are like ships on the high seas, which only seldom come within reach of one another; in solids, the molecules are like ships under construction in the dry docks of the building yard; in liquids, the molecules are like ships on a navigable river or in a busy harbour.

Largely because of the prominence given in classical physical chemistry to the idea of a continuity of state, the liquid state has usually been approached from the vapour end; textbooks almost invariably introduce it as the highly compressed fluid. There has been a tendency during recent years to approach the liquid state from the solid end, and, in fact, the results of experiments on the scattering of X-rays and the diffraction of electrons by liquids have indicated a striking similarity between the molecular arrangements in solids and liquids at low temperatures. There is at present some danger of overemphasizing the crystallike features of liquids and of regarding them as slightly released solids. How the right balance is to be struck is decided by temperature within the relatively narrow region—bounded by the triple and critical points—of the liquid's natural existence in equilibrium with its vapour. At the triple point, a liquid demonstrably retains many of the characteristics of a solid, while acquiring to some extent the characteristics of a gas. The former are not completely lost nor the latter fully developed until the critical point is reached.

The simplest liquids to examine are those formed of nonpolar molecules, because the potential energy is then dependent only on the distances apart, and not on any angular function. Molten metals and salts should also be treated as specialized liquids, or, perhaps more logically, as solutions rather than as pure liquids. Even in the interpretation of the facts established concerning simple, nonpolar liquids, there has appeared a great variety of theories, of which but a few can be mentioned here.

It has long been suspected that many of the properties of liquids are more closely related to their free volumes than to their actual volumes. In the theory of van der Waals, the free space in a gas consisting of noncompressible spheres is taken as the difference between the actual volume and a forbidden volume, the latter being identical with four times the sum of the volumes of the incompressible spheres. Coupled with a not unreasonable postulate concerning the attractive forces, this idea leads to the conclusion that the free space per molecule at the critical point is two-thirds of the critical molecular volume. An alternative assumption concerning the interaction energy led C. Dieterici to identify the forbidden volume with one-half the critical volume. Although neither conclusion can now be sustained, they both bring home the essential truth that the free volume in liquids increases as the temperature is raised. G. Jaeger's important extension of the free space theory is to allow for the possibility that the free space is a function not only of the total volume and the total number of molecules but of the temperature also. The extended theory is more consistent with the isotherms of the vapours and the internal pressures of the liquids. Although it is not always easy to evaluate the free volume in liquids, there is no difficulty in obtaining, at any temperature, the ratio of the free volume in the saturated vapour phase to the free volume in the liquid. Dieterici (1898) showed by the method of chemical kinetics and Lewis (1912) by the method of thermodynamics that this ratio is simply the inverse of the Boltzmann factor, with the internal heat of vaporization as the energy term. At relatively low temperatures, the saturated vapour has a volume that is virtually identical with the free volume; under these conditions, the absolute free volume per molecule of liquid and the vapour pressure of the liquid in terms of its volume are readily obtained. The molecular free volume of water at 25° C., for example, is found to be 7.27×10^{-26} ml.

In these early forms of the free space theory of liquids, the total free volume is assumed to be evenly distributed throughout the liquid, each molecule claiming, as it were, its own *Lebensraum*. The randomness of molecular distribution and energies envisaged in the kinetic theory suggest that the free space may be unevenly distributed. There can be, in other words, more free space in one region than in another. This argument leads naturally to the conception of holes in the liquid. Many versions of the theory of holes have been advanced during the 20th century (*e.g.*, by H. Eyring and by M. Fuerth). It is an attractive theory, capable of explaining phenomena not readily understood by other means, and one that is developing harmoniously with the theories of the solid state. The expansion of volume that most liquids enjoy on fusion can be attributed to the creation of holes; diffusion in liquids becomes readily intelligible; viscosity can be treated not as the passage of molecules in the direction of viscous flow but as the movement of holes in the opposite direction; liquids may be regarded as solutions of holes in matter, and vapours as solutions of matter in free space; the diminution of liquid density with an increase in temperature may be attributed to an increase in the solubility of holes.

The cluster theory of fluids, developed by M. Reinganum in 1901, was revived in 1923 by Raman, who applied it to the problem of the temperature dependence of the viscosity of liquids. The governing notion is one of localized molecular order; it does not extend to great distances. The representative molecule in a liquid is regarded as capable of maintaining order among the small number of members forming the family circle, while lacking control of those placed farther afield. Molecules in the orderly groups form clusters exothermally and therefore in concentrations that diminish as the temperature is raised. The transport of momentum through the liquid is due not solely to the translation of molecules but partly to the transmission of elastic waves through the groups of relatively stationary molecules. The cluster theory thus explains why the viscosity decreases somewhat rapidly with a rise in temperature. Direct experimental evidence for localized molecular order in certain liquids has been afforded by experiments on the scattering of X-rays, which present a novel and fascinating method for tackling the long-neglected problem of the physical chemistry of liquids.

For other important physicochemical topics *see* the following related articles: DIPOLE MOMENTS; VAPORIZATION; DIFFUSION; LIQUID STATE; SURFACE TENSION; SOLUTIONS; THERMOCHEMISTRY; ELECTROCHEMISTRY; RAMAN EFFECT; MOLECULAR SPECTRA; REACTION KINETICS; ISOTOPE; RADIOACTIVITY; REFRACTION; VALENCE; HEAT; VISCOSITY; PARACHOR; DISTILLATION; ADSORPTION; CATALYSIS; PHOTOCHEMISTRY; COLLOID; LOW-TEMPERATURE PHYSICS; KINETIC THEORY OF MATTER.

(E. A. M.-H.)

V. ANALYTICAL CHEMISTRY

Analytical chemistry may be defined as the science of determining the composition of substances in terms of the elements or compounds that they contain. Thus at the molecular level analysis is concerned with the determination of the number and types of atoms present in molecules, whereas the analysis of mixtures is concerned with the determination of the chemical elements or compounds that are present. Qualitative analysis is the identification of constituents and quantitative analysis is the precise determination of their relative amounts.

The early history of methods of analysis shows how analytical chemistry developed from iatrochemistry (1500–1700). Curiosity about the behaviour of chemical substances led Libavius (1540–1616) to originate tests for identifying metal salts in aqueous solution. In the 17th century Boyle coined the term analysis and referred to various tests that could be used for qualitative identification. He showed, for example, that plant extracts such as litmus could be used to differentiate between acids and bases.

During the 18th century, the time of the phlogiston theory, contributions to analytical methods were made by Friedrich Hoffmann, Andreas Marggraf, Karl Scheele and Torbern Bergman. They devised methods whereby metal salts could be separated into groups by reactions in solution. In mineralogy, the blowpipe technique for analyzing ores was being developed by A. F. Cronstedt; the general application of the blowpipe technique as a method of qualitative analysis was due to Berzelius and Johann Hausmann. Flame tests carried out by examination of the colour imparted to flames when they were brought into contact with volatile metal salts were known to Marggraf and were used by him to identify salts of sodium and potassium. Flame tests were shown to be of much greater value by Bunsen and Gustav Kirchhoff, who demonstrated that the spectra produced in flames were extremely characteristic of the metal.

Analytical investigations during the phlogistic period were mainly of a qualitative nature and it was not until the time of Lavoisier that the quantitative method was widely used. He emphasized the importance of discovering the composition by weight of chemical compounds; because of his systematic use of the balance he must be regarded as the founder of methods of quantitative analysis. This technique was of great value to Jeremias Richter (1762–1807) and Joseph Louis Proust (1755–1826) in their studies leading to the recognition of the law of constant proportions, which states that chemical combination occurs only in definite proportions by weight. The experimental inquiry initiated by the atomic theory (1808) proposed by Dalton also required precise measurement and gave further impetus to the development of quantitative analysis, which was placed on a firm foundation by Berzelius, whose laborious investigations may be said to have inaugurated the quantitative era in chemistry and whose studies certainly provided experimental support for Dalton's atomic theory.

Gravimetric analysis involves the transformation of a known weight of a mixture into a weight of a particular compound; this procedure formed the basis of most early analytical methods. This method, however, is extremely time-consuming and the search for alternative methods continued.

Volumetric analysis consists of careful measurement of the volume of a solution of known concentration that reacts quantitatively with a volume of a solution of the substance to be determined. This method has many advantages over gravimetric analysis, particularly in the analytical control of technical processes. The volumetric technique was developed by Gay-Lussac, who also developed the methods of acidimetry and alkalimetry and the method for the chlorimetric determination of silver (1832). The advantages of volumetric methods were not, however, generally appreciated until potassium permanganate was used for the determination of ferrous iron by F. Margueritte (1846) and Bunsen showed that copper could be determined by titration with iodine. Significant contributions were made later by K. F. Mohr and Jacob Volhard, and by the end of the 19th century many gravimetric analytical processes had been superseded by volumetric methods.

Since 1900 the use of instrumental methods has been increasing in analytical chemistry. The most striking developments up until the early 1960s were concerned with electroanalytical procedures including potentiometry, polarography, voltammetry, conductometry and coulometry. (*See* TITRATION: *Electrometric Titrations;* POLAROGRAPHY.) Advent of the manufacture of spectrometers covering the ultraviolet, visible and infrared ranges promoted the use of spectroscopic methods in analytical chemistry. Spectrographic methods, which depend upon the measurement of the wave length and intensity of light emitted by an element in a flame or electric arc, have extensively replaced some conventional methods of qualitative analysis. They are also extremely useful for the quantitative determination of trace substances that are present as minor constituents. (*See* SPECTROSCOPY: *Spectrochemical Analysis;* SPECTROCHEMICAL ANALYSIS; SPECTROPHOTOMETRY.) Another new technique, chromatography (*q.v.*), which was widely used after 1950, completely altered the approach to problems associated with the separation and analysis of mixtures of inorganic and organic compounds. Chromatography includes techniques such as absorption, partition, ion exchange and vapour phase (gas) chromatography. Radiochemical methods of analysis with radioactive tracers were used widely after radioactive isotopes became available.

The elemental analysis of organic compounds has remained almost unchanged since the description by Fritz Pregl of his quantitative microanalytical techniques (1917). Any alterations made between 1917 and the early 1960s were concerned mainly with refinements in the design of apparatus and only to a much smaller extent were the reagents or procedures changed. By the application of microchemical methods, samples weighing only a few milligrams can be analyzed with great accuracy and this has had a profound influence on the rate of progress in organic chemistry. Methods were available in the early 1960s for the determination of most elements that occur in organic compounds; the direct determination of oxygen became possible in 1947.

A. Qualitative Inorganic Analysis

A large number of methods have been described for the qualitative analysis of an inorganic salt or of a mixture of inorganic salts; and, although there are differences between them, these methods all conform to a general pattern. In this section it is not appropriate to discuss the theoretical principles involved in the separation and identification of cations (bases) and anions (acid radicals). Instead, the various methods are described in some detail.

Analysis may be carried out on a normal (macro) scale, but since about 1940, particularly in the teaching of chemistry, there has been an emphasis upon small-scale techniques that use quantities of reagents intermediate between the macro and micro scales. In macroanalysis the weights and volumes of solutions are approximately 1 g. and 10 ml., while the corresponding quantities in microanalysis are 5 mg. and 0.1 ml. Spot tests may be used for the identification of individual anions and cations; the limit of identification is the smallest amount that can be recognized. It is expressed in micrograms (μg.) or gamma (γ). The relationship between these quantities is: $1\ \mu\text{g.} = 1\ \gamma = \frac{1}{1{,}000}\ \text{mg.} = 10^{-6}\ \text{g.}$

Qualitative inorganic analysis employs either dry tests, which are carried out on the solid, or wet tests, which are used in solution (almost invariably in aqueous solution). The systematic analysis of a mixture may be divided into various parts: (1) preliminary dry tests; (2) tests for anions; (3) confirmatory tests for anions; (4) separation of cations into groups; and (5) identification of cations. In some cases the analysis may be considerably shortened by the use of specific spot tests.

1. Systematic Analysis.—Systems for the complete qualitative analysis of a material in the wet way are based on the principle of treating a solution of the material with a succession of reagents so that each reagent separates a group of constituents. The groups are then treated successively with reagents that divide a large group into subgroups or separate the constituents singly. When a constituent has been separated it may be further examined to confirm its presence and to establish the amount present. Portions of the material are dissolved separately and different procedures are used for each to detect the cationic and anionic constituents. (W. D. Os.)

Preliminary Dry Tests.—1. Effect of heat: The substance when heated in a hard glass tube may char, become tarry or smoke; these actions indicate the presence of organic matter. Since many organic compounds interfere with the wet method of analysis, organic matter should be eliminated by preliminary treatment with nitric acid added to sulfuric or perchloric acid. A test for organic matter can be made in a wet way by heating the substance with concentrated sulfuric acid and noting if charring occurs.

If the substance contains water an aqueous deposit will form on the cooler part of the tube. A white sublimate is given by ammonium halide salts, mercurous chloride and bromide, and oxides of arsenic; a yellow sublimate may consist of sulfur (reddish-brown when molten), arsenic sulfide and mercuric iodide (turning red on rubbing). A blackish deposit results from the condensation of violet iodine vapour or of mercuric sulfide, while most mercury compounds other than those mentioned give a gray deposit. Metallic mercury and arsenic appear as minute globules and a gray mirror.

Oxygen results from the decomposition of peroxides, chlorates, nitrates, iodates and similar oxygenated compounds, and also from oxides of the noble metals; carbon dioxide is produced from carbonates and organic substances, usually accompanied in the latter case by charring; sulfur dioxide is obtained from many sulfides and thiosulfates. Chlorine, bromine and iodine are evolved from certain halide salts, particularly in the presence of oxidizing agents, and oxides of nitrogen are evolved from nitrates. Some cyanides evolve cyanogen or hydrocyanic acid and possibly ammonia in the presence of water. All fluosilicates (silicofluorides) decompose on heating and evolve silicon tetrafluoride.

2. Flame tests: When volatilized in a nonluminous flame, the compounds of certain elements cause characteristic colours. This test is carried out by introducing a portion of the substance into the flame; the test material is placed on a platinum wire and is moistened with hydrochloric acid; the acid forms chlorides, which are comparatively volatile salts. Sodium gives an intense yellow coloration; potassium, violet; rubidium and cesium, bluish-violet (the latter blue when pure); calcium, red; strontium and lithium, crimson; barium, yellowish-green; and copper, bright green; while lead, arsenic and antimony (which should not be tested on platinum) give a grayish-blue coloration. By observing the flame through a spectroscope much more definite decisions can be made. Of the rarer metals that give flame colours, indium (blue), thallium (green), cesium and rubidium (violet) were discovered by means of the spectroscope.

3. Blowpipe and bead tests: The substance is placed in a depression on a charcoal block and heated in the reducing flame of a blowpipe. From the changes that occur and the residue that remains, information may be obtained as to the general nature of the material. Specific information as to certain elements may be obtained by treating the residue with certain reagents, such as cobalt nitrate or sodium carbonate, and again heating. The colourless beads obtained by fusing borax (sodium tetraborate) or microcosmic salt (sodium ammonium phosphate) on a small loop of platinum wire are capable of dissolving many metallic oxides or salts, often with the production of characteristic colours; the colour may differ according to whether the bead is heated in an oxidizing or reducing flame. These tests are of uncertain value when applied to complex mixtures and have been largely replaced for practical use by spectrographic methods or in some cases by wet tests that employ organic reagents for the identification of specific elements by the formation of coloured precipitates or soluble compounds.

Preparation of Solution for Wet Tests.—Different procedures are used for dissolving the material for subsequent analysis according to whether the material is to be analyzed for only the common cations or for the rarer elements as well. The solution for the analysis of the common cations is prepared by first treating the material successively with water, dilute nitric or hydrochloric acids, or a mixture of these concentrated acids. Any residue is usually treated separately with hydrofluoric acid in conjunction with fuming perchloric acid or sulfuric acid in order to eliminate silica. A refractory residue is then fused with sodium carbonate, with or without the addition of potassium nitrate. The fusion mass is treated with water, whereby the acidic constituents are extracted, and the carbonate-oxide residue is then dissolved in acid.

Test for Anions.—The analysis for anions presents a more difficult problem and is of necessity less systematic than is that for cations. This is so because it is necessary not only to detect certain acidic elements but also to establish their oxidation state and association with oxygen or other elements. For example, if sulfur is present the analysis should not only detect it but also should determine whether it is present as elementary sulfur, sulfide, sulfite, sulfate, the numerous other sulfur oxygen acids, or in combination with other elements, as in thiocyanate. In addition, many of the anions are stable only in alkaline solutions or may react with each other upon acidification. Because of these facts appropriate tests are made in order to determine if certain groups of anions are present or absent.

The preliminary tests include those for anions that (1) act as oxidizing agents or reducing agents; (2) form precipitates with silver ion in neutral or acid solutions; (3) form precipitates with barium ion in neutral or acid solutions; and (4) form precipitates with calcium ion in ammoniacal solutions.

The solution for the analysis for the anions is usually prepared by treating the material with sodium carbonate solution. This reagent removes most of the heavy metals as carbonates or oxides; otherwise they would interfere with the subsequent analysis. In the systematic analysis a portion of the sodium carbonate solution is acidified with acetic acid; sulfide and cyanide are then volatilized as hydrogen sulfide and hydrogen cyanide and are collected in an alkaline solution. Addition of perchloric acid causes the volatilization of sulfite as sulfur dioxide. Addition of cadmium nitrate causes precipitation of cadmium ferrocyanide and ferricyanide. Addition of silver nitrate to the filtrate precipitates silver iodate, iodide, thiocyanate, bromide and chloride; the iodate is separated and the last four anions constitute the so-called halide group. In those cases where oxidizing agents were detected by the preliminary tests, sodium nitrite is added to the filtrate; this causes chlorate and bromate to be reduced to chloride and bromide and to precipitate as the silver halides. Any iodate previously precipitated is reduced and precipitated as silver iodide. The filtrate is neutralized and then made slightly acid with acetic acid; silver phosphate, arsenate, arsenite and oxalate are precipitated (the phosphate group). From the filtrate, sulfate is precipitated as barium sulfate and oxalate as calcium oxalate.

Tests are made on separate portions of the sodium carbonate solution for acetate, perchlorate, nitrate, nitrite, borate, peroxysulfate and periodate. The sodium carbonate treatment of the material may leave certain acidic constituents in the residue as insoluble compounds; therefore, this residue is decomposed with zinc and sulfuric acid and additional tests made for sulfide, cyanide, phosphate, arsenate, borate and the halides. A separate portion of the material is tested for carbonate.

Confirmatory Tests for Anions.—The tests given above will indicate the presence of certain anions, but this presence must be confirmed by tests that are reasonably specific. Thus, nitrate may be detected by the "brown ring test" with concentrated nitric acid and ferrous sulfate, cyanide by the prussian blue test, and acetate by the formation of ethyl acetate on treatment with ethyl alcohol and sulfuric acid. These tests illustrate the type of confirmatory evidence that is frequently used, but it is often necessary to devise special tests when there are mixtures containing a number of anions. For example, nitrite can be easily detected in the presence of nitrate by the starch-iodide reaction, but the identification of nitrate in the presence of nitrite is difficult because both give a positive "brown ring test." In this case it is necessary to remove the nitrite by treatment with urea or sulfamic acid before carrying out the usual tests for nitrate.

In the analysis for anions many difficult problems may arise when several anions are present; some of these problems may be easily solved by using paper chromatography.

Separation of Cations Into Groups.—Most of the various systems that have been developed employ essentially the same reagents for the major group separations. A typical analytical scheme is summarized below. Minor modifications exist in some cases where the system is designed for a semimicro scale of operation or for elementary instruction.

The ammonium cation may be considered as a constituent of group V but a separate sample must be used for its detection since it is introduced in the course of the analysis. When the analysis is made on a macro scale, the precipitates obtained are usually separated by filtration; centrifugation is more extensively used if the analysis is made on a semimicro scale.

2. Identification of Cations.—The next step, after the cations are separated into groups, is the identification of the individual cations in each group. Innumerable procedures have been suggested for the separation and identification of the individual cations. The methods given below are those that have been used extensively and are representative of the general principles involved.

The Silver Group (Group I).—The group precipitate is leached with hot water to remove the lead chloride; the formation of yellow lead chromate when acetic acid and a soluble chromate are added to the solution identifies lead. The residue is leached with ammonia. Mercurous chloride is converted into a black residue of mercury and mercuric aminochloride; silver chloride dissolves and is reprecipitated by acidifying the ammonia solution.

The Copper Group (Group IIA).—The sulfide precipitate is dissolved in nitric acid (if mercuric sulfide is present it remains as a residue) and sulfuric acid is added; the solution is evaporated until it fumes and is then diluted; this procedure precipitates lead sulfate. The precipitate is dissolved in ammonium acetate and yellow lead chromate is precipitated by addition of a soluble chromate. Addition to the sulfuric acid filtrate of an excess of ammonia precipitates white bismuth hydroxide; treatment of the precipitate with an alkaline sodium stannite solution reduces the bismuth to the black metal. If copper is present the ammoniacal filtrate is blue because of the formation of the cupric tetrammine complex; when copper is present, cyanide is added to form the colourless cuprous tricyano-complex and the solution is treated with hydrogen sulfide to precipitate yellow cadmium sulfide.

The Arsenic Group (Group IIB).—The alkaline sulfide solution is acidified to reprecipitate the sulfides. After this precipitate is treated with potassium hydroxide and peroxide, only mercuric sulfide is left as a residue. The residue is dissolved in hydrochloric acid; first sodium chlorate and then an excess of stannous chloride are added; the stannous chloride precipitates white mercurous chloride, which becomes gray as it is reduced to mercury. Arsenic, antimony and tin are again precipitated as sulfides and the precipitate is treated with hot concentrated hydrochloric acid; as a result, the residue contains only arsenic sulfide. This is dissolved by means of sodium hydroxide and peroxide and the arsenic reprecipitated as magnesium ammonium arsenate. The concentrated hydrochloric acid solution is diluted sixfold, oxalic acid is added and the reddish-orange antimony sulfide is precipitated by hydrogen sulfide. The oxalic and hydrochloric acids are removed from the filtrate by adding sulfuric acid and evaporating to fuming; the solution is diluted and then treated with hydrogen sulfide to precipitate yellow tin sulfide.

The Iron Group (Group IIIA).—The precipitate may contain the hydroxides of iron, chromium and aluminum, but before the precipitate is examined phosphate must be removed by forming, for example, the rather insoluble zirconium hydrogen phosphate.

Scheme for Separation of Cations

<table>
<tr><td colspan="7">HCl or a soluble chloride, preferably NH_4Cl, added to unknown. Filtered</td></tr>
<tr><td rowspan="5">Precipitate:
Contains chlorides of lead, silver and mercurous mercury
$PbCl_2$ (white)
$AgCl$ (white)
Hg_2Cl_2 (white)</td><td colspan="6">Solution: H_2S passed into the acid solution. Filtered</td></tr>
<tr><td colspan="2">NH_4OH, ammonium polysulfide [$(NH_4)_2S_x$] and $(NH_4)_2S$ added. Filtered</td><td colspan="4">Solution: Neutralized with NH_4OH and NH_4Cl. Filtered</td></tr>
<tr><td rowspan="3">Precipitate:
Contains cupric, lead, cadmium, bismuth and mercuric cations</td><td rowspan="3">Solution:
Contains arsenic, antimony and tin cations</td><td rowspan="3">Precipitate:
Contains aluminum, chromium and ferric hydroxides
$Al(OH)_3$ (white)
$Cr(OH)_3$ (gray-green)
$Fe(OH)_3$ (brown)</td><td colspan="3">Solution: H_2S passed into alkaline solution. Filtered</td></tr>
<tr><td rowspan="2">Precipitate:
Contains cobalt, nickel, manganese and zinc sulfides
CoS (black)
NiS (black)
MnS (buff)
ZnS (white)</td><td colspan="2">Solution: Evaporated and NH_4OH and $(NH_4)_2CO_3$ added. Filtered</td></tr>
<tr><td>Precipitate:
Barium, strontium and calcium carbonates (all white)</td><td>Solution:
Contains magnesium, sodium and potassium ions</td></tr>
<tr><td>Group I</td><td>Group IIA</td><td>Group IIB</td><td>Group IIIA</td><td>Group IIIB</td><td>Group IV</td><td>Group V</td></tr>
</table>

The reprecipitated hydroxides are then treated with sodium hydroxide and hydrogen peroxide. An insoluble residue indicates the presence of ferric hydroxide and this is confirmed by dissolving the residue in hydrochloric acid and adding potassium thiocyanate. The original sodium hydroxide solution is divided into two parts. Ammonia is added to one part and a white flocculent precipitate of aluminum hydroxide indicates aluminum. The other part of the solution is acidified (acetic acid), lead acetate is added and a yellow precipitate of lead chromate establishes that chromium is present.

The Zinc Group (Group IIIB).—The precipitated sulfides are treated with very dilute cold hydrochloric acid. The residue may contain either cobalt or nickel sulfide; cobalt may be recognized by a borax bead test. The rest of the insoluble residue is treated with ammonium chloride and ammonium hydroxide until it is alkaline; then dimethylglyoxime is added. A red precipitate indicates that nickel is present. The hydrochloric acid solution may contain manganous chloride or zinc chloride. It is boiled to remove hydrogen sulfide, made alkaline with sodium hydroxide and heated further. A dark-coloured precipitate indicates manganese and this is confirmed by formation of purple permanganic acid on oxidation with nitric acid and lead peroxide. The sodium hydroxide solution may contain sodium hydrogen zincate; if zinc is present, hydrogen sulfide gives a cream-coloured precipitate of zinc sulfide.

The Calcium Group (Group IV).—The precipitate produced by ammonium carbonate is dissolved in acetic acid and then potassium chromate is added; yellow barium chromate precipitates. When the solution is neutralized and alcohol is added, yellow strontium chromate is precipitated. Addition of ammonium oxalate to the filtrate precipitates white calcium oxalate. Magnesium, when present in this group, is precipitated as magnesium ammonium phosphate.

The Alkali Group (Group V).—The filtrate from the ammonium sulfide precipitation is evaporated to dryness and then is heated until ammonium salts are volatilized to prevent them from interfering with the test for potassium. The residue is dissolved in water and the solution is divided into two portions. To one is added sodium nitrocobaltate III (sodium cobaltinitrite), which causes the precipitation of yellow potassium sodium nitrocobaltate III (potassium sodium cobaltinitrite); to the other is added magnesium uranyl acetate, which causes pale yellowish sodium magnesium uranyl acetate to precipitate. A separate portion of the original material to be analyzed is tested for ammonium cation by heating it with sodium hydroxide; ammonia is evolved and may be detected by its odour or by its alkaline effect on litmus paper.

Spot Tests.—A large number of so-called tests for individual cations and anions have been developed, especially by Fritz Feigl. The material to be tested is dissolved, a drop of the solution is placed in an indentation on a white tile (spot plate), a drop of reagent solution is added and the mixture is examined for a characteristic precipitate or coloration; as a modification the solution may be tested by being applied to a strip of paper impregnated with reagent or by being drawn into a capillary tube that contains the reagent. The reagent frequently contains an organic compound capable of forming intensely coloured compounds with certain elements or radicals. When applied to complex mixtures these tests are limited in value because several constituents may give similar reactions, and other constituents may mask or cause the test to fail.

3. Qualitative Analysis for Some of the Rarer Elements.—The analytical schemes that have been described have been concerned with analytical procedures for use when only the commoner salts are present. With the development of modern industrial techniques for the isolation of metals, many metals that once were considered rare are now used widely. The designation "rare element" is retained in analytical chemistry, however, to classify metals such as tungsten, titanium, beryllium, uranium and thallium.

The first system designed to cope with the rarer elements was designed by Arthur A. Noyes and William Crowell Bray (1927). Other systems have been devised, including the one by Arthur I. Vogel (1954). Many of the analytical methods used in the control of industrial processes that involve the more unusual metals are specially devised. They are, therefore, not discussed in detail. The system of Noyes and Bray is mainly of historical interest, but when it was published it employed several novel techniques. Their system is characterized by the separation of groups during the preparation of the solution of the material being analyzed and by the use of separations depending upon the volatility or extractability by immiscible solvents of the compounds of certain elements. The complete analysis is too extended to be given and only the principal separations are outlined below.

The Selenium Group.—The material is distilled with concentrated hydrobromic acid; selenium, arsenic and germanium are volatilized as the bromides.

Silicon, Osmium and Ruthenium.—Any solid residue is treated with hydrofluoric acid to eliminate silica as the volatile silicon tetrafluoride; the solution is then distilled with perchloric acid to volatilize osmium tetroxide; addition of concentrated nitric acid to the perchloric acid and repetition of the distillation volatilizes ruthenium tetroxide.

The Tungsten, Tantalum and Gold Groups.—The residual solution from the ruthenium distillation is diluted, formic acid is added and the mixture is heated. The resulting precipitate contains: the oxides of tungsten, molybdenum, antimony and tin, which form the tungsten group; the oxides of tantalum, columbium and titanium (in part), the tantalum group; also metallic gold, mercury, platinum and palladium, the gold group. The tungsten and tantalum group elements are dissolved by treating the residue with hydrofluoric acid; the solution is fumed with sulfuric acid to eliminate the hydrofluoric acid and then an excess of ammonia and ammonium sulfide is added. By this treatment the tantalum group elements are reprecipitated as oxides and the tungsten group elements are dissolved as sulfoanions.

The Thallium Group.—Hydrobromic acid is added to the formic acid filtrate, thus precipitating the bromides of silver, thallium (ous) and lead (incompletely).

The Hydrogen Sulfide Group.—The hydrogen ion concentration is adjusted to three-tenths molar and the solution is treated with hydrogen sulfide to precipitate the sulfides of tellurium, molybdenum, iridium and rhodium (the tellurium group) and lead, bismuth, copper and cadmium (the copper group). The tellurium and molybdenum are removed separately; then the copper group elements are precipitated as hydroxides.

The Ammonium Sulfide Group.—Small portions of the filtrate from the hydrogen sulfide group precipitation are tested for iron and phosphate. Additional iron is added to the main filtrate and a basic acetate precipitation is made by adding ammonium acetate and boiling the solution. This process causes the precipitation of chromium, aluminum, indium, zirconium, titanium, gallium and vanadium together with the iron as hydrous oxides, basic acetates, phosphates or vanadates; the precipitation of gallium and vanadium is complete only when iron is present.

The precipitate is dissolved in hydrochloric acid and the iron and gallium extracted with ether. The hydrochloric acid solution is made alkaline and excess sodium peroxide added; indium, zirconium and thorium hydroxides are precipitated; these elements constitute the zirconium group.

The filtrate from the basic acetate precipitation is made alkaline with ammonia and then ammonium sulfide is added. Beryllium and the rare-earth elements are precipitated as hydroxides and manganese, zinc, cobalt, nickel and uranium as sulfides. The precipitate is dissolved in acid; excess sodium hydroxide and peroxide are added and manganese, cobalt and nickel (the nickel group) and the rare-earth elements (the rare-earth group) are precipitated as oxides or hydroxides. The two sodium hydroxide filtrates are united.

The elements present are aluminum, chromium, vanadium, beryllium and zinc (the aluminum group).

The Alkaline Earth Group.—This group is precipitated and separated as described above in *The Calcium Group (Group IV).*

The Alkali Group.—The final filtrate is analyzed for lithium, rubidium and cesium in addition to sodium and potassium.

No provision is made in the system for the radioactive elements (other than uranium and thorium), rhenium, the noble gases, nor for any elements with atomic numbers greater than 92.

(E. H. St.; W. D. Os.)

B. Quantitative Inorganic Analysis

The branch of chemistry that deals with the determination of the amount or percentage of one or more constituents of a sample is known as quantitative analysis. This field is important because of its widespread use both in research and in industrial processes; whenever chemicals are used quantitative analyses are needed. Consequently every chemist is trained in analytical methods and in their applications and limitations.

A variety of methods is utilized for quantitative analyses; in fact, almost every property of matter can be made the basis for some analytical process. For convenience these methods may be broadly classified as chemical or physical, depending upon which properties are utilized. Chemical methods are those that depend upon reactions such as precipitation, neutralization, oxidation or, in general, the formation of a new compound. Physical methods are those that involve the measurement of some physical property such as density, refractive index, absorption or polarization of light, electromotive force, production of spectra, magnetic susceptibility and numerous others. Frequently an analysis will involve a combination of chemical and physical methods, the former for separating desired constituents from a sample and the latter for measuring the amounts present.

The basic tool in all quantitative analyses is the analytical balance, which is used for the accurate weighing of samples and precipitates. The balance operates on the principle of levers; the weight of an object is determined by finding the sum of the weights of known mass that are required to balance the object. For usual analytical work the balance should be sensitive to and able to determine differences in mass of 0.1 mg. (about .000003 oz.).

In microanalyses the balance is about 1,000 times more sensitive and for special work balances of even higher sensitivity have been constructed. (*See* Balance: *Ultramicrobalance.*)

1. Chemical Methods (Gravimetric and Volumetric).—The major types of strictly chemical methods are known respectively as gravimetric and volumetric (or titrimetric) analysis. As the names imply, the former is based upon a measurement of the weight of a sample constituent and the latter upon the measurement of a volume of solution required to react with the sample. Application of these two methods may be illustrated by procedures that are used for the determination of chloride. In a gravimetric analysis the sample is treated with an excess of silver nitrate solution, which precipitates the chloride as silver chloride. The amount present is determined from the weight of silver chloride obtained. In a volumetric analysis the sample is treated with a solution of silver nitrate of known concentration and the volume of solution required to react with all the chloride present is measured. From this volume and the known concentration of the solution, the amount of chloride in the sample is computed.

The choice of method, gravimetric or volumetric, depends upon the conditions of the analysis. The two methods are about equal in accuracy. Usually a volumetric analysis is far more rapid than a gravimetric after the necessary standard solutions are prepared. Consequently, whenever many samples are to be analyzed a volumetric method is chosen when one is available. But if only a few samples are analyzed it may be more convenient to use a gravimetric method than to prepare and standardize the solutions needed for the volumetric method.

Gravimetric.—In a gravimetric analysis the constituent sought is converted into a substance of definite composition, as expressed by a chemical formula, in 100% yield. All operations in gravimetric analyses are directed toward the objectives of purity and yield. The following operations are common: (1) preparing a solution containing a known weight of the sample; (2) separating the desired constituent in a pure condition of known composition; (3) weighing the isolated constituent; and (4) computing from the observed weight the amount of the particular constituent in the sample.

There are many methods for isolating the desired constituent from a solution of a sample. The commonest is precipitation. A reagent is added that will form an insoluble compound with the desired constituent but will not precipitate other constituents of the sample. The precipitate obtained is separated by filtration, washed free of soluble impurities, dried or ignited to remove water and weighed. Volatilization is used to separate a substance that can be converted readily into a gaseous compound. An example is the determination of carbonate in a mineral analysis. The sample is treated with an acid and carbon dioxide is evolved as a gas. The gas is absorbed in a weighed portion of an alkaline reagent and the amount of carbon dioxide is determined from the gain in weight of the absorbent. Electrodeposition is used to separate certain metals that can be plated out by passing an electric current through a solution. Copper in alloys is frequently determined by this method when interfering metals are not present in the sample. (*See* Electrochemistry.)

The general methods of precipitation analyses are much like those of qualitative analyses (*see Qualitative Inorganic Analysis* above). If the sample is complex, *i.e.*, contains many constituents, it is necessary to separate the constituents into groups by successive addition of various reagents. Many of the reagents used for group separations are the same as those employed in qualitative analyses. After the groups are separated, each is redissolved and treated with specific reagents to precipitate the constituents separately. The complete gravimetric analysis of a complex mineral may require several days, even with highly skilled operators.

If errors are made in gravimetric analyses they usually relate to the purity of the isolated constituent. In general the compounds precipitated are very insoluble and there is little error due to incompleteness of precipitation. It is a difficult matter, however, to obtain a precipitate that is 100% pure and exactly of the composition represented by a chemical formula. All gravimetric methods are subject to some degree of error because of this.

Volumetric.—In a volumetric analysis a solution of known concentration of the reagent is added to a solution of the substance to be determined until the quantity of the reagent is equivalent to the quantity of substance being analyzed. (An equivalent amount is that which reacts exactly with another substance. *See* Equivalent.) All volumetric operations are directed toward measuring the amount of reagent equivalent to the constituent sought in the analysis. Not every chemical reaction can be utilized for volumetric procedures. The following conditions are necessary: (1) the reagent must react with only one constituent of the sample; (2) reaction must be rapid, so that each portion of reagent reacts as rapidly as added; (3) there must be some change in properties of the solution when the equivalence point is reached (usually a sudden change in concentration of ions present); and (4) an indicator (*see* Indicator, Chemical) must be available to show the point at which equivalence is reached.

The steps in volumetric analysis are: (1) preparation of sample solution; (2) titration of sample solution with standard solution that contains a known concentration of the reagent chemical; and (3) computation of the amount of constituent in the sample from the volume and concentration of reagent solution used. Titration, which is the name for the process of determining the amount of reagent equivalent to the sample, is performed by adding the reagent slowly from a burette until the indicator shows a colour change. Ordinarily a 50-ml. burette is used and the analyst chooses conditions so that 30 to 40 ml. of reagent are required. In microchemistry the burette may have a capacity of one millilitre or sometimes even less. Chemical indicators generally are used in titrations but various physical methods can also be used in special cases to show the equivalence point. A chemical indicator is a highly coloured substance that reacts with one of the components of the system and shows by a colour change when a component disappears or appears. A well-known example is starch, which gives an intense blue colour with iodine. If an iodine solution is being titrated the end point is marked by the disappearance of colour or, conversely, if iodine is the titration reagent the presence of an excess of iodine when the equivalence point is passed is marked by the appearance of blue colour.

All volumetric analyses must be preceded by standardization of the reagent solution. This is usually done by comparing the solution with a weighed sample of known purity. An acid solution, for example, is standardized by titration of a known weight of some pure basic substance such as sodium carbonate.

The determination of the amount of acid or base in a sample by titration with a standard solution of base or acid is known as neutralization. This type of volumetric analysis is widely used. Examples are the determination of the amount of free acid in vinegar or the amount of free base in lye. A variety of acid-base indicators is known. Among the most frequently used are phenolphthalein, methyl red and bromothymol blue. These differ from each other by showing colour changes at different hydrogen ion concentrations. In an acid-base titration it is important to select an indicator whose colour change corresponds to the hydrogen ion concentration of the equivalence point; use of the wrong indicator might lead to erroneous results.

Many volumetric methods are based upon oxidation-reduction reactions, in which there is a change in valence of some ion. A familiar example is the determination of iron by titration with permanganate or ceric sulfate solution. Before this determination is started all iron must be reduced to the ferrous (Fe^{2+}) condition and all other reducing agents that might react with the standard solution of oxidizing agent must be removed. In the titration iron is oxidized to the ferric condition (Fe^{3+}). The amount present is computed from the volume of oxidizing agent required to react with the iron. If the standard solution used is potassium permanganate no indicator is required for the titration. Permanganate ion is so highly coloured that when the equivalence point is passed a drop or two of solution in excess will impart colour to the solution, thereby giving the end point. Oxidation indicators also can be used. These are substances that are less readily oxidized than ferrous ion and consequently are not affected until the equivalence point is reached and all the ferrous ion has been oxidized. At this point the indicator is oxidized and shows by a colour change that the end point is reached.

The most widely used standard oxidizing agents are potassium permanganate and ceric sulfate. Both are strong oxidizers and can be used to titrate numerous reducing agents, such as iron, titanium, vanadium, uranium, sulfides, nitrites, sulfites, oxalates, hydrogen peroxide, arsenic, antimony, molybdenum and many others; the material to be titrated must be in its lower valence state.

Another important class of oxidation-reduction (frequently called redox) determinations involves iodine. When potassium iodide is treated with any strong oxidizing agent iodine is liberated in equivalent amount. Titration of the liberated iodine gives an indirect measure of the amount of oxidizing agent that reacted with the potassium iodide. Thus this method can be used to analyze any oxidizing agent that liberates iodine from potassium iodide. The standard solution used to titrate the iodine may be either sodium thiosulfate or arsenic trioxide.

Precipitation reactions can often be used for volumetric analyses when an indicator is available to show when the equivalence point is reached. A common example is the determination of chloride by titration with silver nitrate solution.

Good volumetric methods are lacking for numerous substances. Among these substances are ions that are not readily oxidized or reduced and do not give precipitates that are suitable for use in volumetric analyses; examples are sodium, potassium, calcium and aluminum. For some of these it is possible to devise an indirect method of volumetric analysis. Calcium, for example, can be determined volumetrically by first precipitating it as calcium oxalate, then dissolving the precipitate in sulfuric acid and determining oxalate by titration with potassium permanganate.

Since the amounts of calcium and oxalate in the precipitate are equivalent, the titration gives the equivalents of calcium in the sample.

2. Other Chemical Methods.—Several chemical and physicochemical methods used less frequently than gravimetric and volumetric analyses are listed below:

Colorimetric analyses are based upon the absorption of light by coloured substances in solution. They can be used when the constituent sought can be converted by chemical reaction into a coloured compound without creating other coloured compounds in the solution.

Nephelometric analyses are based upon the amount of turbidity in a solution and the effect of this turbidity upon the transmission of light. This method can be applied only to the determination of small amounts of substances that yield a precipitate when treated with certain reagents.

Gas analysis depends upon selective absorption of constituents in a gaseous mixture and measurement of the changes in volume that occur when absorption has taken place.

Fire assay is used to determine the amounts of precious metals in ores. The ore samples are heated with a flux and the metals are reduced to the free state. The free metals are then extracted from the flux by molten lead, which on cooling retains the precious metals as an alloy. The amounts of precious metals are determined by dissolving (parting) the lead button in acids and then performing a chemical analysis on the solution or on the metals that do not dissolve.

3. Computation of Chemical Analyses.—The basis for all quantitative computations is the weight relations expressed by a chemical equation. For example, the equation:

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

shows that two molecules of sodium hydroxide react with one molecule of sulfuric acid to give one molecule of sodium sulfate and two molecules of water. Since a molecule of sodium hydroxide weighs 39.99 atomic weight units (the sum of the atomic weights of Na, O and H) and a molecule of sulfuric acid 98.07 units then 2×39.99 units of NaOH react with 98.07 units of H_2SO_4. The ratio of weights of NaOH and H_2SO_4 reacting is the same regardless of the units employed, whether these are grams, ounces, tons, etc.

In gravimetric analysis the weight of the constituent sought is computed from the weight of a precipitate by using a factor based upon the atomic weights. Thus, from the weight of AgCl precipitate the weight of Cl is computed by the relation

$$\text{Weight Cl} = \text{Weight AgCl} \times \frac{\text{Atomic weight Cl}}{\text{sum of atomic weights of Ag and Cl}}$$

and

$$\% \text{ Cl} = \frac{\text{Weight of AgCl} \times 24.73}{\text{Weight of sample}}$$

In volumetric analyses the computations involve the volume and concentration of the reagent solution. The unit of concentration usually chosen is the equivalent weight (*see* EQUIVALENT); a solution that contains one equivalent weight of solute per litre is known as a 1 normal (1N) solution. Since titrations are made to the point that the equivalents of reagent equal the equivalents of sample, it follows from the definitions that the product (volume of reagent in litres times the normality of the reagent) is the total equivalents of reagent and therefore the total equivalents of the sought constituent in the sample. Multiplying this value by the weight of one equivalent gives the weight of the sample constituent in grams. For example, if titration of a Cl sample requires 40.00 ml. of 0.1N $AgNO_3$ solution, the weight of Cl in the sample is

$$\underset{\text{(vol. in litres)}}{40.00/1{,}000} \times \underset{\text{(normality)}}{0.1} \times \underset{\text{(eq. wt. Cl)}}{35.45} = \text{grams Cl}$$

(W. C. P.; W. D. Os.)

4. Physical Methods.—Progress in the field of chemical analysis has been concerned mainly with the discovery of instrumental methods based upon physical properties. Practically all these processes have been developed since 1930 and most of them rely upon spectroscopic, optical or electrochemical phenomena. By the use of modern electronic apparatus it is possible for the analytical results to be displayed by pen-recording devices, and it is also possible for the analysis to be carried out completely automatically and to effect direct control of the technical process. (*See* SPECTROCHEMICAL ANALYSIS.)

Absorption Spectroscopy.—By the 1960s, colorimetric analysis had been in use for many years as an analytical technique. It is an application of the fact that the intensity of colour varies with the concentration of a coloured component. Thus, by matching a coloured solution with a series of solutions of the same substance of known concentration, it is possible to determine the unknown concentration. This method of analysis depends on comparisons at one wave length. With recording spectrometers that can determine absorption characteristics in the ultraviolet, visible and infrared parts of the spectrum, these methods can be used for the analysis of colourless compounds and are of tremendous power and value.

Emission Spectroscopy.—The work of Bunsen and Kirchhoff (1860) showed that many metals, when suitably excited, emit radiation of characteristic wave lengths. These emission spectra have long been used in the qualitative identification of metals, as in the flame tests for alkali metals and the alkaline earth metals. Quantitative emission spectroscopy or flame spectrometry has become increasingly important as an analytical tool, and by employing more powerful excitation by means of electric arcs the method can be extended to include many nonmetallic elements. The emission spectrum can be observed visually with a spectroscope or it may be recorded photographically with a spectrograph. From the intensity of the lines of the spectrum produced under standard conditions, the nature and the quantity of various elements present can be determined. Elements such as barium, calcium, cesium, copper, gallium, indium, palladium, rhodium and vanadium are detectable in amounts less than one part per million (1 p.p.m.).

The application of emission spectroscopy to quantitative analyses is now so well established that in many control laboratories it has supplanted chemical analyses for numerous constituents. This is particularly true in the analysis of alloys for minor constituents. The basis for the method is the fact that the intensity of spectral lines can be related to the concentration of the emitting element in the sample (*see* SPECTROSCOPY: *Observations and Measurements.*) Requirements are a spectroscope of sufficient dispersion in both the visible and the ultraviolet regions and a microphotometer for measuring the blackness or density of the spectral line.

Before a spectrochemical method can be used it is necessary to work out curves relating line densities to concentrations, based upon samples of the general composition of those to be analyzed. This preliminary preparation of the working curve is based upon chemical analyses of the standard samples. Weeks of careful work may be required to standardize conditions and develop the working curve for a given analysis. Consequently the spectrochemical method is not well suited to the analysis of occasional samples but is well suited for routine analyses where large numbers of samples must be processed. Once methods are developed the spectrographic procedure is very rapid and accurate. It is possible to take molten metal samples from a furnace and obtain an analysis for several constituents within minutes after the sample is withdrawn.

Polarimetry and Optical Rotatory Dispersion.—Polarimetry (*q.v.*), or the measurement of the rotation of the plane of polarized light by solutions of optically active substances, has been used for many years as an analytical procedure. One application is the analysis of sugar solutions (saccharimetry). The concentration of sugar solutions can be determined directly by using a suitably graduated polarimeter.

Since 1955, mainly because of the studies of Carl Djerassi, it has become possible to make routine measurements of the optical rotation of optically active substances at various wave lengths throughout the ultraviolet and visible parts of the spectrum. The rotations recorded in the ultraviolet are much higher than in the visible regions and may be used for analytical purposes.

Refractivity.—The refractive index (a measure of the bending of light when it crosses the boundary between two media of different optical density) is often used to identify organic compounds and to measure the concentration of solutions. A useful application is in the determination of the alcoholic content of beverages. Alcohol is distilled from the sample and collected in a measured volume of water. From the refractive index of the resulting solution the alcoholic content of the original sample is readily computed. (*See* LIGHT: *Refraction and Double Refraction.*)

Potentiometry.—There are two ways in which potentiometric methods are used in analytical chemistry: (1) the potential of a cell is measured and is used to calculate the concentration of one constituent (this is an application of the Nernst equation, which states the simple relation between the relative potential of an electrode and the concentration of the corresponding ionic species in solution); and (2) the variation of potential during a titration is used to determine the end point.

Ordinary volumetric methods are subject to personal error; potentiometric titration has two important advantages: the end point may be detected even with highly coloured solutions and the method is very accurate even with small amounts (0.2–2.0 mg.) of material.

A great many titrations can be followed potentiometrically by choosing suitable electrodes. Acid-base titrations can be followed with a glass electrode and a calomel reference electrode; oxidation-reduction reactions can be studied with a platinum electrode.

One analysis that is very frequently carried out potentiometrically is the determination of hydrogen-ion concentration (pH). Some potentiometers are calibrated to give the pH value directly. The continuous and accurate determination of hydrogen-ion concentrations is important in many manufacturing processes. To facilitate this determination, many types of pH meters have been constructed in which the hydrogen-ion concentration is related to the voltage reading of the meter. By a slight modification these instruments can be used to detect potentiometrically the end point in oxidation-reduction and in certain precipitation titrations. (*See* HYDROGEN IONS: *Glass Electrode* [*Cell With Glass Membrane*].)

Conductometry.—The conductivity of a solution depends upon the nature and concentration of the ions present in the solution. Thus, by measuring the conductivity with inert electrodes it is possible to determine ionic concentration.

Polarography.—In this method the timed relationship between voltage and current is determined for two electrodes in a solution. The reference electrode is nonpolarizable (usually saturated calomel) and the polarized electrode is the dropping mercury electrode. The general process that uses other polarizable electrodes is called voltammetry. Instruments are available for recording the voltage-current curves directly; the position of the curve on the voltage axis is characteristic of the substance. The amplitude of the curve is proportional to the concentration. Polarography can therefore be used both for the qualitative and quantitative analyses of inorganic or organic substances and it can be used for mixtures and in trace analysis for concentrations as low as 10^{-5} or 10^{-7} molar. The volume of the solution may be of the order of 0.3 ml.

Polarography is a most important analytical technique. Jaroslav Heyrovsky was awarded the 1959 Nobel prize for chemistry for originating and developing polarography.

Coulometry.—This analytical technique is based on Faraday's law of electrolysis. In direct determination, the quantity of charge required to bring about electrolytic deposition or solution is measured, but this technique has serious limitations because it is essentially a gravimetric method. The indirect methods of coulometry do not have this disadvantage; they usually require the determination of the amount of charge necessary to produce a substance that will react stoichiometrically with the substance to be determined. Such methods can be controlled automatically and have been used, for example, in the continuous determination of sulfur compounds in coal gas.

The movement of the recording pen is a measure of the amount of charge required to maintain a small excess of oxidizing agent (bromine) in the electrolyte. This is an analytical method that can be applied widely in the automatic analytical control of technical processes.

X-ray Diffraction.—The characteristic X-ray diffraction pattern given by crystalline substances can be made the basis for qualitative and quantitative analyses where other methods are not suitable. A beam of monochromatic X-rays is passed through a small tube of the powdered sample and the diffracted lines detected by their effect upon a photographic plate or film. The position of the lines serves to identify the crystalline species present; quantitative measurements of amounts present can be made by measuring the intensity of the lines. (*See* SPECTROSCOPY, X-RAY.)

Mass Spectrometry.—By using high resolution mass spectrometers it is possible to carry out remarkably accurate analyses on even microgram quantities of volatile materials (*see* MASS SPECTROSCOPY). Identification may be made with certainty by comparison of cracking patterns.

Countercurrent Distribution.—The physical principle on which this method is based is that of partition. Countercurrent distribution involves a multiple, consecutive extraction process in which a sample is distributed between two immiscible liquid phases. Since it is a repetitive process, mixtures of substances with only very slightly differing partition coefficients are easily separated. It is a powerful method for the analysis of complex mixtures of organic substances of biochemical origin.

5. Analysis With Radioactive Substances.—The ability to produce radioactive forms of many elements and compounds has opened up a field of analytical chemistry in which very accurate measurement of ionizing radiation is possible. Techniques such as activation analysis, isotope dilution and radiometric analysis make use of this high-precision technique. Neutron activation analysis involves irradiation of the substance in a nuclear reactor where, as a result of neutron bombardment, radioactivity may be induced in the elements present. The sample is then removed and the change of activity with time is plotted, giving a decay curve. From the shape of this curve the elements may be identified by their characteristic half-lives, and from their relative activities the amounts present may be calculated.

Isotope Dilution.—This method permits the quantitative determination of an element or substance in a mixture. A compound containing a radio-labeled atom or atoms of the element or substance is added to the mixture and a pure sample of the element or substance is isolated from the mixture by any suitable process. The radioactivity of the pure isolate is determined and, since the radioactivity and amount of labeled material first added are known, the amount of unlabeled material originally present is easily calculated. (*See* ISOTOPE: *Uses of Isotopes.*)

Radiometric analysis is a powerful method of analysis in which a radioactive substance is used indirectly. For example, chloride ion can be easily determined by adding radioactive silver (Ag^{110}) nitrate and determining the activity of the precipitated silver chloride. (W. D. Os.)

C. ORGANIC ANALYSIS

The number of elements (carbon, hydrogen, oxygen, nitrogen, sulfur, the halogens and occasionally phosphorus and some metals) usually present in organic compounds is limited. All these elements can be estimated quantitatively. Although oxygen is usually determined by difference, it can be determined directly.

1. Qualitative Tests for the Elements.—*Carbon and Hydrogen.*—The organic nature of a compound is generally indicated by its behaviour on being heated in air; solids usually melt, then burn with a more or less smoky flame, leaving a black residue of carbon. To test directly for carbon and hydrogen, a small quantity of the material intimately mixed with about 20 times its bulk of dry copper oxide powder is heated in a dry test tube closed by a cork carrying a delivery tube that dips into a solution of limewater. The copper oxide is reduced, the hydrogen is converted to water, which condenses on the cool part of the tube, and the carbon is oxidized to carbon dioxide, which with limewater yields a precipitate of calcium carbonate.

Nitrogen, Halogens, Sulfur.—When organic compounds containing any or all of these elements are heated strongly with metallic sodium, they decompose and form sodium cyanide, halide and sulfide, respectively (Lassaigne's test). To test for these elements, a small quantity (1 mg.) of the substance and a small pellet of sodium (or potassium) are heated in a narrow test tube, gently at first and afterward more strongly, until the glass softens; the hot tube is shattered by plunging it into water, thereby converting any residual sodium into sodium hydroxide and yielding an alkaline solution of the sodium salts; the solution is boiled and filtered, and the filtrate is used in the following tests:

1. Nitrogen.—A portion of the filtrate is mixed with a ferrous sulfate solution that contains a small quantity of the ferric salt and the mixture is boiled, thereby converting any sodium cyanide present to ferrocyanide, which gives a bluish-green solution and a precipitate of prussian blue when hydrochloric acid is added.

2. Halogens.—A second portion of the alkaline filtrate is acidified with nitric acid, and silver nitrate is added; any precipitate of chloride, bromide or iodide, or a mixture of these, is examined in the usual manner. If the original substance also contains nitrogen or sulfur, the acid solution must be boiled to expel the hydrogen cyanide or hydrogen sulfide before the silver nitrate is added.

3. Sulfur.—A third portion of the alkaline filtrate is tested for sodium sulfide: its presence is indicated (1) by the formation of a deep violet colour when the filtrate is treated with a few drops of a freshly prepared solution of sodium nitroprusside; (2) by the evolution of hydrogen sulfide when the filtrate is acidified—this is readily detected by its odour and also by lead acetate test paper.

Phosphorus.—A small portion of the organic compound is intimately mixed with about ten times its bulk of a mixture of sodium carbonate and sodium peroxide (2:3) and heated to fusion in a nickel crucible. The cold water extract of the melt is filtered, acidified with nitric acid and tested for phosphoric acid with ammonium molybdate.

Metals.—They are detected in organic compounds by using the standard methods mentioned in *Qualitative Inorganic Analysis* above.

2. Quantitative Analysis of Organic Compounds.—*Estimation of Carbon and Hydrogen.*—The carbon and hydrogen in an organic compound are estimated by completely oxidizing a weighed quantity of the substance and weighing the carbon dioxide and water thus formed. The simple method devised by Liebig in 1831 for carrying out this operation was in all essential principles the one still employed in the early 1960s. A weighed quantity of the substance is heated in a tube filled with dry copper oxide, and the water and carbon dioxide are absorbed in weighed tubes filled with dried calcium chloride and potassium hydroxide solution or soda lime respectively. A current of dry air or oxygen is passed through the tube to sweep the products of combustion into the absorption apparatus.

In the absorption apparatus, water is collected in a glass-stoppered U-tube that is filled with calcium chloride (carefully freed from lime). Carbon dioxide is absorbed by the soda lime contained in a connected pair of U-tubes; the second limb of each tube contains a short filling of calcium chloride. The two soda lime tubes may be replaced by an apparatus in which the bulbs are charged with concentrated potassium hydroxide solution and the side tube filled with soda lime and calcium chloride. An apparatus for purifying the current of air or oxygen is connected with the anterior end of the tube; it consists of a series of washing cylinders charged with potassium hydroxide or sulfuric acid and tubes filled with soda lime or calcium chloride to remove moisture and carbon dioxide from the incoming gas. This apparatus is arranged in duplicate, one for the air and one for the oxygen supply. The copper oxide tube may be heated electrically or by any simple form of gas furnace.

The combustion tube and its copper oxide charge are thoroughly dried while the compound to be analyzed, its container (a platinum or porcelain "boat") and the collecting tubes are weighed. The fore part of the tube containing the oxidized spiral and the first six inches of copper oxide is cooled and the boat and its contents are then introduced into the anterior end of the combustion tube. A slow current of air is passed through the tube, and the burners under the oxidized spiral in the rear of the boat are lighted. The heating is gradually extended toward the boat, the object being to distill the contents of the boat, or the volatile products of decomposition, on to the cold copper oxide, where the combustion is completed. This most critical part of the operation must be carried out very slowly and is finally completed in a current of oxygen that burns any residue of carbon left in the boat and reoxidizes the reduced copper oxide. After the oxygen in the apparatus is displaced by air, the absorption tubes are removed, closed, cleaned and allowed to cool in the balance room before being reweighed. From the weight of carbon dioxide and water yielded by the known weight of the compound, the percentages of carbon and hydrogen in the compound may be calculated.

The simple method described above applies to compounds containing carbon, hydrogen and oxygen only; if elements other than these are present the filling of the tube must be modified as follows: (1) *Nitrogen present.* The copper oxide spiral is replaced by a similar spiral of freshly reduced copper to reduce any oxides of nitrogen that may form during the combustion. The reduced copper is introduced into the previously cooled end of the tube before the absorption apparatus is attached. (2) *Halogens, sulfur or arsenic present.* The first six inches of copper oxide after the boat are replaced by a lead chromate cartridge. The container becomes oxidized in the preliminary heating of the tube; nonvolatile lead compounds are formed with the sulfur or arsenic in the compound, and sparingly volatile compounds are formed with the halogens. A short spiral of silver gauze should, therefore, be introduced at the posterior end of the tube when the compound contains halogens.

Estimation of Nitrogen.—The two methods used for the estimation of nitrogen are (1) the absolute method (Dumas), in which the nitrogen in a known weight of the compound is converted to the elemental form and determined directly; and (2) the Kjeldahl method, in which the nitrogen in a known weight of the material is reduced to ammonia and estimated volumetrically by titration.

The Dumas method consists of completely oxidizing a known weight of the compound by heating it with copper oxide in a tube in a current of carbon dioxide, passing the gaseous products of combustion over a heated copper spiral and collecting the nitrogen in a gas burette over strong potassium hydroxide solution.

The amount of the substance used in an analysis should be sufficient to give about 20 ml. of nitrogen. The charged tube is placed in the furnace and connected with an apparatus for generating carbon dioxide and with a Schiff's nitrometer filled with a concentrated solution of potassium hydroxide. While the air in the apparatus is being displaced by carbon dioxide, the part of the tube containing the coarse copper oxide and reduced spiral is heated to dull redness. When no insoluble gas collects in the charged nitrometer, the current of carbon dioxide is stopped and the nitrometer is filled with the potassium hydroxide solution, which is allowed to overflow into the thistle funnel seal attached to the end of the capillary transferring tube. The burners under the copper oxide spiral are then lighted, and when this part of the tube is at a dull red heat, the heating is extended toward the mixture of the substance with copper oxide and so regulated that not more than three bubbles of gas are ascending the nitrometer tube at the same time. Finally, when all the burners are lighted, the tube has attained a uniform dull red heat and there is no further evolution of gas, a slow current of carbon dioxide is again passed through the tube to sweep out the remainder of the nitrogen. The nitrometer is then removed and the gas reduced to atmospheric pressure. The nitrometer tube itself may be calibrated; or after about 15 minutes the nitrogen is transferred to a eudiometer tube over boiled-out water; the eudiometer tube is then completely immersed in a tall glass cylinder that contains water and a thermometer. After about ten minutes the volume of the nitrogen (v), the temperature (t) and the barometer (p) are read. If p' is the tension of aqueous vapour under these conditions and w denotes the weight of substance taken, the weight of nitrogen in the compound is given by the expression

$$N = \frac{v}{w} \times \frac{273 \times (p - p') \times 0.12507}{(273 + t) \times 760}$$

The Kjeldahl method is used for the estimation of nitrogen in foodstuffs, therapeutic substances, fertilizers or other materials in which the amount of nitrogen is small and under circumstances in which many determinations must be carried out simultaneously and rapidly. The method consists of decomposing the organic material by heating it with concentrated sulfuric acid; the carbon is oxidized and the nitrogen converted to ammonium sulfate, which is afterward estimated in the usual manner by distillation (*see* AMMONIA: *Detection and Estimation*). A weighed quantity of the material (0.5 to 5.0 g.) is placed in a long-necked, pear-shaped flask of 500 ml. capacity, 20 ml. of concentrated sulfuric acid are added, the flask is clamped in an inclined position and the contents are heated gradually to avoid frothing. After the acid has been boiling for about 15 minutes, 10 g. of potassium sulfate are added and the heating is continued until the contents of the flask become clear and faintly straw coloured. Small quantities of certain metallic salts such as copper or mercuric sulfate or mercurous iodide may be added when materials that are not easily oxidized are being analyzed. Finally the cold acid liquid is transferred, with the washings of the flask, into the distilling flask of an ammonia distillation apparatus; after the contents of the flask have been made alkaline, the ammonia is distilled into a measured volume of standard sulfuric acid and is estimated by titrating the excess of acid.

The Kjeldahl method can also be applied to the analysis of pure organic compounds, provided those compounds that contain nitrogen combined directly with oxygen or with nitrogen, as in nitro-, nitroso-, azo- or diazo-compounds or hydrazines, are first reduced by a pretreatment with hydrogen iodide (hydriodic acid).

Estimation of Halogens.—The estimation of halogens involves the complete decomposition of the compound with the conversion of the halogen element into the halogen acid or one of its salts, which is subsequently precipitated and estimated as the silver salt. (1) Liebig's is the oldest method and the one that can be applied to the largest number of organic compounds. It consists of decomposing a weighed quantity of the compound by heating it to redness with a large excess of pure lime in a glass tube sealed at one end, plunging the hot tube into cold water, dissolving the lime and calcium halide in cold dilute nitric acid, filtering and estimating the halogen acid in the filtrate in the usual manner. (2) Stepanoff's method, as modified by Bacon, is applicable to compounds in which the halogen is readily eliminated as halogen acid by hydrolysis or by reduction. It consists of heating a weighed quantity of the compound with sodium and alcohol, and estimating the sodium halide in the resulting solution. (3) The method of Carius, as modified by Kuster, is the one most generally employed; it consists of the destructive oxidation of a weighed quantity of the compound (about 0.2 g.) by means of fuming nitric acid (2 ml.) in the presence of silver nitrate in a sealed tube at a temperature of 250°–270° C. The halogen is converted into the silver salt and is weighed as such.

Estimation of Sulfur.—The estimation of sulfur in organic compounds involves the destructive oxidation of the substance; the sulfur is converted to sulfuric acid and then is determined as barium sulfate. The two methods in general use are: (1) The method of Carius, in which the operation is carried out as for halogen; no silver nitrate is required but, since the oxidation is facilitated by the presence of a small quantity of bromine, a crystal of potassium bromide is placed in the tube containing the compound. The contents of the tube are diluted with water, the nitric acid is removed by evaporation and the sulfur is determined as barium sulfate precipitate. (2) The method of Asboth, in which the oxidizing agent employed is a mixture of sodium peroxide (three parts) and sodium carbonate (two parts). A weighed quantity of the substance (0.2 to 0.5 g.) is mixed with about 15 g. of the oxidizing mixture in a nickel crucible, which is then carefully heated until the contents become liquid. When cold, the melt is extracted with water and the soluble sulfate is estimated as barium sulfate.

Estimation of Phosphorus.—Organic compounds containing phosphorus are oxidized by fuming nitric acid, by concentrated nitric acid and potassium permanganate, or by chromic and sulfuric acids. The resulting phosphoric acid is precipitated as ammonium phosphomolybdate and subsequently weighed as magnesium pyrophosphate.

Estimation of Metals in the Salts of Organic Acids and Bases.—These may be determined by using the standard methods of quantitative inorganic analysis (*see* above).

The methods of quantitative organic analysis just described have now frequently been replaced by semimicro or micro methods except in certain industrial processes. In some cases they have been retained because the organic material to be examined is rather heterogeneous and a representative sample is difficult to obtain. They are still used, for example, in the analysis of some solid and liquid fuels, creosote and some plastic materials.

(M. A. W.; W. D. Os.)

D. MICROANALYSIS

Chemical analysis becomes chemical microanalysis when the quantities of substance examined are in the 1–5 mg. range. It is customary to use the terms semimicro, micro or ultramicro with reference to the following amounts of material: semimicro (20–50 mg.), micro (1–5 mg.). Ultramicro refers to trace analysis on the microgram (gamma) scale.

The emergence of microchemistry and microanalysis as a separate discipline was the result of the teachings of Friedrich Emich who, about 1893, started a systematical development of micromethods of chemistry by embarking on a study of all kinds of chemical experimentation on an ever-smaller scale. He showed that only the techniques of handling, observing and measuring must be changed when extremely small quantities are being used. Emich developed micromethods of chemistry not only for qualitative and quantitative analysis but also for preparatory work, physicochemical studies and lecture demonstration.

Since most information regarding matter is derived from visual impressions, the microscope must be employed whenever the amounts of material become very small. The microchemical balance by W. H. Kuhlmann in Hamburg, Ger., was adopted for service in microanalysis because of its comparatively large carrying capacity of 20 g., which is required for the weighing of absorption tubes or organic combustion analysis. A variety of microbalances with beams of vitreous silica and using different principles for weighing (elasticity and torsion forces, buoyant effect, electromagnetic attraction) have been designed. (See *Physical Methods* above.)

Microanalytical analyses by spectroscopy, spectrophotometry, colorimetry, fluorimetry, nephelometry, polarography, radioactivity, chromatography and microbiological assay possess in certain instances high specificity and extraordinary sensitivity that give these methods a supreme position for the determination of trace constituents. Application of the methods on a small scale further increases their efficiency, and truly amazing limits may be obtained. Spectrophotometric measurements have yielded a sensitivity of 0.1 milligamma (nanogram), or 10^{-10} g. A. E. Mirsky and A. W. Pollister have performed colorimetric measurements on the microscopic image of tissue-thin sections, and they were able to measure as little as 0.0001 milligamma of tyrosine. Small-scale application of microbiological assay allows accurate estimations of quantity with less than 1 milligamma of certain substances.

1. Qualitative Microanalysis.—Modern inorganic qualitative analysis is frequently done on a semimicro (centigram) scale; results are confirmed by spot tests. In at least one instance the milligram scale has been adopted and the confirmatory tests are observed under the microscope. Schemes of analysis, including those for rare elements, are available on the semimicro as well as on the milligram scale. A technique for efficient work on the microgram scale, with sensitivities from 1 to 10 milligammas for the confirmatory tests, was developed during the 1930s. Most operations are performed under the low-power stage of the microscope with simple manipulators having rack-and-pinion motions. The microgram technique is, of course, applicable to general chemical experimentation, and it has been used in the study of the chemistry of small quantities of elements produced synthetically or obtained as a consequence of nuclear fission processes. Since most of the work is done by remote control, the technique is especially attractive for work with highly radioactive material.

Since each element produces its own characteristic emission spectrum, an examination of the spectrum of a substance reveals the identities of the elements present. The delicacy of the method transcends that of most sensitive chemical reactions. The presence of $\frac{1}{100,000}$ part of a milligram of lithium may be revealed in this way; or $\frac{5}{100,000}$ of a milligram of the rare gas neon, which is present in the atmosphere, may be detected. The metallic elements, gallium, rubidium, indium, cesium and thallium were discovered with this technique. The absorption spectra of many inorganic and organic substances are also characteristic and are widely used for the identification of small amounts of material. (*See* SPECTROCHEMICAL ANALYSIS: *Emission Spectrochemical Analysis*; SPECTROSCOPY: *Emission Spectra*.)

Spot tests are widely employed. They are purely chemical methods that depend upon the production, when reagents are added to the sample or to its solution, of (1) colorations or colour changes; (2) precipitates having characteristic odour, colour or crystalline form; or (3) gases or liquids that can be distilled and identified. These tests, many of which are very delicate, may be specific for particular compounds, radicals or elements, or for groups of these. Thus, the presence of 1 part of copper in 100,000,000 parts of water is shown by the blue colour produced on the successive addition of alcoholic hydrogen peroxide and guaiacum resin in pyridine. The presence of 1 part of gold in 20,000,000 parts of solution is revealed by the yellow coloration given with *o*-tolidine. Prussic acid (1 part in 2,000,000 of air) may be detected by the blue colour it gives on a test paper moistened with a solution containing *o*-tolidine, acetic acid and copper acetate. There are many hundreds of such tests, some of which are also quantitative.

Schemes of organic qualitative analysis may be carried out on a centigram or milligram scale with microtechniques developed mostly by Emich and his co-workers and spot tests devised by Feigl.

2. Quantitative Microanalysis of Organic Compounds.—The milligram procedures for organic analysis (determination of carbon, hydrogen, nitrogen, oxygen, sulfur, halide, phosphorus and metallic constituents) have almost displaced the old macromethods, and the same may be said of the micromethods for the determination of the functional groups in the molecule. Economy with regard to the material under investigation has become progressively more important as organic chemistry has turned to the study of biochemical problems. The superior reliability and general efficiency of the micromethods were no longer questioned in the early 1960s. The original methods of Pregl are still widely used with and without modifications. There is a trend toward mechanizing organic analysis with the use of automatic furnaces.

A brief outline of one of the more important microanalytical procedures is given below:

Determination of Carbon and Hydrogen.—A weighed quantity (three to five milligrams) of the substance, placed in a small platinum boat, is burned in a current of dried oxygen in a hard-glass combustion tube. The tube is 40 cm. in length and contains a filling of chemicals designed to arrest the escape of nitrogen, sulfur, halogens and other products that might vitiate the analysis. The remaining gaseous products of the combustion, water and carbon dioxide, are swept over with air and are retained in separate water-absorbing and carbon dioxide-absorbing tubes that are weighed before and after the experiment. From the gains in weight of these tubes, the amounts of hydrogen and carbon in the original material are calculated. The gas pressures at different points of the apparatus are carefully regulated, and the temperature of lead dioxide placed at the exit of the combustion tube to insure maximum combustion is maintained at 180° C. by an external heating device. Practically all classes of organic substances may be analyzed for carbon and hydrogen with great accuracy in this type of apparatus.

3. Microanalytical Apparatus and Micromethods.—Complicated separations involving rare elements followed by the determination of the isolated constituents have been carried out on the milligram scale. The most flexible technique of filtration is provided by the use of Emich's filterstick, an immersion filter consisting essentially of a tube with a filter mat near its lower (immersed) opening. The foundation for gravimetric work on a microgram scale has been laid by Emich's systematic investigations on highly sensitive microbalances with beams of vitreous silica. Little progress had been made in the early 1960s beyond the performance of simple residue determinations and electrolytic precipitations.

A systematic investigation of titrimetry, predominantly on the milligram scale, was carried out by J. Mika. Titrimetric and colorimetric methods are, however, widely used on the microgram scale. Various burettes have been developed for the purpose; some use the principle of the injection syringe and others rely on the surface tension force originating in the fine tip to take the place of the stopcock of the customary burette. With the latter type it is possible to dispense and measure volumes of standard solutions down to 0.0000002 ml. by adopting the injection technique of the microbiologist and performing the titration in the field of a microscope.

Micromethods for the determination of density, some based on the use of pycnometers and some based on the principles of the floating and falling drop methods, have been applied to the determination of heavy water and to various biochemical studies. Of the gas volumetric and manometric procedures, the very sensitive technique of D. D. van Slyke demonstrated its great versatility. An ingenious adaptation of the principle of the Cartesian diver for gas volumetric determinations on a microgram scale was made by K. Linderstrom-Lang.

Micromethods for the analysis of small samples of gases, originally introduced by C. Timiriazeff and A. Krogh, have been variously modified and refined for use in connection with chemical, industrial, biological and medical work.

4. Chromatographic Analysis.—Chromatography, which is widely used in microanalysis, is the general term for several related techniques that are used for separating the components of a mixture by a process involving differential migration. The discovery of partition and paper chromatography was one of the major advances in technique made in chemistry, biochemistry and allied subjects. An equally important development was the introduction of gas chromatography. These are discussed in detail elsewhere (*see* CHROMATOGRAPHY). (A. A. B.-P.; W. D. Os.)

E. GAS ANALYSIS

The field of gas analysis in a broad sense embraces the sampling and determining of all types of gaseous substances. The applications of such analyses are many and varied. The following are a few typical examples: (1) evaluation of toxicity hazard of a particular gas in a specific place, such as carbon monoxide in a vehicular tunnel; (2) determination of the composition of fuel gases to ascertain heating value or for control of plant operations, flue gases to evaluate efficiency of combustion, exhaust gases from internal-combustion engines to establish proper carburetor adjustment for maximum efficiency and mine gases to evaluate explosion hazard and quality of air; and (3) determination of products of combustion of various types of materials to ascertain toxic constituents formed.

Gas analysis is treated as a special branch of analytical chemistry because the manipulation of gases involves the use of specialized apparatus. The methods are of two main types: those that depend upon volumetric determination of the components of a mixture; and those that rely upon physical methods such as infrared spectroscopy and mass spectrometry for their qualitative and quantitative determination. Outstanding developments have taken place in the application of physical methods to gas analysis and this, coupled with the discovery of gas (vapour phase) chromatography, has provided a challenge to the older methods of gas analysis. However, many of the older volumetric methods were still used in the early 1960s because they do not require the use of expensive electronic equipment.

The classical methods of gas volumetric analysis such as those using the Orsat apparatus or the Bone and Wheeler apparatus depend upon the selective removal of the constituents by suitable absorption reagents. In the Orsat method, the composition of the sample can be determined from the known original volume of the gas sample and the known volume of each constituent measured under standard conditions of temperature and pressure. In the Bone and Wheeler method, the volume is kept constant and changes in pressure associated with the removal of each constituent by absorption are determined. The latter method is more accurate.

The applicability of these methods of volumetric gas analysis depends upon the availability of suitably selective absorbents. In some cases, as with the saturated gaseous hydrocarbons (*e.g.*, methane or ethane) and with hydrogen, methods dependent upon absorption cannot be used directly and in these cases the change in volume associated with oxidation and absorption of the oxidation products is used to determine these gases. With mixtures of saturated hydrocarbons, analysis by combustion methods is not very satisfactory and physical methods are often employed.

Methods of gas analysis have also been designed in which the amount of absorbed gas is determined by: (1) titration (*q.v.*) of the absorbed gas with a suitable reagent as in acidimetric or iodimetric titration; (2) colorimetric methods (*see* COLORIMETRY); and (3) gravimetric methods as in the determination of carbon dioxide by its conversion to barium carbonate.

This discussion is limited to some typical gas analysis methods and does not include descriptions of specialized techniques such as that of Van Slyke for the determination of gases in biological fluids or Warburg's apparatus for studying the production or absorption of gases in biochemical reactions.

Sampling.—It is often extremely difficult to secure a representative sample of a gaseous mixture; various methods have been devised to reduce this potential source of error. These include the snap collection of samples in evacuated tubes or the displacement of air or a liquid such as mercury, water or brine from a vessel. When gas samples are collected it is particularly important to avoid contamination with air; errors due to solubility are possible with methods that involve liquid displacement with liquids such as water.

1. Gas Volumetric Analysis.—These methods usually require the use of solutions that specifically absorb certain constituents. Such absorbents include aqueous sodium hydroxide or potassium hydroxide for carbon dioxide, fuming sulfuric acid or bromine water for unsaturated hydrocarbons, alkaline pyrogallol for oxygen and chromous chloride for carbon monoxide. Hydrogen is removed by oxidation to water by using heated copper oxide at 270°–280° C. Saturated hydrocarbons are oxidized by copper oxide-iron oxide at 580°–600° C. to carbon dioxide and water.

Two basic procedures are used to absorb the gases; in one the absorbent is confined in a vessel or pipette into which the gas is passed for absorption, and in the other the absorbent is added to the gas in the burette or auxiliary vessel. The absorbent in the pipette is used to analyze a number of samples, whereas when the absorbent is added to the burette or auxiliary vessel it is used only once.

The Hempel, Orsat and Haldane apparatus are examples of the former, and the Elliott and Morehead are examples of the latter. In the Hempel apparatus the burette and pipette are separate. The appropriate pipette is connected to the burette for each specific constituent.

In the Orsat and Haldane apparatus a series of pipettes is securely attached to the burette through a manifold to make an integral unit.

As a discussion of all types and modifications of apparatus that utilize these principles would be too extensive, only typical examples are described.

2. Orsat Type of Gas Analysis Apparatus.—The Orsat type of gas analysis apparatus is designed for various applications that range from small compact portable types with only one or two pipettes to large laboratory models having a half dozen or more pipettes.

The Orsat type of gas analysis apparatus consists essentially of: (1) burette, (2) pipettes, (3) copper oxide tube, (4) confining liquid, (5) compensator tube and (6) a water jacket for the burette and compensator tube. The burette is a cylindrical glass tube of 100 ml. capacity with carefully calibrated graduation marks to permit reading of gas volumes to a fraction of a millilitre. The burette is closed at the top with a stopcock, and the bottom is connected by a rubber hose to a reservoir for the confining liquid. The confining liquid may be water, a salt solution or mercury. As gases may dissolve in water or aqueous solutions, mercury is preferred and usually is employed in laboratory apparatus. Acid water or salt solutions are usually employed in portable units. The number and type of pipettes depend on the type of work to be done, but laboratory models usually have pipettes for the removal of carbon dioxide, illuminants, oxygen, carbon monoxide and for slow combustion of methane and ethane. The copper oxide tube is for the oxidation of carbon monoxide and hydrogen. The confining liquid not only confines the gas in the burette but also draws the sample into the burette and forces it into the pipettes or copper oxide tube as required. Since the results of the analyses are based on change in volume due to absorption or combustion, it is essential that the volume of the sample is not changed because of changes in temperature, atmospheric pressure or water vapour. The water jacket surrounding the burette and compensator tube serves to control the temperature. Changes in pressure and water-vapour content due to slight changes in temperature are controlled by the compensator and by having a small amount of water on the mercury in the burette and in the compensator tube.

3. Analysis of Fuel Gas.—The use of the Orsat type of gas analysis apparatus for the analysis of a fuel gas offers a typical example of the application and technique of gas analysis. The analysis of a fuel gas may require determination of the following constituents: carbon dioxide, illuminants, oxygen, carbon monoxide, hydrogen, methane, ethane and inert gases, mainly nitrogen. Illuminants include a number of unsaturated hydrocarbons, such as ethylene, propylene, butylene, benzene, toluene and acetylene.

Since the constituents are removed one at a time it is necessary that the absorbent used for the first constituent does not remove any of the other components. In other words, the order of removal of constituents is important and is fixed by the reagents used.

The following is the order in which the gases are usually determined and the reagents or reactions that are commonly used for the determination of the various gases:

(1) Carbon dioxide	Absorbed with potassium hydroxide
(2) Unsaturated hydrocarbons	Absorbed with fuming sulfuric acid
(3) Oxygen	Absorbed with alkaline pyrogallol
(4) Carbon monoxide	Absorbed with acid or ammoniacal cuprous chloride and 2-naphthol-cuprous sulfate. Also determined by oxidation with heated copper oxide or by slow combustion with heated platinum spiral
(5) Hydrogen	Determined by oxidation with heated copper oxide or by slow combustion with oxygen
(6) Methane	Determined by slow combustion with oxygen
(7) Ethane	Determined by slow combustion with oxygen
(8) Nitrogen and other inert gases	Estimated by difference. Not determined directly

The potassium hydroxide solution is prepared by dissolving 30 g. of KOH in 100 ml. of distilled water. Sodium hydroxide also may be used; but it has the disadvantages of greater chemical action on the glass, and it forms a bicarbonate precipitate more readily than potassium hydroxide. The fuming sulfuric acid when fresh should contain 20% to 25% free sulfur trioxide. Bromine water (prepared by dissolving bromine in water until an excess of liquid bromine remains in the bottom of the pipette) also may be used to absorb unsaturated hydrocarbons but should not be used when mercury is used as the confining liquid. Alkaline pyrogallol is prepared by dissolving 50 g. of pure pyrogallol in 150 ml. of distilled water, and mixing with a solution containing 1,200 g. of potassium hydroxide in 800 ml. of water. The mixture should be immediately protected from the air. Oxygen may be absorbed by other reagents such as white phosphorus, chromous chloride or acetate, and sodium hydrosulfite. There are objections to the use of these reagents and therefore alkaline pyrogallol is usually employed. For the absorption of carbon monoxide, acid cuprous chloride (450 g. of chemically pure cuprous chloride dissolved in 2,500 ml. of concentrated C.P. hydrochloric acid) is frequently used, but 2-naphthol-cuprous sulfate is also used. The latter is prepared from cuprous oxide, 20 parts; sulfuric acid, 200 parts; water, 25 parts; and 2-naphthol, 25 parts.

4. Analytical Procedure.—Before an analysis is started, the apparatus should be checked to be sure that it is in proper operating condition. It should be tested for leaks to assure that the sample is not lost or diluted with air. A small amount of water should be placed in the burette and in the compensator tube. The air in the compensator tube should be adjusted to atmospheric pressure. The capillary tubes of the manifold through which the sample is passed to the pipettes and copper oxide tube should be swept free of air by drawing a sample of air into the burette, absorbing the oxygen in the alkaline pyrogallol solution and then passing the residual inert gas through the apparatus.

To obtain a sample for analysis, the mercury reservoir or leveling bulb is raised to free the burette of air. The burette is then connected to the gas sample container with capillary tubing and the leveling bulb lowered to draw the sample into the burette. The stopcock at the top of the burette is closed and the volume of gas in the burette is read at atmospheric pressure by adjusting the mercury in the leveling bulb and burette to the same level. The analyst is now ready to proceed with the analysis.

Carbon Dioxide.—The stopcocks are aligned so that the sample can be forced, by raising the leveling bulb, from the burette into the pipette that contains the potassium hydroxide. The leveling bulb is alternately lowered and raised in order to pass the sample back and forth from the burette to the pipette. This procedure facilitates absorption of the carbon dioxide, which should be completely removed after four or five passes into the pipette. The leveling bulb is finally lowered until the potassium hydroxide reaches a mark on the capillary at the top of the pipette. The stopcock to the pipette is then closed and the volume of gas in the burette read as previously described. The decrease in volume is due to removal of carbon dioxide since the other constituents are not absorbed. If the original volume of the sample was 100 ml., and after removal of carbon dioxide the volume was 98 ml., then the amount of carbon dioxide present in the sample was 2 ml. or 2 parts in 100, that is, 2% by volume.

Unsaturated Hydrocarbons.—The stopcocks are now aligned so that the sample can be passed into the pipette containing the fuming sulfuric acid. The sample is passed into the pipette three or four times as described for carbon dioxide. However, before the volume is read, the sample is passed once or twice into the potassium hydroxide pipette to remove any sulfur trioxide vapours removed from the fuming sulfuric acid. The volume of the residual gas is then read on the burette. If the reading is 95 ml., then 3 ml. (98 minus 95) or 3% unsaturated hydrocarbons are present.

Oxygen.—The procedure described for carbon dioxide and unsaturated hydrocarbons is repeated; the sample is passed into the pipette containing the alkaline pyrogallol 6 to 12 times, depending on the concentration of oxygen in the sample. If the burette reading has decreased from 95 to 94 ml., then the sample contains 1 ml. or 1% oxygen.

Carbon Monoxide.—The procedure used for the previous constituents can be used for determining carbon monoxide by passing

Typical Values for Individual Constituents of Several Kinds of Fuel Gas

Kind of gas	Carbon dioxide	Unsaturated hydrocarbons	Oxygen	Carbon monoxide	Hydrogen	Methane	Ethane	Nitrogen
Natural	. .	. .	. .	. .	.	85.5	13.5	1.0
Blast furnace	10.8	. .	. .	28.2	0.8	.	. .	60.2
Producer	5.6	.	0.4	25.4	15.2	1.4	. .	53.0
Coal	2.1	3.3	0.4	8.2	50.5	28.6	. .	6.9
Water (blue)	5.2	. .	0.6	41.5	48.7	1.4	.	3.6
Carburetted water	2.7	9.2	0.7	33.6	35.2	12.4	. .	6.2
Coke oven	1.9	3.5	0.3	6.4	52.5	30.6	. .	4.8

Information on the composition of a fuel gas can be used in various ways; for example, by calculating the heating value and specific gravity of the gas, data that are essential for the safe and efficient utilization of gaseous fuels.

the sample five or six times into a pipette containing one of the absorbents for carbon monoxide. The percentage present is calculated in the same way as for carbon dioxide.

Carbon monoxide also may be determined by oxidation with copper oxide as described below.

Hydrogen and Carbon Monoxide.—The stopcocks are aligned so that the residual sample can be passed through the copper oxide tube, which is heated by means of a small furnace to from 290° to 310° C. The sample is passed through the copper oxide tube slowly (about 10 ml. per minute) and returned to the burette. This operation is repeated and the contraction in volume noted. The carbon dioxide produced by the oxidation of carbon monoxide is then determined as prescribed previously for carbon dioxide. The reactions that take place are as follows:

$$H_2 + CuO \rightarrow H_2O + Cu$$
$$CO + CuO \rightarrow CO_2 + Cu$$

Thus for hydrogen there is a decrease in volume equal to the amount of hydrogen in the sample since the water formed condenses and occupies a negligible space. The carbon monoxide produces an equal volume of carbon dioxide and therefore no change in volume. The volume of hydrogen in the sample equals the contraction of the sample after oxidation and the volume of carbon monoxide is equal to the volume of carbon dioxide produced.

Methane and Ethane.—At this stage in the analysis the residual gas may consist of methane, ethane and inert gases, mainly nitrogen. Since methane and ethane require oxygen for combustion, it is necessary to add oxygen. The residual gas is stored in the potassium hydroxide pipette and an excess of oxygen necessary for combustion of the methane and ethane is carefully measured in the burette. The oxygen is passed into the combustion pipette and the residual gas returned to the burette. The platinum spiral at the top of the combustion pipette is heated electrically to a bright yellow and the residual gas passed slowly (about 10 ml. per minute) into the combustion pipette. Methane and ethane are oxidized to carbon dioxide and water according to the following equations:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$
$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

On the basis of these reactions, the percentages of methane and ethane can be calculated as follows:

$$\%\text{ ethane} = \frac{(2 \times \text{carbon dioxide} - \text{contraction}) \times 100}{1.5 \times \text{ml. sample taken}}$$

$$\%\text{ methane} = \frac{(\text{carbon dioxide} - 2 \times \text{ethane}) \times 100}{\text{ml. sample taken}}$$

The sum of the percentages of all the constituents determined is then subtracted from 100 and the remainder is the percentage of nitrogen or inert gas in the sample.

In presenting the analytical procedure, only the basic steps have been described and no attempt has been made to incorporate numerous minor steps that are necessary to obtain accurate results.

5. Haldane Apparatus.—Another gas volumetric apparatus widely used for the analysis of mine atmospheres and samples that contain small quantities of carbon dioxide, combustible gases and oxygen, with an accuracy greater than that obtainable with the apparatus of the type previously described, is known as the Haldane apparatus. The basic principles of the apparatus and procedures are the same as for those of other gas volumetric methods of analysis. The conventional apparatus consists of a water-jacketed burette and compensator, with two absorption and one combustion pipettes. The burette consists of an ungraduated bulb at the top having a volume of 15 ml. and a stem with a volume of 6 ml. graduated to 0.01 ml. Samples to be analyzed must not contain an explosive mixture of combustible gases, and there must be sufficient oxygen in the sample to burn completely all the combustible gases. Carbon dioxide is removed first, then the combustibles (methane, hydrogen and carbon monoxide) and finally oxygen. The oxygen determined is that remaining after combustion, and therefore it is necessary to add the amount consumed by the combustion. Calculation of results is essentially the same as for the Orsat type of apparatus.

6. Bone and Wheeler Method.—This method of constant volume gas analysis, devised by W. A. Bone and R. V. Wheeler (1908), is based on selective absorption in a single vessel. The reagent for a single constituent is added to the vessel, the constituent is removed and the change in pressure at constant volume is measured. The reagent for that constituent is removed and the process is repeated with a reagent for another constituent. The method is still used for gas analysis although it has been modified a number of times. The most important modifications were made by W. J. Gooderham (1938) and include an alteration to the absorption pipette and the use of better absorption reagents. Gooderham also described (1957) a constant volume gas analysis apparatus that includes further modifications.

7. Gooderham's Method.—In this method, a stream of gas is bubbled through a series of absorbent solutions. Placed after each bath is a device for measuring the reduction in volume resulting from the selective removal of each constituent. The device is a flowmeter and is essentially a glass tube along which a soap film travels; by measuring the change in the rate of movement of the soap film it is possible to calculate the reduction in volume. The analysis of coal gas by this method can be completed in 10 minutes with a high degree of accuracy (error less than 0.1%).

8. Thermal Conductivity Method.—This method, which may be used to analyze simple mixtures, depends upon the fact that the rate of loss of heat from an electrically heated wire is dependent upon the nature of the gaseous medium surrounding the wire. Changes in the temperature of the wire will produce changes in electrical resistance that can be determined by a Wheatstone bridge arrangement. The instrument is empirically calibrated beforehand by standard mixtures and can then be used for quantitative analysis.

9. Low-Temperature Distillation Method.—In this method the components of a mixture that are gaseous at normal temperatures are separated by fractional distillation. Distillation is achieved by cooling to low temperatures with refrigerants such as liquid air; with this method it is possible to separate mixtures of gases with boiling points in the range −190° C. to +40° C. and to operate in "closed" high-vacuum gas analysis equipment. Quantitative measurements are made with a McLeod gauge and gases are circulated and collected by pumps.

10. Mass Spectrometry and Infrared Spectroscopy.—These methods are extensively used in gas analysis, particularly for the analysis of hydrocarbon mixtures. They are important for the control of processes in the petroleum cracking industry.

11. Gas Chromatography.—The usual arrangement for analytical gas chromatography is a column filled with a porous granular solid, the pores of which contain an organic liquid with a high boiling point. The column is enclosed in a box equipped with a thermostat and an inert carrier such as helium or argon is passed through the column. The sample is injected and is transmitted by the carrier gas through the column by a process involving partition between the stationary liquid phase and the moving gas phase. The constituents of the sample as they emerge are detected by a suitable physical method such as their effect upon thermal conductivity. Qualitative identification is achieved by comparison with known compounds; quantitative estimations of the material present also can be made.

See ULTRAMICROCHEMISTRY; *see* also references under "Chemistry" in the Index. (H. H. Sk.; W. D. Os.)

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(H. M. L.; R. N. Cl.; E. A. M.-H.; E. H. St.; A. A. B.-P.; H. H. Sk.; W. D. Os.)

CHEMISTRY, SOCIETIES OF. Chemical organizations are among the most active agencies for promoting the increase and diffusion of chemical knowledge. At first the chemists functioned purely within such general scientific bodies as the Royal Society of London. In the closing decades of the 18th century, however, a few chemical societies sprang up in England, Scotland and the United States. Some doubt exists as to the order of priority in which these societies were formed but the most likely sequence seems to be: a London chemical society (1782); a chemical society at the University of Edinburgh (1785) composed of the students of Joseph Black; a chemical society at the University of Glasgow (1786); a chemical society in Manchester (prior to 1787); the Chemical Society of Philadelphia, founded by James Woodhouse (1792); another chemical society in Glasgow (1798); and a chemical society in Edinburgh (1800).

In the more industrialized areas in Europe, South Africa and the United States, permanent chemical societies developed before 1900 to provide a means for exchange of practical and theoretical knowledge. All these organizations have similar origin, and all foster original research and dissemination of new knowledge through publications, meetings, lectures, grants for research and medals for meritorious work. In 1841, 25 men, among them Sir William Robert Grove and Lyon Playfair, met in London to promote a chemical society. Robert Warrington was a moving spirit and Thomas Graham the first president. A royal charter was granted in 1848 to this group, to be known as "The Chemical Society for the advancement of Chemical Science as intimately connected with the prosperity of the manufactures of the United Kingdom, many of which depend upon the application of chemical principles and discoveries for their beneficial development and . . . economical application of the industrial resources and sanitary condition of the community." Its principal publications are the *Memoirs*, *Quarterly*, and *Journal of the Chemical Society* and *British Abstracts*. The society has one of the largest chemical libraries in the world, including the Roscoe collection of alchemical and early chemical works. The Royal Institute of Chemistry was founded in 1877 with high membership standards to promote efficiency among its members and interest throughout the country.

In 1857, with the British society as a model, three lecture demonstrators invited seven men to study means of communication between the foreign chemistry students in the Paris laboratories. This endeavour grew into the unification of all chemists in France in the Société Chimique de France. By Dec. 1858 the membership was extended to older men and an illustrious group was elected as officers. J. B. Dumas was president, Louis Pasteur and A. Cahours vice-presidents, C. A. Wurtz secretary and F. S. Cloëz the treasurer. The official organ is the *Bulletin de la société chimique de France*.

One hundred persons attended the organization meeting of Der Deutschen Chemischen Gesellschaft in Nov. 1867. This was called by a provisional committee. The speaker, Adolph Baeyer, regarded the time propitious for a union of Berlin chemists. August Hofmann, who was familiar with the British society, was temporary president. He recommended an alliance between theorists and industrial chemists who welcomed scientific assistance. In full session in Jan. 1868, Robert Wilhelm von Bunsen, Justus von Liebig and Friedrich Wöhler, who lent their powerful support, were elected honorary members. The society, reorganized as Gesellschaft Deutscher Chemiker in 1946, publishes *Angewandte Chemie* and sponsors *Chemisches Zentralblatt* and Beilstein's *Handbuch der organischen Chemie*. Its journal is *Chemische Berichte* (known prior to 1947 as *Berichte der deutschen chemischen Gesellschaft*).

In the United States, the short-lived Columbian Society of Philadelphia, founded in 1811, antedated the American Chemical society. To celebrate the 100th anniversary of the discovery of oxygen by Joseph Priestley, a pilgrimage to his home in Northumberland, Pa., was made by 77 chemists in 1874. Friendly relations then stimulated a group of New York chemists to found the society two years later under the presidency of J. W. Draper. The society's principal journals and their founding dates are *Journal of the American Chemical Society* (1876), *Chemical Abstracts* (1907), *Chemical and Engineering News* (1923), *Industrial and Engineering Chemistry* (1909), *Analytical Chemistry* (1929), and *Journal of Agricultural and Food Chemistry* (1953). The society also publishes the *Journal of Physical Chemistry* and the *Journal of Organic Chemistry*.

There are separate societies for industrial chemistry, chemical engineering, electrochemistry and other specialized fields. An International Congress of Pure and Applied Chemistry was organized in Brussels in 1894. The present International Chemical Union of Pure and Applied Chemistry was started in 1919.

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CHEMNITZ (Kemnitz), **MARTIN** (1522–1586), the leading German Lutheran theologian of the late 16th century, known (with reference to Martin Luther) as "the second Martin," was born at Treuenbrietzen, Brandenburg, Nov. 9, 1522. He attended the universities of Frankfurt an der Oder (1543) and Wittenberg (1545), where he became a protégé of Philipp Melanchthon and studied chiefly mathematics, branching out into the then respectable field of astrology. He took his master's degree at Königsberg (Kaliningrad), where a subsequent appointment as ducal librarian (1550) gave him the opportunity for theological studies. Back at Wittenberg (1553), he began to lecture on Melanchthon's *Loci communes*. In 1554 he received holy orders in order to become co-adjutor to Joachim Mörlin, whom he succeeded (1567) as superintendent of the churches of Brunswick, the post that he held the rest of his life. In 1568 he took a doctorate in theology at Rostock and with Jakob Andreä began the Reformation of the duchy of Brunswick-Wolfenbüttel. For another decade the two worked together for the reunion of the Lutheran Church; the document that achieved this end, the *Formula of Concord* (1577), is chiefly their work. Ill-health forced Chemnitz to retire in 1584; he died April 8, 1586.

Chemnitz' importance may be measured by his Roman Catholic opponents' epigram: *Si Martinus non fuisset, Martinus vix stetisset* ("If Martin [Chemnitz] had not come along, Martin [Luther] would hardly have survived"). His great contribution was the building of a bridge between Luther's and Melanchthon's theologies. His main works are: a defense of the Lutheran doctrine of the real presence of Christ's body and blood in the Eucharist (1561); a systematization of the biblical and patristic data on the relation of the divine and human natures in the single person of Christ (1570); *Examen Concilii Tridentini* (1565–73), the classic Lutheran analysis of the doctrinal decisions of the Council of Trent (1545–63); and an extended but incomplete presentation of his theology in the form of a commentary on Melanchthon's *Loci* (edited in 1591, after his death).

Bibliography.—Chemnitz' autobiography, trans. by Augustus L. Graebner, in *Theological Quarterly* 3:472–487 (1899); G. Noth, *Grundlinien der Theologie des Martin Chemnitz* (1930); Reinhard Mumm, *Die Polemik des Martin Chemnitz gegen das Konzil von Trient* (1905). (A. C. Pn.)

CHEMNITZ: *see* Karl-Marx-Stadt.

CHEMOTHERAPY is the treatment of infectious or parasitic diseases by chemical compounds. The word was coined by Paul Ehrlich (*q.v.*) in Germany, and it provided a distinction from the treatment of such diseases with serums and vaccines. It is generally used in this sense, though there is a tendency to broaden its scope to include the chemical treatment of nonparasitic diseases.

Until the end of the 19th century, most drugs were derived either from minerals or from plants. The researches of Louis Pasteur in France and Robert Koch in Germany laid the foundations of bacteriology, which found its first practical application in medicine when Joseph Lister (later Lord Lister) at Glasgow in 1865 introduced antiseptic surgery, using phenol (carbolic acid) as the disinfectant. It was Ehrlich, however, who made the greatest contribution to the science he named. The problem was to produce a disinfectant which would destroy parasites within a living animal without serious damage to the host.

William H. Perkin, in England, made the first aniline dye as a result of abortive attempts to synthesize quinine, the sole antimalarial drug available at that time (1856). About 30 years later, by a curious paradox of history, Ehrlich found that a synthetic dye, methylene blue, has antimalarial properties. He had been led to this by a study of the specific staining of organs of an animal or of a parasite following the injection of a synthetic dye. From these studies there emerged in 1901–04 Ehrlich's well-known "side-chain" theory, in which he sought for the first time to correlate the chemical structure of a synthetic drug with its biological effects. In 1903 Ehrlich invented a dye, trypan red, which was the first drug to show activity against trypanosomal infections in mice. Ehrlich's greatest triumph, however, was the discovery of the organic arsenical drug salvarsan, which proved to be effective in the treatment of syphilis (1910). Largely as a result of the energetic pursuit of chemotherapy by German industrial concerns, other important chemotherapeutic agents followed, and it is perhaps not surprising, historically, that these were mainly remedies for tropical diseases. Of great importance among these was Atabrine (mepacrine), which was widely used during World War II as an antimalarial agent but which was largely superseded later by drugs such as proguanil (Paludrine) and chloroquine. Chemical compounds of varying types also were developed for the treatment of trypanosomiasis (African sleeping sickness).

For many years the search for an antibacterial chemotherapeutic agent proved elusive, but authoritative pronouncements on the improbability of this ever being achieved were confounded by the discovery of Prontosil in Germany in the early 1930s. This was the forerunner of the sulfonamide drugs, which came to be widely used for the treatment of bacterial infections in man and domestic animals (*see* Sulfonamides). Other important synthetic drugs used in the treatment of bacterial infections are p-aminosalicylic acid and isonicotinic hydrazide, both employed in the treatment of tuberculosis.

The discovery of penicillin (*q.v.*) by Sir Alexander Fleming in England in 1928, and its practical development by Sir Howard Florey and his associates at Oxford (1940), marked another important advance in bacterial chemotherapy. Penicillin was the first of the so-called antibiotics, which are chemical products of fermentations, and it was followed by other important antibiotics such as streptomycin, the tetracyclines and the macrolides. Research in this field is intense and the production of antibiotics is a large industry. (*See* also Antibiotics.)

Apart from the antiprotozoal and antibacterial drugs, there are synthetic chemotherapeutic agents to combat other types of parasitic diseases, such as those caused by worms in domestic animals and man. The outstanding problem awaiting solution at the beginning of the 1960s was the chemotherapy of virus infections, though diseases caused by certain of the larger viruses had already shown themselves amenable to chemotherapy. The treatment of parasitic diseases of plants by means of chemicals remained mainly in the disinfectant stage. After World War II, however, there were attempts to develop plant chemotherapy, whereby chemicals which are poisonous to insects or fungi (but not to the plants themselves) are absorbed and translocated within the plants. *See* also Pharmacology.

See also references under "Chemotherapy" in the Index volume. (W. A. S.)

CHEMULPO (Inch 'ŏn), seaport and industrial centre in central Korea, near the mouth of the Han river, is 25 mi. W.S.W. of Seoul. Connected with Seoul by rail lines, it serves as the city's chief seaport.

Formerly a small fishing village, it became one of three treaty ports opened in 1883. During Japanese occupation (1910–45) modern industries and port facilities were developed and tidal basins constructed to overcome 33-ft. differences in tide levels. Successful UN landings at Inch'on crippled the North Korean invasion in mid-September 1950 (*see* KOREAN WAR). After the Korean war, a plate glass factory, an iron and steel plant, and new docks, constructed with U.S. and UN economic aid, increased the yearly port capacity to 2,300,000 tons. Other industries are chemicals, lumber and rice cleaning. Pop. (1960) 402,009. (S. McC.)

CHEMURGY is the application of the sciences, particularly chemistry, to the industrial utilization of farm products. The name, coined in 1935, is derived from two Greek words that may be freely translated as chemistry at work. The term farm chemurgy is frequently used.

The farm chemurgic movement rose in the United States because of the distress caused by the enormous crop surpluses blocking the farmers' market in the late 1920s and middle 1930s. It was started in 1935 by a group of industrialists and agriculturists, who proposed to meet this problem in three ways: (1) by discovering new uses for established farm crops; (2) by developing new crops for acreage devoted to surplus crops; and (3) by more profitable use of farm wastes, better described as farm residues.

In a broad sense, most farm crops go into industry, but in a manner based largely on the old uses, food, clothing and shelter. These uses have not changed essentially since the middle of the 19th century. They have only been made more complex by the coming of the industrial age and the departure of most agricultural industry from the farm. The substitution of the power loom for farm weaving and the replacement of the home container by the tin can do not mean that more wool, cotton or farm produce are consumed than previously but merely that they are used elsewhere and travel farther than they did in the days when wool moved almost directly from the back of the sheep to the back of its owner.

Many factors contributed to build up the burdensome crop surpluses of the 1920s and 1930s. The advent of automobiles and tractors and the departure of the horse left available for other crops the approximately 30,000,000 ac. formerly devoted to forage crops in the United States, while the markets for nonforage crops remained about the same. The development of high-yielding crop varieties, the extensive use of fertilizers and the application of other improvements resulting from research led to greater farm productivity. Thus the farmers' productivity increased while the traditional uses for their products were about stationary or even diminishing.

At the beginning of the 20th century, the industrial utilization of agricultural raw materials for purposes other than foods and feeds began to receive the attention of many organizations in the United States, notably the U.S. department of agriculture. Much work was done on the manufacture of alcohol from starchy crops; on new crops for fibres, alcohol and oil; and on the production of paper and furfural from cornstalks, wheat straw, corncobs and other agricultural residues. Many of these investigations were completed on a laboratory and a pilot-plant scale.

At this point the farm chemurgic movement was started. A committee of those interested in improving the situation of the farmer—businessmen, agriculturists and scientists—mailed invitations for a conference. The first meeting, held at Dearborn, Mich., in 1935, resulted in the formation of the National Farm Chemurgic council (later called the Council for Agricultural and Chemurgic Research), the central organization of the chemurgic movement in the United States.

The council's chief function is to encourage the advancement of chemurgic objectives. The council sponsors local and regional conferences at which representatives of agriculture, science and business discuss the chemurgic possibilities of the particular area. The discussions cover many fields, including industrial developments, new research achievements and suggestions for new crops. These activities have contributed to state, industry and government accomplishments in chemurgy. In fact, it can be said that the chemurgic movement is largely responsible for the biggest government venture in this field—the establishment of the four large regional research laboratories of the U.S. department of agriculture.

Leading to the establishment of the four laboratories was the 1935 Bankhead-Jones bill, which provided funds for additional research in the department of agriculture and the state agricultural experiment stations.

The U.S. Regional Soybean Industrial Products laboratory, set up under the provisions of this bill in 1936, was a chemurgic laboratory devoted primarily to finding new industrial uses for the soybean. Its success in making paints, varnishes, plastics and fibres from soybeans led to a flood of other bills in congress proposing the establishment of similar laboratories to expand the industrial utilization of other crops.

These activities culminated in an amendment to the Agricultural Adjustment act of 1938 which authorized the establishment of the four regional research laboratories to study new uses for agricultural raw materials. These laboratories, sometimes known as the chemurgic laboratories, were designed according to the latest construction developments, including ample provisions for work on a semi-industrial scale. They cost, fully equipped, around $2,000,000 each. Accommodations were planned for approximately 400 scientists and auxiliary workers in each laboratory. The sites chosen were at Peoria, Ill.; New Orleans, La.; Philadelphia, Pa.; and Albany, Calif. The laboratories were appropriately named for the four points of the compass.

The commodities to be studied, chosen primarily from those in surplus, included: Northern laboratory: cereal crops, oilseeds of the region, agricultural residues; Southern laboratory: cotton, cottonseed, peanuts, sweet potatoes; Eastern laboratory: dairy products, tobacco, apples, white potatoes, vegetables, animal fats, hides, skins, tanning materials; Western laboratory: fruits, vegetables, alfalfa, wheat, poultry products.

The research of these four laboratories and their associated units, done co-operatively with industrial and many other organizations, has led to the creation of vast new wealth and benefits for agriculture, industry, national defense and consumers. The value of the commercial processes, machinery and products stemming from—or significantly aided by—their work amounted to billions of dollars.

Contributions included penicillin and other antibiotics; dextran, a blood plasma extender; the drugs rutin and quercetin; surgical sponge from starch; elastic bandage from cotton; certain vitamins; fibres from corn, peanuts and milk; new products from feathers; improved dried-egg products; new cotton-processing machinery; chemical fibres from cotton having new properties for specific end uses; improved wool products; synthetic rubbers and rubber chemicals; improved methods for making rubber from guayule; frozen citrus concentrates; fruit juice powders and new types of dehydrated foods; methods for recovering fruit essences; improved processes for tanning leather; apple sirup as a humectant for tobacco; new coatings from vegetable oils and pine gum, and industrial products from animal fats; detergents; antioxidants; synthetic lubricants; wax and chemicals from sugar cane; newsprint and paperboard from agricultural residues; and improved methods for processing oilseeds, pine gum and other crops.

While the direct, visible benefits of this work are certainly great, the indirect benefits—resulting primarily from the publication of several thousand scientific papers—are in all probability even greater.

Chemurgic research in other organizations, *e.g.*, state experiment stations, schools and industry, also has proved highly profitable. Important achievements resulting from this work include nylon from the chemical furfural, which is manufactured from oat hulls and corncobs; paper, newsprint and plastics from sugar cane bagasse; plastics and protective coatings from cotton linters; chemicals from corn; cortisone and related drugs; the chemical sorbitol and detergents from sugar; synthetic rubber from alcohol; chemicals for making rubber and resins from naval stores; fibres, protective coatings and plastics from castor oil; and chemicals from tall oil.

Favourable to the progress of chemurgy are the establishment of new industries and the expansion of old ones that represent outlets for chemurgic products. For example, the chemical industry expanded about threefold during the first 15 years' existence of the four regional laboratories. This advantage is counterbalanced to some extent by the fact that competition from petroleum, natural gas and other raw materials is becoming stronger. The volume of research to make new and better products from these raw materials is many times greater than that devoted to expanding and improving the utilization of farm crops.

Chemurgy, already successful, will continue to aid agriculture and improve living standards for all. Being based on the use of annually renewable raw materials, chemurgy will also enable nations to conserve their other resources.

See Wheeler McMillen, *New Riches From the Soil* (1946); U.S. Department of Agriculture, *Crops in Peace and War, Yearbook of Agriculture, 1950–1951* (1951). (C. H. Fr.)

CHENAB (Sanskrit Asikni, Greek Acesines), one of the "five rivers" of the Punjab. Its headwaters are the Chandra and the Bhaga, which rise southeast and northwest respectively of the Bara Lacha pass (16,047 ft.) in the Himalayas in India. The two unite at Tandi (7,500 ft.) as the Chandra-Bhaga or Chenab. The joint stream flows northwestward for 100 mi. in the trough formed by the Great Himalayan and Pir Panjal ranges. It then turns southward about Kishtwar in Kashmir and crosses the Pir Panjal by a gorge, leaving the mountains at Akhnur. From the Bara Lacha pass to Akhnur the length of the Chenab is 378 mi. and the total fall 15,500 ft. It enters Punjab (Pakistan) at Khairi Rihal in Sialkot district. Its catchment area above the 1,000-ft. contour is 10,588 sq.mi., including 1,475 sq.mi. under glaciers. Mean annual rainfall in the catchment is 47.24 in.

The Upper Chenab irrigation canal is taken off at Marala 8 mi. from the Kashmir border, and the Lower Chenab canal at Khanki, 35 mi. farther downstream. Thence the Chenab flows on, greatly diminished, dividing the Chaj doab in the northwest from the Rechna doab in the southeast. The Jhelum joins it at Trimmu and the Ravi near Sidhu, after which it is called Trimab. The Sutlej, already united with the Beas river, joins it at Madwala. The united stream flows on as Panjnad ("five streams") to join the Indus. The general set of the stream is to the west. There is evidence that as late as A.D. 1245 it flowed east of Multan and by 1397 had shifted its course to the west of that city. The total length of the Chenab, excluding the Panjnad, is 599 mi. The river begins to rise in March and attains its maximum level in July and August, after which it gradually falls. It is at its lowest from November to February. Its height has a range of about 15 ft.

The annual inundation affects generally only a narrow fringe along the river ranging in width from 2 to 6 mi., but because of the loose, sandy nature of its banks, the moisture percolates far inland and benefits much land not actually covered by floods. The deposits left by the annual flood are very sandy and much inferior to the rich silt laid down by the Jhelum and other Punjab rivers. (K. S. Ad.)

CHEN-CHIANG, one-time treaty port on the south bank of the Yangtze river in Kiangsu province, China, 160 mi. above Shanghai and 43 mi. below Nanking, on the railway. Pop. (1953) 201,400. It lies where the north-south route of the Grand canal from Hangchow to Peking crosses the east-west route of the Yangtze and three miles upstream from a barrier of forts commanding the one-mile river width. So long as the Grand canal remained an arterial line of communication, Chen-chiang retained its significance. But after 1850 traffic on the Grand canal declined, moving instead by coastal steamships and the Tientsin—P'u-k'ou railway which meets the Yangtze opposite Nanking, itself the terminus of a railway from Shanghai. Channel silting has also been reducing the port's usefulness.

As a local centre, Chen-chiang is well-known and was the provincial capital (1928–49). Streets were widened beginning in 1934 when the walls were leveled. Kiangsu Medical college is located there. Three of its local products are much prized by consumers in east China: lacquerware inlaid with mother-of-pearl, thin natural coloured silk for summer clothing, and its famous vinegar. There is also some brocade weaving from thrown silk as part of the larger production in the Nanking area. (Te. H.)

CHENCHU, a people of southern India, about 11,000 in number, residing mainly in the districts of Kurnool, Guntur and Mahbubnagar in the state of Andhra Pradesh. The Chenchu speak variants of Telugu (*q.v.*), the regional language. They have medium stature, brown skin, wavy brown or black hair and varied facial features similar to those found among the Andhra peasantry. Their round houses of wattle and thatch are not unlike those used by peasants of the region, while their costume is distinguished mainly by its brevity. They follow Telugu kinship patterns generally.

An older seminomadic way of life and one of the simplest technologies known to aboriginal India are practised by a few hundred Chenchu who dwell in the wooded hills of the Amrabad plateau in Mahbubnagar. Those Chenchu gain nine-tenths of their food supply by hunting and by collecting the edible products of the jungle, particularly tubers. The bow and arrow, a metal-tipped digging stick, an ax and a simple knife are the only essential tools. There most families leave their fixed homes and wander for weeks on collecting tours of their large village territories, especially during the hot dry season. Such hill Chenchu are of a markedly individualistic disposition. Baskets, honey and herbs are increasingly exchanged with plains people for iron, cloth and grain, but the hill Chenchu remain among those aboriginal peoples of India who are most removed from the dominant Hindu civilization. Rituals are few and simple; religious and political specialization is slight. Small conjugal families predominate, women taking equal rank with men and marrying in maturity.

Most Chenchu, however, have been pressed by the expanding peasantry into agricultural and forest labour and out of their wandering, collecting life. Most have taken on Hindu gods and customs to a greater extent and have been accorded a relatively high caste status.

See Christoph von Fürer-Haimendorf, *Aboriginal Tribes of Hyderabad*, vol. i, *The Chenchus* (1943). (M. Ma.)

CHENEY, CHARLES EDWARD (1836–1916), U.S. clergyman, one of the founders of the Reformed Episcopal Church, was born in Canandaigua, N.Y., on Feb. 12, 1836. He graduated from Hobart college, Geneva, N.Y., in 1857 and spent a year at Virginia Theological seminary, Alexandria, Va. He was ordained deacon in the Protestant Episcopal Church on Nov. 21, 1858, and priest on March 4, 1860. After serving briefly as assistant minister in St. Luke's church, Rochester, N.Y., and minister-in-charge of St. Paul's church, Havana, N.Y., he became rector of Christ church, Chicago, in 1860. A pronounced evangelical, Cheney soon became deeply involved in the bitter ecclesiastical controversies of the period. He was one of the signers of the "Chicago protest" against "unprotestantizing" tendencies in the church, issued on Feb. 18, 1869. On June 21, 1869, he was brought to trial before an ecclesiastical court for omitting the words "regeneration" and "regenerate" from the baptismal office of the Book of Common Prayer. He was convicted and suspended. After a second trial he was deposed for continuing to officiate when under suspension, but a civil court overruled the deposition. His parish followed him when he united with the Reformed Episcopal Church on its organization in 1873. He was elected missionary bishop of the northwest and consecrated on Dec. 14, 1873, his title being changed to bishop of the synod of Chicago in 1878. He continued to serve as rector of Christ church as well as bishop until his death on Nov. 15, 1916. (W. W. Ms.)

CHENGCHOW (Cheng-Chou), the provincial capital of Honan province, China. Pop. (1953) 594,700. Located at the western edge of the north China plain, where the Yellow river enters the plain, Chengchow has long been an important trade centre. Its modern importance is derived from its position at the junction of the east-west Lunghai railway with the north-south Ping-Han railway, and it has become the dominant urban trade centre of Honan. Manufacturing was confined to agricultural processing and handicrafts until 1952, when the Communist government began the development of modern industry. Between 1955 and 1958 a new thermal power plant, rail yards, textile mills, new agricultural processing plants, textile and heavy machinery plants and secondary steel processing plants have been established in an industrial suburb on the western outskirts of the old city. (J. E. Sr.)

CH'ENG-TE (formerly Jehol), a city of China and capital of the former Jehol province, lies about 130 mi. N.E. of Peking on a tributary of the Luan river at 40° 59′ N., 117° 52′ E., within a plain enclosed by scarps which separate the Mongolian plateau from the north China plain. Pop. (1953) 92,900. The city was the summer residence of the Manchu rulers, being used mainly in autumn as a base for the imperial hunting parties in the great forests. After 1911 Chinese farmers moved in, cleared timber from the rugged hills, and so began the soil erosion that kept them in poverty thereafter. At one time a railway from Peking ran through Ch'eng-te to Chin-chou on the Peking-Mukden line, but a less difficult route was established 20 mi. E. In 1955 Jehol province, formed from an administrative area in 1929, was abolished, with Ch'eng-te and other parts of southern Jehol being joined to Hopeh province. (Te. H.)

CH'ENG-TU, capital of Szechwan province, China (pop. [1953] 856,700) lies in the centre of the fertile Ch'eng-tu plain, in the northwest corner of the Szechwan basin. The plain (area 2,800 sq.mi.) is the alluvial fan of the Min river spilling south from the Great Snow mountains (Ta-hsüeh shan). By a unique irrigation system begun by Li Ping in the 3rd century B.C. and rigorously maintained ever since, the river waters are led off by countless channels for irrigation. At the lower end of the plain, the channels meet and flow eventually into the Yangtze as the Min and T'o rivers. The plain is well sheltered from winter cold by lofty mountains and with much fertilizer gives heavy yields of rice, sugar, citrus fruits, silk, wheat and tung oil. Ch'eng-tu has long been known as a centre of regional administration, wealth and scholarly achievement. One of its most famous residents was the great T'ang dynasty poet, Tu Fu, whose home is a provincial museum. Because of its location, the city is the focal point for the trade of the western Szechwan basin, and the pastoral mountain country of the upper Min which produces wool, hides, furs and medicines for the Ch'eng-tu market.

Ch'eng-tu is the seat of Szechwan university, and during World War II several universities were moved there temporarily from Japanese-held areas. There are also institutes of technology, geological prospecting and telecommunications and a medical college. Under the Chinese People's Republic, the city is changing greatly. Many of the old streets have been widened for bus services, while sanitation has been improved by building underground sewers. Industrial expansion on the north side includes a new steam-power plant, railway repair shops and freight yards, machine tools and brick and tile factories. The Ch'eng-tu—Chunking railway, completed 1952, extends for 300 mi., and meets in Ch'eng-tu the 400-mi. railway built across the 10,000-ft. high Tsinling mountains north to Pao-chi in southwest Shensi province; construction of the line south to K'un-ming is in progress. Two important new highways link Ch'eng-tu with the high Tibetan plateau: one, 310-mi. long, leads northwest to Ahpa, 9,800 ft. above sea level; the second bends southwest via Ya-an, Kan-tzu and Lhasa to Shigatse, 1,700 mi. away in south-central Tibet, permitting trucks and animal caravans to transport goods over some of the world's most rugged high-level mountain and gorge country. This is in keeping with increased control of Tibet by the People's Republic, and also with the establishment in Ch'eng-tu of one of eight institutes for national minorities to educate young Tibetans and other non-Han peoples of China. (Te. H.)

CHÉNIER, ANDRÉ MARIE DE (1762–1794), French poet who was, after Racine, one of the greatest writers in French classical verse. Born at the end of Oct. 1762 in Constantinople, where his father was French consul general, he returned to France with his parents in 1765 and though his father later went to Morocco as consul general, the rest of the family did not follow him. André was educated at the Collège de Navarre and in 1782 entered the army at Strasbourg, but he asked to be released after serving for only six months and returned to Paris where he mixed with the writers and artists who frequented his mother's salon. A journey to Switzerland and Italy in 1783 and 1784, besides improving his delicate health, made a deep impression on his mind and strengthened his passion for the antique. In 1787, partly because of his father's worsening financial situation, he took a post in London as secretary to the French ambassador, who was a relative, and stayed there for three years. London, however, displeased him and he returned to France in 1790 and plunged into political writing.

He was mainly concerned with condemning the authors of disorder and, in particular, the *club des Jacobins*. Three works were especially noteworthy, *Avis au peuple français sur ses véritables ennemis*, *Le Jeu de Paume à David peintre* and *Hymne aux Suisses de Châteauvieux*, the first in prose, published in the *Mémoires de la Société de 1789* and the others, in verse, printed over his name in the *Journal de Paris*. He escaped the massacres of Sept. 1792 by fleeing to Normandy, but he returned at the end of the year and wrote in defense of Louis XVI. After the king's execution he was obliged to go into hiding at Versailles, but was arrested on March 7, 1794. His imprisonment lasted 141 days. Despite the efforts of his brother, Marie Joseph, who was a member of the Convention, to save him, he was executed on July 25, 1794.

Among his best and most famous works are *La Jeune Tarentine*, written after his return from Italy; the *Ode à Charlotte Corday* and *Ode à Versailles*, which date from the months after Jan. 1793 when he was in hiding; and *Jeune Captive* and *Iambes* which belong to the period of his imprisonment.

During his lifetime he was known only by the *Jeu de Paume* and the *Hymne aux Suisses* and the circumstances of his death explain how it was that an interval of 20 years passed before there was the merest recognition of his genius. The *Jeune Captive* and *La Jeune Tarentine* were published in 1795 and 1801, but there was no attempt to collect the body of his work before 1819. Since that date there has been unanimous acknowledgment of his genius, but the critics have been divided as to whether he should be classed, as Sainte-Beuve classed him, as the forerunner of Victor Hugo and the romanticists, or, as Anatole France would have it, as the last exponent of the art of the 18th century. Perhaps his influence was greatest on the classicists who led the reaction against the romanticists at the end of the 19th century, on Leconte de Lisle and Hérédia.

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CHÉNIER, MARIE JOSEPH BLAISE DE (1764–1811), French dramatist, poet and politician, whose work achieved success by its expression of popular republicanism and anticlericalism, was born at Constantinople, Feb. 11, 1764. He spent two years in the army before beginning a literary career in Paris. His first success, *Charles IX* (written in 1788 but produced after censorship in Nov. 1789) set the pattern for his later tragedies—conventional imitations of the Voltairian model, using subjects from classical or modern history as a vehicle for political ideas. He supported the first stages of the Revolution, and was a member of the Convention and of the committees of general security and public safety, but his disapproval of the violence of the Terror reflected in the plays *Caius Gracchus*, *Fénelon* and *Timoléon* led to their being censored.

Unjustly suspected of having connived at the death of his brother André, Chénier might himself have been a victim of the Terror had it not ended. His poem *Sur la Calomnie* is a reply to royalist journalists who compared him with the fratricide Timoléon in his tragedy.

He remained politically active until 1802 and from 1803 to 1806 was inspector of education. His last tragedy, *Cyrus* (1804), was in honour of Napoleon. He was also the author of patriotic hymns—of which *Le Chant du départ* was the most famous—conventional odes, elegies and epigrams, and translations. He died in Paris, Jan. 10, 1811.

Bibliography.—His *Oeuvres complètes* were published in 8 vol. (1824–26); *see* also A. Liéby, *Étude sur le théâtre de M.-J. Chenier*, (1901); A. J. Bingham, *M.-J. Chenier, Early Political Life and Ideas* (1939). (W. D. Hh.)

CHENILLE, a cotton, wool, silk, acetate, rayon or nylon yarn that has a pile protruding all around at right angles so that it simulates a caterpillar. (*Chenille* is the French word for "caterpillar.") The yarn is used as filling (weft) for heavy draperies, curtains and carpets, embroidery and fringes.

It is woven in gauze or leno weave with cotton or linen warp and silk, wool, acetate or cotton filling. The warp threads are taped in groups and the filling is beaten into fabric very compactly. After the fabric is woven it is cut between the groups of warp ends, and the latter is twisted, thereby forming the chenille effect. (G. E. L.)

CHENNAULT, CLAIRE LEE (1890–1958), U.S. air commander in China during World War II, was born in Commerce, Tex., on Sept. 6, 1890. After almost 20 years of service with the U.S. army air corps, Chennault was retired for physical disability in 1937 and became adviser on aeronautical affairs to the Chinese Nationalist government. A zealous believer in the importance of fighter aviation, Chennault acquired a reputation as a daring pilot and a serious student of air tactics. In 1941 he organized and trained the famous "Flying Tigers," a group of U.S. pilots recruited to fight for the Chinese, especially in defense of the Burma road.

In April 1942 Chennault returned to active duty with the U.S. army air forces as a brigadier general and until the end of the war commanded units in China which were organized in 1943 as the 14th air force.

Chennault's brilliant leadership and superior tactics helped greatly to overcome the inferiority of his airmen in numbers and equipment. He was promoted to major general in 1943 and retired in 1945. He died in New Orleans, La., on June 27, 1958.

See his autobiography *Way of a Fighter* (1949). (A. Gg.)

CHENONCEAUX, a village of central France, in the *département* of Indre-et-Loire (*q.v.*), is on the right bank of the Cher, 34 km. (21 mi.) S.S.E. of Tours by road. Pop. (1962) 285. Chenonceaux owes its interest to its château, which bridges the Cher. "*Son et Lumière*" is presented at the château. The village is on a secondary railway from Tours to Bourges.

The château represents a type of architecture transitional between Gothic and Renaissance. Founded in 1515 by Thomas Bohier, it was confiscated by Francis I in 1535. An isolated tower flanking a drawbridge is part of an earlier building of the 15th century. Henry II presented it to Diane de Poitiers, who on his death was forced by Catherine de Medicis to exchange it for Chaumont-sur-Loire. Catherine built the gallery that leads to the left bank of the Cher and in 1559 she entertained her son, Francis II, and his bride, Mary, queen of Scots, in the château.

Chenonceaux passed thereafter through several hands, and in the 19th century it was extensively restored. The village was occupied by the Germans during World War II.

CHENOPODIUM (Goosefoot), a genus of erect or sometimes prostrate herbs of the family Chenopodiaceae, comprising about 60 species, natives of temperate regions, some of which have cosmopolitan distribution as weeds. Inclusive of those introduced from the old world, about 25 species occur in North America. A well-known representative is the common goosefoot (*C. album*), called also lamb's quarters and pigweed. It is native to Europe and Asia, is found in Great Britain, and is widely prevalent in North America as a naturalized weed. The green angular stem is often striped with white or red, and, like the leaves, often more or less covered with mealy particles. The leaves are entire, lobed or toothed and often more or less triangular in shape. The minute flowers are borne in dense axillary or terminal clusters. The fruit, usually enclosed by the persistent calyx, is a membranous utricle covering a small, black, often glossy seed.

Among native North American species are the red goosefoot (*C. rubrum*), growing on saline soils on seacoasts and in the interior, and found also in Europe; the strawberry blite (*C. capitatum*), with fleshy red fruit clusters somewhat resembling strawberries, native to dry soil from Nova Scotia to Alaska southward to New Jersey and California, and also in Europe; and the California goosefoot or soap plant (*C. californicum*), found in the foothills of the Sierra Nevada and coast ranges, the grated roots of which are used as soap by the Indians.

Among other goosefoots found in Great Britain and also naturalized in North America are the maple-leaved goosefoot (*C. hybridum*), the nettle-leaved goosefoot or sowbane (*C. murale*), the oak-leaved goosefoot (*C. glaucum*), the many-seeded goosefoot (*C. polyspermum*), the city goosefoot (*C. urbicum*), and good-King-Henry (*C. Bonus-Henricus*). Other old-world species naturalized in North America are the Jerusalem oak (*C. Botrys*), the Mexican tea (*C. ambrosioides*) and the wormseed (*C. anthelminticum*).

Quinoa (*C. Quinoa*), native to the Andean region, is cultivated in South America for its seeds, used as food. The wormseed (*q.v.*) yields an oil used in the U.S. as a remedy for the round and hookworms.

See Lamb's Quarters; Good-King-Henry.

CHEOPS: *see* Khufu.

CHEPHREN: *see* Khafre.

CHEPSTOW, a market town, urban district and river port in the Monmouth parliamentary division of Monmouthshire, Eng., on the western bank of the Wye near its confluence with the Severn, 16 mi. S.S.E. of Monmouth by road. Pop. (1961) 6,041. As the key to the passage of the Wye, Chepstow (Estrighoiel, Striguil) was the site of prehistoric, Roman and Saxon fortifications. The Norman castle was built on a rocky ledge by William Fitz-Osbern to defend the Roman road into south Wales. Founded in the 11th and rebuilt in the 13th century, it was granted by Henry I to the Clare family; after its reversion to the crown, Edward II granted it to Thomas de Brotherton. It passed to the dukes of Norfolk from whom, after again reverting to the crown, it passed to the earls of Worcester. It was confiscated by parliament but restored to the earls in 1660. Parts of the town wall can still be seen and in the Old Town gate (formerly the only entrance to the town except by the bridge) is a small museum. The present bridge, replacing at least two former ones, was built to the design of John Rennie in 1816. The Tubular bridge (1852) was designed by I. K. Brunel. The church of St. Mary, which originally belonged to a Benedictine priory, has some old features but was restored in 1841. The borough grew up around the castle between the 14th and 15th centuries and in 1524 the earl of Worcester granted it a charter of incorporation. A port since early times, when the lord took dues of ships going up to the Forest of Dean, Chepstow had no ancient market and no manufactures except that of glass, which was carried on for a short time within the ruins of the castle. A local trade during the 19th century was handicapped by the narrowness and depth of the channel and the consequent tidal bore. Mainly agricultural, Chepstow has several industries, among them engineering, brushmaking and asphalt processing. There is a racecourse in Piercefield park. Tintern abbey (*q.v.*), the picturesque Cistercian ruin, is 4 mi. N.

CHEQUERS. Chequers court, near Wendover, Buckinghamshire, Eng., 30 mi. N.W. of London, became the official country residence of British prime ministers in 1921 through the generosity of its owners, Lord and Lady Lee of Fareham. The estate is about 1,500 ac. in extent. (*See* Lee of Fareham, Arthur Hamilton Lee, 1st Viscount.)

On Bulpit hill, about ¾ mi. to the southwest, are traces of what was possibly a small Iron Age settlement. "Radulphus," clerk to the exchequer, was owner of the manor under Henry II, and the place appears to have taken its name from his office. In 1565, his descendant, William Hawtrey, remodeled the house and gave it much of its present character and appearance. In the 18th century, a unique collection (which still remains) of Cromwell portraits and other relics was brought by the Russells, who were descended from one of the Protector's daughters. The Russells maintained the Elizabethan house with little alteration, but Robert Greenhill, who inherited from them early in the 19th century, plastered the whole of the outside and redecorated the interior in Strawberry Hill "Gothick" fashion.

When the Lees entered on a long tenancy in 1909 they sought to reveal all the remaining ancient features, and to introduce others characteristic of the days of the Hawtreys and the Russells. In

1917 Lord and Lady Lee changed their tenancy into a freehold, and created a trust, which, on their deaths should make the house an adequate seat where the prime ministers could entertain guests. The original draft for the Chequers Trust declared that:—"The main features of the scheme are, therefore, designed not merely to make Chequers available as the official country residence of the prime minister of the day, but to tempt him to visit it regularly, and to make it possible for him to live there, even if his income should be limited to his salary." With this object an endowment was provided to cover the cost of a small, permanent domestic staff, of keeping up the gardens and grounds, of maintenance and repairs and other necessary expenses. There is also a residential allowance for the official occupant calculated in a fashion deliberately designed to encourage regular weekend visits. The draft, however, insisted upon the unaltered preservation of both house and contents. Parliamentary approval of the gift was formally declared by the Chequers Estate act, 1917.

In 1920 Lord and Lady Lee resolved that this scheme should not await their death but should take immediate effect. All the preparations for establishing and working the trust having been completed, the prime minister, David Lloyd George, held his housewarming on Jan. 8, 1921. His successors have spent part of their time there during their terms of office and ministerial week ends at Chequers court are a part of British political life.

CHER, a *département* of central France, formed from the eastern part of the ancient province of Berry, together with parts of Bourbonnais, Nivernais and Orléanais. It is bounded on the north by Loiret, west by Loir-et-Cher and Indre, south by Allier and Creuse and east by Nièvre. Area 2,820 sq.mi. Pop. (1954) 284,376. The capital is at Bourges (*q.v.*).

From the crystalline rocks of the Massif Central that form the highest ground in the extreme south, the *département* extends northward across the belt of Jurassic rocks to the chalk of the Sancerrois hills and the margins of the lake-studded Tertiary country of the Sologne, within the great arc of the river Loire. The Cher and its tributaries, flowing north, cross the rich pastures of the clay vale that fringes the Massif Central and then traverse the limestone platform of Berry where there are great stretches of hedgeless arable fields. The broken chalk escarpment that forms the hills of Sancerrois east of the river Cher is less prominent farther west. Its south- and southeast-facing slopes formerly were covered with vineyards, but most of these have not been re-established since the phylloxera plague at the end of the 19th century. The area under vineyards is now small, but the dry, white wines are of high repute. To the north and west the chalk plateau is usually coated with clay with flints, giving heavy soils (*pays fort*) that still carry a considerable amount of woodland. The valley of the Loire in the extreme east is especially fertile, and is cultivated in small holdings with a variety of crops among which fruits are especially important. The *département* is profoundly agricultural, and, although iron ore was formerly worked and stone is quarried, there is little industry except at Bourges and the railway junction of Vierzon where there are engineering and ordnance works.

The chief rivers, besides the Cher and its tributaries, are the Grande Sauldre and the Petite Sauldre on the north, but the Loire, which forms the eastern boundary, and the Allier, though not falling within the *département*, drain the eastern districts, and are navigable. The Cher itself becomes navigable when it receives the Arnon and Yèvre. The Berry canal connecting the Cher with the Loire is no longer important, but the Loire lateral canal, which follows the left bank of the river in this *département*, is still used and is connected from Briare with the Seine and Paris.

The *département* is divided into the two *arrondissements* of Bourges and St. Amand-Mont-Rond. Bourges is the seat of an archbishop and has a court of appeal, but the *département* belongs to the educational division (*académie*) of Paris.

For the history of the region, *see* articles on the ancient provinces mentioned above. (Ar. E. S.)

CHER, a river of central France, tributary to the Loire, rises in the north of the Massif Central and flows northward across the Combrailles uplands past Montluçon. Leaving the crystalline rocks, it traverses the rich pastures of the clay vale fringing the massif and crosses the limestone platform of Berry in a trenchlike valley. Farther north, the Cher receives the Yèvre at Vierzon and the Arnon a little farther downstream. Between these valleys the limestone of Berry presents tracts of dry, hedgeless cornfields and sheep pastures. Swinging west below Vierzon the Cher opens out; farther west it receives the Sauldre, from the marshland of Sologne. In its lower course the silt-laden Cher flows in a wide valley with rich meadows, vineyards and numerous cave dwellings cut in the chalk. The valley converges with that of the Loire, but the Cher passes south of Tours to join the Loire farther west at Cinq-Mars-la-Pile. Except for the industrialized area of Montluçon and industrial development at Bourges and Vierzon the Cher basin is rural. The Berry canal, which parallels stretches of the Cher above Noyers, is disused. (Ar. E. S.)

CHERBOURG, a naval station, fortified town and seaport of northwestern France, in the *département* of Manche, is on the English channel, 348 km. (216 mi.) W.N.W. of Paris by road. Pop. (1954) 35,246. Cherbourg is situated at the mouth of the Divette river, on the north shore of the Cotentin peninsula, overlooked by the steep Montagne du Roule.

The Cherbourg naval harbour, with an area of 55 ac., consists of three main basins cut out of the rock. The minimum depth of water is 30 ft. Connected with the harbour are dry docks, shipbuilding yards and a large naval hospital. The commercial harbour, at the mouth of the Divette, has an outer tidal harbour of 17½ ac. and an inner basin of 15 ac., with a depth of 25 ft. Outside these harbours is the triangular bay that forms the roadstead of Cherbourg. The bay is naturally sheltered on every side but the north, where lies the huge breakwater (begun by Louis XVI), 2¼ mi. in length, 650 ft. wide at its base and 30 ft. at its summit. The breakwater, protected by forts, leaves passages for vessels at both sides.

Near the roadstead is the church of La Trinité (1423–1504), a good example of the flamboyant style and one of the few historic buildings of Cherbourg. A rich collection of paintings is housed in the *hôtel de ville*, and a statue of the painter Jean François Millet, born near the town, stands in the public garden. The city is the home of a naval school. It is the terminus of a main railway line from Paris, and in the summer air services operate from Maupertus airfield (12 km. [7 mi.] E.) to Southampton, Eng., and the Channel Islands.

The main economic activities of the town spring directly from its position as a seaport. The naval port is a supply station and a base for small units, and its dockyards specialize in repair work and shipbuilding. Cherbourg is also a major port of call for transatlantic liners. The commercial harbour proper has a varied trade, importing coal, timber, fuel, tar, wine and various manufactured goods, and exporting iron ore. The fishing port is developing rapidly, and the yachting station, much visited by English yachtsmen, is the French winning post for many English sailing races. Cherbourg is to some extent an industrial city (boatyards, agricultural machinery), and it is an important market town. Early vegetables are one of the principal agricultural products of the region. The picturesque regions of La Hague cape (29 km. [18 mi.] W. of Cherbourg), with its wild, rocky cliffs, and the Saire valley (villages of Barfleur and Saint-Vaast-la-Hougue, 29 km. [18 mi.] E. of Cherbourg) rank among the town's tourist attractions.

Cherbourg is supposed to occupy the site of the Roman station of Coriallum. The peninsula, reaching toward the Isle of Wight, seems to have been used by Bronze Age traders as a starting place for the British Isles. William the Conqueror provided the settlement with a hospital and a church. Under Philip Augustus it became of military importance; in 1295 it was pillaged by an English fleet from Yarmouth, and in the wars of the 14th century it suffered frequently. Captured by the English in 1418 after a four months' siege, it was recovered by Charles VII of France in 1450. Harbour works were begun under Louis XVI and continued by Napoleon I, but it was left to Louis Philippe and Napoleon III to complete them. In World War II Cherbourg was occupied by the Germans in June 1940. They destroyed most of the harbour installations and the arsenal before evacuating the town, which was taken by the U.S. 7th corps in June 1944. By October the port was handling 200 tons of war material daily. The maritime station was reopened in 1952. (Ra. H.; An. J. R.)

CHEREMIS, the name applied in the west, as it was in pre-Soviet Russia, to a people, now totaling about 500,000, who speak a language of the Finno-Ugric family. The people, however, refer to themselves as Mari, a term which has been adopted by the Soviet Russians and incorporated in the name of the Mari Autonomous Soviet Socialist Republic. Created on Dec. 5, 1936, this republic, with a Cheremis population in excess of 51%, is located in the upper Volga basin; there are also some Cheremis in adjacent regions, as well as nearly 100,000 in the Bashkir A.S.S.R.

The Cheremis language contains more than 1,000 Turkic loanwords, borrowed from two languages: Volga-Bulgar and Tatar. About half of them—the earlier layer—come from the language of the forefathers of the present-day Chuvash. The Cheremis and Chuvash have lived in a quasi-symbiotic relationship from about A.D. 700 to this day, although the period of most intense influence ended in 1236, when Tatar contacts became pressing. Tatar loans date from 1236 to 1552; then Kazan fell and the area came increasingly under the influence of Moscow. The process of Cheremis assimilation to Russian civilization accelerated during the 17th century, and the ever mounting symptoms of social and economic change may be traced in many forms, including strong nativistic movements.

The local group among the contemporary Cheremis is the cooperative village or *kolkhoz;* the principal source of subsistence is agriculture combined with animal husbandry. Yoshkar-Ola, the Mari capital, boasts of training schools in subjects such as animal husbandry, forestry, optics and papermaking, as well as factories and department stores.

See Thomas A. Sebeok, ***The Cheremis*** (1955); Thomas A. Sebeok and Frances J. Ingemann, ***Studies in Cheremis: the Supernatural*** (1956). (T. A. Sb.)

CHEREMKHOVO, a town of Irkutsk *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., stands on the Trans-Siberian railway, about 80 mi. N.W. of Irkutsk. Pop. (1959) 123,000. A branch line links Cheremkhovo to Svirsk on the Angara river. The town is also on the Irkutsk-Krasnoyarsk motor road. Founded in 1772 as a station on the Siberian Post road, the town has developed as the chief mining centre of the Cheremkhovo coal field, which is the largest in eastern Siberia, and extends for about 150 mi. along the Trans-Siberian railway. There are also heavy engineering and timberworking industries. (R. A. F.)

CHEREPOVETS, a town of Vologda *oblast* in the Russian Soviet Federated Socialist Republic, U.S.S.R., stands on the right bank of the Sheksna river (70 mi. W. of Vologda), where it flows into the vast Rybinsk reservoir of the Volga. Pop. (1959) 92,000. The Sheksna is linked by the Mariinsk waterway system to Lake Onega and thus to the Baltic-White sea waterway, while Cherepovets lies also on the Leningrad-Vologda railway. These excellent communications led to the establishment there in 1955 of a large integrated iron and steel works, using iron ore from the Kola peninsula and coal from Vorkuta. The slag from the works is used to make thermo-insulating sheeting. Shipbuilding and repair and timberworking, especially the production of veneer, are also carried on. (R. A. F.)

CHERIBON (Tjirebon) is a city and residency of northeast West Java province on the Java sea, Indon. Pop. (1957 est.) 2,917,009. Although some Javanese live in the north, Cheribon is Sundanese country, its eastern boundary dividing the Sundanese from the Javanese territory of central Java. It has been for centuries the centre of Islam in west Java, for it is there that the Muslim power was strongly established as early as 1526, under Gunung Djati, and much of the opposition to Dutch rule at a later date came from this district. The northern half of the residency is flat and marshy in places, while the southern half is mountainous. Southwest of the city stands the huge volcano Tjaremai, clad with virgin forest and plantations, and surrounded at its foot by rice fields.

Sulfur and salt springs occur on the slopes of Tjaremai and near Palimanan, where a cavernous hole exhales carbonic acid gas.

The principal products of cultivation are tea, rice, tobacco, essential oils, sugar, cinchona, cassava, peanuts and pulses. Cheribon city and seaport has a good open roadstead and quay and warehouse accommodation for lighters. It was formerly the residence of the powerful sultans of Cheribon. Indramaju is another principal town, and Kuningan, famous for a breed of horses, is a hill resort (2,200 ft.). The residency was occupied by the Japanese from 1942 to 1945.

On Nov. 15, 1946, the Dutch-Indonesian pact (the Cheribon, or Linggadjati, agreement) recognizing the Republic of Indonesia was drafted at Linggadjati, a resort village 13 mi. S. of Cheribon port. *See* Java: *History.*

CHERIMOYA (Cherimoyer or Chirimoya), the fruit of *Annona cherimola,* a medium-sized tree of the family Annonaceae, originally from the Andes of southern Ecuador and northern Peru, now cultivated commercially, on a small scale, in California, Mexico, Chile, Argentina, southern Spain, Queensland and several other regions. Throughout the highlands of tropical America it is a favourite dooryard tree and the fruit is often seen in local markets.

Its abundance of large, ovate, rich green leaves makes the tree a handsome one, while the fruit, which matures from September to January in the northern hemisphere, was termed by Mark Twain "deliciousness itself." It is oval to round in form, sometimes weighing 2 to 3 lb. though usually less, pale-green in colour with a thin skin enclosing creamy white flesh in which numerous seeds the size of beans are embedded. The texture of the flesh is like that of firm ice cream, the flavour delicately subacid. It has been compared to a combination of pineapple and banana.

Though geographically tropical in origin, the cherimoya does not attain perfection in the tropical lowlands. Its culture is limited to elevations of 3,000 to 7,500 ft. in the tropics, and to mild-wintered subtropical regions. Its climatic requirements are, in fact, quite specialized; it will grow satisfactorily in many regions, but in some of these, little fruit will be produced and may be of unsatisfactory quality. Successful efforts to increase production have been made in California and elsewhere by hand pollinating the flowers.

Propagation is commonly by means of seeds, but the cherimoya lends itself readily to grafting, and superior varieties are perpetuated in this way. The method commonly used is the one employed with citrus fruits, *i.e.,* shield budding. Trees are planted in orchard form, spaced about 25 ft. apart; they are given much the same cultural attention as oranges. They come into commercial production at three to five years of age.

To this same family, Annonaceae, belong several other tropical American fruit trees. The best of these is probably the guanábana or soursop (*Annona muricata*); its large fruits are used to make ice creams and refreshing drinks, popular in Cuba. Another species, *A. squamosa,* usually known in English as sugar apple, is commonly grown in drier parts of the American tropics as well as in India and elsewhere. A hybrid between this and the cherimoya is cultivated commercially on a small scale in Israel. Another species, *A. reticulata,* known as custard apple, produces a fruit of mediocre quality; this tends to confuse it with the cherimoya to which the same name is sometimes applied in English-speaking regions. Annonas in general require care in handling and transportation. Harvested at an appropriate stage of maturity and carefully packed, however, they will remain in good condition for a week or so without refrigeration. (W. Po.)

CHERKASSY, an *oblast* (administrative division) and a town and administrative centre in the Ukrainian Soviet Socialist Republic of the U.S.S.R. Pop. of *oblast* (1959) 1,470,214. Area 7,992 sq.mi. By far the greater part of the *oblast,* which was formed in 1954, lies in the Dnieper right bank area. A small part, of low-lying flood plain, lies on the left (eastern) bank around Zolotonosha. The right bank consists of rolling hills of the Dnieper uplands, much cut up by the valleys of small streams flowing to the Dnieper and by the headwaters of the Sinyukha, flowing south to the Southern Bug river. The area is covered by loess, overlying an ancient granite platform, which occasionally outcrops in the valleys. The loess is easily eroded and the formation of gullies is widespread. On the loess are developed the fertile black earth soils (chernozem), but little survives of the natural steppe vegetation of feather grasses and fescues. There are intermittent small groves of oak.

In 1959 about 23% of the population were urban. The towns are mostly small and the more important are Cherkassy, Smela, Uman and Zvenigorodka. Population density (184 per square mile) is above average for the Soviet Union. Agriculture takes first place in the economy, the main crops being sugar beet and winter wheat. Part of the chief sugar beet area of the U.S.S.R., the *oblast* has a number of sugar refineries. Barley, maize (corn), sunflowers, tobacco and hemp are also grown, while livestock, particularly dairy cattle and pigs, is important. Industry is largely concerned with processing agricultural products, sugar refining, flour milling and fruit and vegetable canning. Some lignite is mined near Zvenigorodka. Smela and Uman have light engineering. The *oblast* is traversed by the Moscow-Odessa railway, from which lines branch off at Smela to Belaya Tserkov and the western Ukraine.

Cherkassy, administrative centre of the *oblast*, stands on the high right bank of the Dnieper, on the shores of the reservoir formed by the Kremenchug hydroelectric station 95 mi. S.E. of Kiev. Pop. (1959) 83,000. Founded in the 15th century in the Polish Ukraine, the town was annexed by Russia in 1795. It began to acquire importance in the late 19th century, as the point where the direct Moscow-Odessa railway bridged the navigable Dnieper. Cherkassy was occupied (1941–43) by the Germans in World War II. Industries include light engineering (producing machinery for the food industry), food processing, textiles and timberworking. A pedagogical institute is located there. (R. A. F.)

CHERKESSIA (Circassia) is a historical region (part of Ciscaucasia) of the Union of Soviet Socialist Republics between the western end of the Greater Caucasus range and the Kuban river, and now the area comprising Krasnodar Krai (*q.v.*) of the Russian Soviet Federated Socialist Republic. Cherkessia derives its name from the Cherkess people (Circassian; *q.v.*), one of the main ethnic groups of the Western Caucasus, who are still found in the Karachai-Cherkess autonomous *oblast*, the Kabardino-Balkar Autonomous Soviet Socialist Republic, U.S.S.R., and the Adygei autonomous *oblast* (*qq.v.*), the Kabardinians and Adygei being branches of the Cherkess. After resisting Russian expansion into the Caucasus, the Cherkessians were eventually subjugated by 1864. A mass emigration movement into Turkey followed. The related Abkhaz of the Abkhaz Autonomous Soviet Socialist Republic, U.S.S.R. (*q.v.*), are also sometimes referred to as Circassians. *See* also Caucasus. (R. A. F.)

CHERNIGOV, an *oblast* (administrative division formed in 1932) and a town and an *oblast* centre in the Ukrainian Soviet Socialist Republic in the U.S.S.R., lying in north central Ukraine, east of the Dnieper river, which in part forms its western boundary. Pop. (1959) 1,553,773 (*oblast*). Area 12,162 sq.mi. Mostly in the basin of the Desna, a major tributary of the Dnieper the *oblast* is a low-lying plain, three-quarters covered by damp or swampy areas and mixed forest of oak, pine, hornbeam, maple and other trees. In the south, around Priluki, it is drier and more open, with rich black earth soils (chernozem) developed on loess subsoils, where groves of oak alternate with open steppes, now almost wholly under the plow. Less than a quarter of the population are urban. Apart from Chernigov, towns are small, the most important being Priluki and Nezhin. The economy is mainly agricultural, although less than half the area is under crops. The drier forest steppe is most important, with grain, sugar beet, tobacco and maize (corn). Grain crops occupy two-thirds of the arable land. In the damp north drainage operations were undertaken and flax and hemp are widely grown, together with rye, oats, potatoes and vegetables. The Nezhin area is noted for its cucumbers and onions. Pigs are important and there are large herds of beef and dairy cattle, especially on the meadows of the north. Industry is mostly concerned with processing agricultural products. Enterprises are usually small and scattered through the rural areas. In the towns, light engineering, textile and footwear manufacture and timberworking predominate. The industries in Priluki include furniture, plastics and loading machinery.

Chernigov, town and *oblast* centre, lies on the right bank of the Desna 80 mi. N.N.E. of Kiev. Pop. (1959) 89,000. First mentioned in 907, it was one of the chief towns of Kievan Russia, but after the Tatar invasion (1239) it lost its importance. Its Spasski cathedral dates from 1024. In 1797 it became the provincial centre. It is now an important communications focus, on the navigable Desna, with railways north to Gomel, west to the Polish frontier and south to Cherkassy and Odessa. Industries include boot and shoemaking, leatherworking, textiles, timberworking, musical instrument making and food processing. Chernigov is the seat of a university (1875) and has a pedagogical institute. In World War II the town was occupied (1941–43) by the Germans. (R. A. F.)

CHERNIKHOVSKI, SAUL GUTMANOVICH (1875–1943), Hebrew poet, was a leading representative of the "classical" or "Odessa" period of the modern Hebrew revival. Born in the Crimea on Aug. 20, 1875, he lived at Odessa during 1890–99, after which he studied medicine at Heidelberg and Lausanne until 1907. During World War I he served in the Russian army as a surgeon. In 1922 he left Russia and, after wanderings which took him to the United States in 1928–29, he settled in Palestine in 1931 and became a school physician at Tel Aviv. His poetic production, from the age of 14 until a month before his death, was immense, and included sonnet cycles, idylls of Jewish village life in Russia, and translations of the *Iliad*, the *Odyssey*, *Gilgamesh*, Shakespeare, Molière and Longfellow. He also wrote short stories. When nearly 60 years old he changed the rhythm of his poetry from the eastern European to the Palestinian pronunciation. Chernikhovski's poetry is deeply romantic and suffused with a love of Greek culture; the conflict between this and Judaism gave rise to some of his finest work.

Chernikhovski died at Jerusalem on Oct. 13, 1943.

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CHERNIKOVSK: *see* Ufa.

CHERNOV, VIKTOR MIKHAILOVICH (Viktor Olienin) (1876–1952), one of the foremost leaders of the Russian Social Revolutionary party. Engaged in revolutionary activity from 1893, he shared in the foundation of the party in 1902 and became a member of its central committee and editor of its periodical *Revolyutsionnaya Rossiya*. At the Zimmerwald conference of 1915 (*see* International, The), during World War I, he supported the "defeatist" resolution of the party's left wing condemning the "imperialist war." After the revolution of March 1917 he returned to Russia and changed to a "defender" of his country against the German imperialist war.

Chernov edited the journal *Delo Naroda* and opposed the left wing of his party and the Bolsheviks. He became minister of agriculture in the provisional coalition governments of May, July and August 1917 and drew up a radical project of agrarian reform, but resigned in September after the anarchist peasant movement had seized lands from their owners. He was elected president of the constituent assembly which opened in Petrograd on Jan. 18, 1918, and was dispersed next day by the Bolsheviks. During the civil war he fought against the Reds on the Volga. Emigrating in 1920, he devoted himself to literary work after the failure of the Kronstadt rising of 1921, living in Paris until the outbreak of World War II, when he went to the United States. There he contributed to anti-Communist periodicals. He died in New York city on April 15, 1952.

CHERNOVTSY, an *oblast* (administrative division) of the Ukrainian Soviet Socialist Republic, U.S.S.R. Pop. (1959) 774,121. Area 3,127 sq.mi. It is roughly triangular, with the apex on the crest of the Carpathian mountains and extending down over the foothills and the Seret and Prut valleys to a base line on the Dniester. Most of the Carpathians are thickly forested, mainly with beech, but the highest areas are open Alpine meadows, known as *poloniny*.

Formerly the northern part of Bukovina (*q.v.*), the *oblast* was formed in 1940, when this area, together with Bessarabia, was ceded to the U.S.S.R. by Rumania. In 1959, 203,025 (26%) of the population were urban. Chernovtsy, the *oblast* centre, and Khotin are the only notable towns. In general there is a great deal of dispersed settlement. Over-all population density (248 per square mile) is one of the highest in the U.S.S.R., but it is far higher in the valleys, where most of the population lives.

The complex political history of this area has led to a very mixed population. As well as Ukrainians, who form about three-quarters of the total, there are Russians, Poles, Jews, Hungarians, Rumanians and Moldavians. Arable land is confined to the valleys of the Dniester and Prut, while pasturage predominates in the mountains. Timberworking and food processing are the main industries. (R. A. F.)

CHERNOVTSY (Ger. CZERNOWITZ; Rum. CERNĂUTI), a town and *oblast* (administrative) centre of the Ukrainian Soviet Socialist Republic in the U.S.S.R., stands on the high right bank of the Prut river in the Carpathian foothills. Pop. (1959) 146,061. An ancient town of Kievan Russia, once the capital of Bukovina (*q.v.*), Chernovtsy has known Polish, Austro-Hungarian and Rumanian rule. It was finally secured from Rumania by the U.S.S.R. in 1947. Industries include woolen and cotton textiles and stockings, light engineering, timberworking, chemical production and food processing. The town has excellent rail connections to Lvov (140 mi. S.E.) and Ternopol in the Ukraine, to the Moldavian Soviet Socialist Republic and to Rumania. There is a university, founded in 1875, and a medical institute. (R. A. F.)

CHERNYAEV, MIKHAIL GRIGORIEVICH (1828–1898), Russian general distinguished for his Pan-Slav activities. He first made a name for himself with the Russian forces in central Asia, where his conquest of Tashkent in 1865, contrary to instructions from St. Petersburg, made him a controversial figure. Enthusiastic in his support of the Balkan Slavs, Chernyaev dreamed of leading them in a war of liberation against Turkey. In 1867 he offered his services to Prince Michael of Serbia. The Russian war minister, D. A. Milyutin, already angry with him over the Tashkent episode, promptly placed him on the army's retired list, but Chernyaev through intrigue got himself reinstated and then served in the Russian army in Poland.

Early in 1875 Chernyaev left the army to become editor of the nationalist St. Petersburg newspaper, *Russki Mir*. When the Hercegovina revolt broke out in July, his newspaper aroused Russian sympathies for the rebels. Chernyaev sought to raise a detachment of volunteers to fight the Turks but could not obtain sufficient funds from the Moscow Slav committee.

Early in 1876 Chernyaev, through the committee, again offered his services to the Serbian government. Somewhat reluctantly the Serbs invited him to Belgrade. Contrary to the emperor Alexander II's wishes, he journeyed clandestinely to Serbia in April, accepted Serbian citizenship and was named commander in chief of the armed forces by Prince Milan. Believing that Russia would back up Chernyaev, Milan declared war on Turkey in June. Chernyaev persuaded the Serbs to launch an offensive into Bulgaria expecting that the Balkan Slavs would rise against the Turks. Tremendous enthusiasm was stirred up in Russia by exaggerated reports of his early successes and several thousand Russian volunteers joined his army. He was widely regarded in Russia as the hero of the hour.

Despite generous aid from the Slav committees, Chernyaev's poorly trained forces met defeat in Oct. 1876 and were saved from annihilation only by a Russian ultimation to Turkey. His faulty strategy and lack of political acumen played a major part in Serbia's defeat. Russian public opinion shifted strongly against him. Discredited by defeat, he was relegated to a staff post in the Caucasus during the Russo-Turkish war (1877–78). Under Alexander III he emerged briefly as governor-general of Turkestan (1882–84). He died at his country seat at Tybushki, in the Mogilev district, on Aug. 17, 1898.

See B. Sumner, *Russia and the Balkans* (1937). (D. MacK.)

CHERNYAKHOVSK, a town of Kaliningrad *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., until 1945 the German Insterburg in East Prussia, stands on the Pregolya (Pregel) river, at the head of navigation 50 mi. E. of Kaliningrad city. Pop. (1959) 29,063. It is an important railway junction on the Kaliningrad-Kaunas line, with a line north to Klaipeda (Memel) and Riga and lines southwest and southeast into Poland. There are light industries, of which the most important is the preparation of foodstuffs. The town was founded by the Teutonic knights as a stronghold in the 14th century. It was occupied by the Russians in 1914 and again in Jan. 1945. At the Potsdam conference (1945) it was awarded to the Russians, who renamed it after the Soviet general who led the forces that captured it during World War II (R. A. F.)

CHERNYSHEVSKI, NIKOLAI GAVRILOVICH (1828–1889), Russian radical journalist and author, who greatly influenced the young Russian intelligentsia of the 1860s, was born on July 1, 1828, in Saratov, where his father was a poor priest. In 1854 he joined the staff of the review *Sovremennik* ("Contemporary"), whose readers were swayed by the burning sincerity, practical bent and clear, responsible tone of his articles. Though he focused attention on social and economic evils and expounded predictable laws of economic change, he followed V. G. Belinsky (*q.v.*) and the English utilitarians in preaching a highly purified egoism as the most natural and desirable mainspring of human conduct. Landowners accused him of stirring up class hatred and of creating distrust of the government committees which were then drafting the emancipation edicts of 1861. The extent to which he was actively subversive is a matter of controversy, but in 1862 he was arrested and, after two years' imprisonment, was exiled to Siberia, where he remained until 1883. While in prison he wrote his didactic novel *Shto Delat'?* (1863; Eng. trans. *A Vital Question* or *What Is To Be Done?* 1866). Chernyshevski always remained a westernizer who opposed the nationalist Slavophils. In the U.S.S.R. he is interpreted as a forerunner of Lenin. He died in Saratov on Oct. 29, 1889.

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CHEROKEE, an important Indian tribe of the United States, of Iroquoian lineage, originally located in eastern Tennessee and western North and South Carolina. Within this area they possessed approximately 200 settlements or towns. In 1650 their population was about 22,000, after a smallpox epidemic had reduced their number by nearly one-half.

Cherokee life and culture greatly resembled that of the Creek and other southeastern tribes (*see* MUSKOGEAN INDIANS). The Cherokee nation was composed of a confederacy of red and white towns, otherwise known as war and peace towns. The chiefs of the red towns were subordinated to a supreme war chief of the entire tribe, while the officials of the white towns were under the supreme peace chief of the tribe. The white towns were regarded as places of sanctuary, as in the ancient Hebrew cities of refuge where those who fled from blood avengers might find asylum.

When first encountered by Europeans, the Cherokee possessed a variety of stone implements including knives, axes and celts. Skills such as basket weaving and pottery making were known, and the characteristic Amerindian plants (maize, beans and squash) were cultivated. The art of hunting was well developed, and deer, bear and elk furnished meat and clothing. As with other tribes of the southeast, a simple shelter was derived from a framework of poles with coverings of bark and cane. James Adair, William Bartram and Henry Timberlake have given first-hand observations on the Cherokee of the 18th century.

The Cherokee first came to notice in 1730 when Sir Alexander Cuming, an emissary of King George II, conferred the title of emperor on Chief Moytoy at Tellico, Tenn. In 1740 a party of Cherokee under Chief Kalanu, the Raven, took part in Gen. James Oglethorpe's expedition against the Spaniards of St. Augustine, Fla. During the French and Indian War, Col. George Washington complained of the unseasonable delay in obtaining aid from the

Cherokee, noting that their friendship and assistance were well worth cultivating. In 1761 Outacity, a Cherokee warrior, visited London with a delegation of fellow tribesmen and received an audience with George III. A subsequent visit by a Cherokee delegation to London in 1765 resulted in the arrival among the Cherokee of John Hammerer, the first white teacher.

During the American Revolution the attitude of the Cherokee was a matter of great concern. Although opinion was divided, the tribe tended to favour the king against the colonists. This attitude persisted even after the conclusion of peace, and in the treaty of 1793 between Spain and the southern Indians the Cherokee nation requested the Spanish king to admit it under his immediate protection, as the Chickasaw, Alibamu and Choctaw had been previously admitted. In a speech made on Aug. 29, 1796, President Washington informed the Cherokee that they would be used as an experiment in Indian education and that the future of all other Indian tribes and their dealings with the federal government would depend on their example. In accordance with this policy, Dartmouth college set up loans in 1799 to educate Cherokee youth.

During the first three decades of the 19th century, progress of the Cherokee in the arts of civilization was both rapid and revolutionary. Georgia was the principal seat of the reorganized Cherokee nation, and forms of republican government accompanied adoption of the white man's agriculture, animal husbandry, log cabin homes and weaving. Perhaps the most remarkable development of all was the invention of a native system of writing the Cherokee language by Sequoyah, or George Guess, about 1820. This syllabary was so successful that almost the entire tribe became literate within a short time. It was now possible for Cherokees to communicate with their brethren who had migrated westward and to develop the first Indian press north of the Rio Grande. A written constitution was adopted by the tribe, and religious literature flourished, including translations from the Christian scriptures. An Indian newspaper, the *Cherokee Phoenix*, the first of its kind, appeared Feb. 21, 1828.

Despite valuable aid rendered by the Cherokee under Chief Junaluska to Andrew Jackson against the Creek in the battle of Horse-shoe Bend, pressure on the Cherokee in Georgia from advancing white settlers grew rapidly in the early 19th century. At the treaty of New Echota, Dec. 29, 1835, the Cherokee signers agreed to move west of the Mississippi in the neighbourhood of the Arkansas river. The agitation connected with removal led to the compilation of the John Howard Payne manuscripts on Cherokee life and customs about 1836. The authors of these papers, Daniel Sabin Butrick and others, believed that the Cherokee were descended from the Ten Lost Tribes of Israel and advanced extensive reasons for this hypothesis. John Haywood, in his *Natural and Aboriginal History of Tennessee* (1823), advanced the idea that the Cherokee were compounded of tribes from India and Scythia.

Opposition to forced removal of the Cherokee westward was voiced by many prominent Americans of the time, both in the north and south, but their protests were in vain. Pres. Andrew Jackson took personal direction of the situation, and in 1838 his successor, President Van Buren, ordered Gen. Winfield Scott to enforce the provisions of the treaty of New Echota. The removal, consummated in the winter of 1838–39, was a calamity. The tribe lost nearly 25% of its number as casualties mounted from disease and exposure. Even when the main body had finally reached its new home in what is now northeastern Oklahoma, they were faced by controversies with the old settlers who had preceded them in the west. Feuds and murders rent the tribe as reprisals were made on those Cherokee who had signed the treaty of New Echota. With the advent of the Civil War 20 years later, the tribe was rent again by new partisan groups and military devastation.

The fate of the western Cherokee has been traced by Morris Wardell in his *Political History of the Cherokee Nation, 1838–1907* (1938). The capital of the nation was at Tahlequah, and the old council house still stands in that city. Many thousand Cherokee still reside in northeastern Oklahoma. The tribal government was abolished in 1906 during the procedures leading to the establishment of the state of Oklahoma.

At the time of the removal a few hundred Cherokee escaped to the mountains and furnished the nucleus for the 3,000 Cherokee of western North Carolina. The construction of modern highways through the area beginning in 1931 led to economic development, historical museums, a summer-long pageant of Cherokee history entitled "Unto These Hills" and Oconaluftee village, a replica of a Cherokee settlement of 1750.

See also references under "Cherokee" in the Index volume.

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CHERRAPUNJI, a village in the United Khasi and Jaintia Hills district of Assam, India, about 32 mi. S. of Shillong, capital of Assam. It is situated on the southern margin of Shillong plateau, a detached block of the Rajmahal hills, of Archaean origin, and is inhabited by Khasi tribes, a proto-Australoid group having a matriarchal social system. Pop. (1961) 4,122. Cherrapunji is notable for its heavy rainfall. The annual average is 428 in., which varies greatly; 905 in. was recorded in 1861 with a maximum precipitation in July of 366 in. The heaviest rainfall in the world is recorded in the nearby village of Mawsynram, with an annual average of 550 in. The excessive rainfall is due to the situation on an amphitheatre relief and on the windward side of the monsoon. The Chera coal mine is important. Among the tribal groups *jhum* (shifting cultivation) and terrace cultivation is common, and rice is the staple crop. Common fruits include the banana, plum, citrus fruits and pineapple. (M. BA.)

CHERRY, a widely grown fruit of the temperate zone; also the name given to many trees belonging to various species of *Prunus* that produce cherrylike fruits. Cherries belong to the great group of stone fruits characterized by having a single seed enclosed in a hard covering or "stone." The stone is enclosed in a fleshy tissue which, in most species of *Prunus*, is edible. The stones are nearly round and are relatively smooth. These characteristics distinguish cherries from the other important kinds of stone fruits.

There is a large number of species of cherry, mostly native to the northern hemisphere. Some 10 to 12 species are recognized in North America and a similar number in Europe. The greatest concentration of species, however, appears to be in eastern Asia. These native species vary in size from bushes to trees 40 to 50 ft. in height.

The native habitat of the species from which the cultivated cherries came is believed to be western Asia and eastern Europe from the Caspian sea to the Balkans. Cherries had spread throughout Europe, however, before agricultural history was recorded. Greek and Roman writers before the time of Christ described various kinds of the fruit. Cherries were taken to America by the earliest European settlers.

Cherry Fruit.—Three types are mainly grown for their fruit. These are the sweet cherries, *P. avium*, the sour cherries, *P. cerasus*, and, grown to a much smaller extent, the dukes, which are crosses of sweet and sour cherries. The sweet cherry trees are large and rather upright, attaining heights up to 35 ft. The fruit is generally heart-shaped to nearly globular, about one inch in diameter and varies in color from yellow to red to nearly black. The acid content of the fruit is low so the fruits taste sweet. Sour cherry trees are smaller, rarely over 15 ft. in height. The fruit is round to oblate in shape, generally dark red in color and has so much acid that it is not appealing for eating fresh. The duke cherries are intermediate in both tree and fruit characters.

Regions of Cherry Production.—Cherries are grown in all areas of the world where winter temperatures are not too severe and where there is sufficient winter cold to break the rest period of the trees. Sweet varieties will withstand winter temperatures down to about −15° F. (−26° C.) without injury. Sour types will generally withstand temperatures down to −25° F. (−31° C.). The trees bloom quite early in the spring, just after peaches and earlier than apples, and crops are often lost or damaged by spring frosts unless they are planted on the most frost-free sites. The cultivated cherry is not adapted to tropical countries as the trees require a period of winter cold to break the rest period and start them into uniform and vigorous spring growth. Cherries do not thrive well where summer temperatures are extremely hot or humid. Sweet cherries particularly tend to crack open if rain occurs when the fruit is nearly ripe. Therefore they are grown mainly in areas where summer rainfall is low.

Production.—The United States is the leading country in production with an annual crop of about 225,000 tons. In all of the European countries, however, cherries are a major crop and total production in western Europe is about 600,000 tons annually. Western Germany, Italy and Switzerland lead in production in Europe. Turkey, Japan, Argentina, Chile, Australia and Canada all produce substantial quantities.

In the United States over half of the production is sour cherries, with major-producing areas adjacent to the Great Lakes in Michigan, New York and Wisconsin. Most of the sweet types are produced in the Pacific coast states of California, Washington and Oregon. Sour cherries are utilized largely for processing, about half of the crop being frozen and half canned. Sweet cherries, in season, are consumed fresh, widely canned and are the principal source of maraschino cherries. In Europe, the fruit is used fresh, canned or made into wine.

Hardy bush cherries of north Asian origin were introduced into northern plains areas of the United States, southern Canada and the colder sections of Europe. Some of them produce quite good fruit somewhat resembling the commercial sour cherries.

In the orient, particularly Japan, cherries have been selected for the beauty of their flowers. Most of these do not set fruit but are beautiful ornamentals and are featured in many gardens. Mainly after 1900, these became widely disseminated throughout the moderate temperature areas of North America and Europe. The famous flowering cherries of Washington, D.C., are introductions from Japan.

Diseases and Insect Pests.—Cherries, wherever grown, are subject to attack by diseases and insect pests. Some viral diseases kill the trees, others affect them only mildly. No cure exists for the virus diseases, and severely affected trees should be destroyed. The brown rot fungus that causes fruit rot and leaf attacking fungi that cause leaf drop are serious in humid climates. Important insect pests include scales, fruit flies and mites. Several sprays per season of suitable insecticide and fungicide materials are required in most areas to produce high quality fruit. Ripening cherries are a favourite food of birds, and bird feeding causes severe losses, especially in small, isolated plantings.

The wood of a number of the cherry species is close-grained, dark red in colour and especially esteemed for the manufacture of fine furniture. (J. R. Mag.)

CHERRY VALLEY, a village of Otsego county, in east central New York, U.S., 54 mi. W. of Albany, scene of the Cherry Valley massacre, was founded in 1741 chiefly by Scotch-Irish settlers from New England.

During the American Revolution it was a fortified frontier town exposed to enemy attack. On Nov. 11, 1778, about 800 Indians and Tories under Capt. Walter Butler and Joseph Brant, the Iroquois chief, surprised the village and destroyed it. Fourteen soldiers were killed; 30 settlers, including women and children, were massacred. Many survivors were made prisoner but most were released the next day.

Incorporated in 1812, Cherry Valley became for a time a thriving transportation centre on the Great Western turnpike. Bypassed by railroads and major highways, it is a charming rural community surrounded by dairy farms; population is about 700. (J. A. Fr.)

CHERSONESE (Chersonesus or Cherronesus), in ancient geography a word equivalent to "peninsula" (Gr. *chersos*, "dry," and *nesos*, "island"). In ancient times the Chersonesus Thracica, Chersonesus Taurica or Scythica and Chersonesus Cimbrica correspond to the Gallipoli peninsula, the Crimea and Jutland (*see* Chersonese, Tauric; Chersonese, Thracian); the Chersonesus Aurea or Golden Chersonese is usually identified with the Malay peninsula. The Tauric Chersonese was further characterized as "the Great," in contrast with the Heracleotic or Little Chersonese at its southwestern corner (where Sevastopol now stands) which was part of it.

CHERSONESE, TAURIC, in ancient geography, denotes the Crimea. The Greek word *chersonesos* ("peninsula") was used to indicate both cities and regions in a peninsular situation. Tauric Chersonese is therefore descriptive not merely of the city of Chersonesus, situated on a peninsula 3 mi. W. of the modern Sevastopol, but also the Crimea as a whole (*see* Crimea; Bosporus, Kingdom of the). This article deals with the history of the city and its inland territory.

The city of Tauric (or Heracleotic) Chersonese was founded by Ionian Greeks in the 6th century B.C., perhaps as a trading factory rather than a city. In the 5th century it was refounded by Megarian Greeks from Heraclea Pontica on the southern side of the Black sea and became a purely Dorian city. Its history is obscure until the 4th century B.C. when it appears to have entered a fairly long period of prosperity coinciding with that of the kingdom of the Bosporus to the east. Although differing from the Bosporan state in that it maintained a free constitution of the Greek type, it had similar problems in its external relations; both had to contend with the power of the Scythians who occupied southern Russia and the northern Crimea, and both had to secure satisfactory markets for their natural produce in other parts of the Greek world. Additional problems for the Chersonesites were the tasks of defending their lands against the native Tauri, who inhabited the mountains of the southern Crimea, and of maintaining their independence against the imperialist ambitions of the Bosporan kings.

The Heracleotic peninsula on which the city stood was divided into individual allotments for the citizens, and vineyards were planted which proved extremely productive. Large areas of land in the western Crimea grew wheat and a large surplus was exported. In the early period commercial relations existed with Athens and the cities of the coast of Pontus; later, in the Hellenistic age, there was trade with Delos, Rhodes and Delphi.

About 110 B.C. the citizens turned to Pontus for protection against the Scythians, who were then pressing heavily upon the Crimean Greeks, with the result that Chersonese, together with the Bosporan state, was incorporated in the empire of the Pontic king Mithradates VI (*q.v.*). Under the Roman empire Chersonese was treated as a free city protected by the client-king of the Bosporan state. The export trade in grain was of considerable importance in the imperial economy; to safeguard the traffic a Roman military station was established at Chersonese. In the 1st and 2nd centuries A.D. the city flourished, as in the early Hellenistic age. Later it became increasingly exposed to barbarian attacks from the peoples of the interior. During the period of the Byzantine empire prosperity returned.

The city's remains occupy a space about two-thirds of a mile long by half a mile broad, enclosed by a Byzantine wall. Remains of an earlier wall going back to the 4th century B.C. have been found beneath this in the eastern or original part of the site. Many Byzantine churches have been excavated. Uninhabited since the 14th century, the site is important for our knowledge of Byzantine life.

See E. H. Minns, *Scythians and Greeks* (1913); M. Rostovtzeff, *Iranians and Greeks in South Russia* (1922). (R. H. Si.)

CHERSONESE, THRACIAN, in ancient geography corresponds to the modern Gallipoli peninsula. Situated on the Hellespont (Dardanelles), and therefore on the main route between Europe and Asia, it was important to the Athenians for the corn trade from the Euxine (Black sea).

In the 7th century the Thracian Chersonese was colonized by Aeolian settlers from Lesbos and by Ionian Greeks from Miletus and other towns. Xenophon states that it contained 11 or 12

Greek cities. The local inhabitants, the Thracian Dolonci, appealed to the Athenians about 560 B.C. for help against the neighbouring Apsinthii. Miltiades, sent by Pisistratus, founded an Athenian colony and built a defensive wall across the isthmus from Cardia to Pactya. Chosen by the Dolonci as king, Miltiades became tyrant of the Greek cities and founded a dynasty. His nephew Miltiades abandoned the Chersonese to Darius I of Persia about 492. After the Persian wars, the Athenians controlled the Chersonese by enrolling its cities in the Confederacy of Delos, and colonies were established about 450. At the end of the Peloponnesian War the Chersonese was taken by the Spartans (405). In the 4th century, however, Athenian sea power revived and Athenian settlers were sent out in 353. It remained in Athenian possession until 338, when it was ceded to Philip II of Macedonia after the battle of Chaeronea. Part of the Seleucid empire, the Chersonese was given to Eumenes II of Pergamum at the peace of Apamea (188) between the Romans and the Seleucid king Antiochus III. In 133 Attalus III of Pergamum bequeathed his kingdom to the Romans and most of the Chersonese became *ager publicus* (state-owned land). Under the emperor Augustus it was imperial property, governed by a procurator.

CHERT AND FLINT. Chert is a rock composed essentially of very fine-grained quartz (silica) with minor impurities. Chert forms by the chemical precipitation of silica, hence is distinguished from sandstone in which quartz particles are deposited mechanically.

Varieties.—Several varieties are included under the general term chert: flint, which with common chert is discussed in this article, and jasper, chalcedony, agate and novaculite (*qq.v.*). Flint is gray to black and nearly opaque because of included carbonaceous matter (translucent brown in thin splinters). Jasper is opaque and red or green as a result of abundant inclusions of iron oxide, chlorite or clay minerals. Chalcedony is translucent gray to white with waxy lustre. Agate is banded with various colours and novaculite is opaque white chert of homogeneous texture. Opaque, dull whitish to pale brown or gray specimens are simply called chert. The light colour and opacity of common chert are caused by abundant, extremely minute inclusions of water or air.

All chert varieties are harder than steel or glass, thus a knife blade leaves a silvery streak across the surface. Chert is usually nonporous and brittle with a smooth, splintery or conchoidal fracture. When shattered, it breaks into extremely sharp slivers like glass. Because of the minutely granular structure, chert has a waxy or dull lustre; upon weathering, flint develops a light gray, dull patina a few millimetres thick. Most chert has a density of about 2.65 and consists of 95% to 99.5% silica (SiO_2). Slowly soluble in strong alkalies and hydrofluoric acid, it is inert to other common reagents. Mineralogically chert consists of exceedingly fine-grained quartz mixed with a small and variable amount of free water occupying discrete, usually spherical cavities 0.00005 to 0.002 mm. in diameter. This included water lowers the refractive index and density of chert relative to pure quartz, and is responsible for the brownish appearance of much chert under the microscope.

Fine-grained quartz assumes two forms in chert and flint. Greatly preponderant is microcrystalline quartz, consisting of irregular, subequant polyhedral grains 0.001 to 0.010 mm. in diameter; under the polarizing microscope, this type appears as minute, pinpoint grains. Secondly, chalcedonic quartz under polarized light appears as spherulites or bundles of radiating fibres 0.02 mm. to several millimetres long, often concentrically banded with water bubbles; this variety occurs in small amounts and usually fills cavities or replaces fossils. Along with chalcedonic and microcrystalline quartz and a trace to several per cent of free water, some chert contains more coarsely crystalline quartz, opal and other impurities such as organic matter, calcite, dolomite, pyrite, iron oxides, clay minerals and sand or silt grains.

Occurrence and Origin.—Chert and flint occur as individual nodules or layers of nodules in limestone or dolomite; they are common in rocks of all ages (notably Cretaceous chalk of England). Nodules range from an inch to several feet across, and are smoothly ellipsoidal, tabular, bulbous or irregular tuberous. Masses generally lie parallel with bedding of the enclosing strata, but some cut across bedding or follow inclined veins. Hard and chemically resistant, the nodules become concentrated in residual soils as the surrounding carbonate rock weathers away. In places chert forms massive beds several hundred feet thick which extend laterally hundreds of miles. Chert also occurs as a fine powder disseminated throughout carbonate rock, impregnates shale and rarely forms cement in sandstone. It also develops in the vicinity of some metalliferous veins, precipitated by hot ore-depositing solutions. Erosion of chert beds or chert-bearing limestone produces chert pebbles, which are abundant in river and beach gravel. The origin of chert has been a subject of much controversy. At first it was assumed that chert nodules formed by coagulation of silica gel directly from sea water, to form a spheroidal mass resting on the sea bottom. Perhaps some chert may have formed in this way, but microscopic study shows conclusively that most chert and flint has formed by replacement of the enclosing carbonate sediment after burial beneath the sea floor. This replacement origin (similar to the petrifaction of wood) is substantiated by preservation in chert of the minute textural details of the enclosing carbonate rocks. Beds of oölite, fossils, carbonate pebbles, bedding planes and colour bands are faithfully duplicated and can be traced from the carbonate rock directly through chert. Irregular shapes attained by some chert masses and embedded patches of unreplaced limestone can only be explained by replacement. Probably chert is precipitated in place of limestone as limestone simultaneously dissolves, the two substances remaining always in immediate contact in order to preserve the textures. Analogously, one might imagine a wall of red bricks set in complex designs; one could then replace the wall by placing a white brick in the position of each red one as it was removed, and the pattern of the wall would be perfectly preserved. Replacement usually occurred while the surrounding carbonate sediment was still a soft, plastic material buried perhaps a few feet beneath the sea floor. Some chert masses have been bent or even torn apart when the surrounding soft carbonate sediment deformed plastically during mudflows or submarine landslides, and cracks in chert nodules are frequently invaded by unconsolidated lime mud. Nevertheless, some nodules may have formed much later upon deep burial of the rocks, and other chert masses have formed upon weathering in surface outcrops. Bedded chert presents a different problem; it is not usually associated with carbonate beds and shows little evidence of replaced carbonate rock structure. This evidence, albeit largely negative, indicates that perhaps bedded cherts were precipitated directly from sea water. Most silica required to form chert is evidently derived from normal weathering processes on land, which contribute dissolved SiO_2 to the sea in entirely adequate amounts. Organisms often acted as intermediate agents; some chert nodules have obtained their silica by solution and redeposition of siliceous (opaline) sponge spicules, radiolarians and diatoms. Many cherts contain abundant remains of these organisms. Locally, volcanic ash falls or submarine eruptions have contributed much silica in solution.

Uses.—Flint and chert provided the main source of tools and weapons for Stone Age man. The uniform fine grain, brittleness and conchoidal fracture made it easy to shape arrowheads by spalling or flaking off chips, and the edges produced were quite sharp. Quarrying and manufacture of flint weapons were among mankind's earliest business ventures, and it is sometimes possible to trace ancient trade routes by knowing where a particular type of flint was obtained (*see* FLINTS). From the 17th through the early 19th centuries, flints again found extensive military use in flintlock rifles, gunpowder being ignited by sparks produced when flint struck steel. Flint is used as an important ingredient in pottery. Several thousand tons of flint pebbles are used yearly in mills which grind raw materials for ceramic and paint industries. The use of flint pebbles (instead of steel balls) as a grinding agent is desirable in order to avoid contaminating the product with iron. Considerable chert finds use in road construction and concrete aggregate, although some types of chert are objectionable because they react with cement and may crack the structure. Novaculite is used for whetstones; buhrstone (a porous chert) for grindstones; basanite (a velvety black flint) to estimate purity of alloys by observing the colour of the metallic streak. Some chert, agate and jasper take an excellent polish and serve as semiprecious jewelry. *See* also SILICA. (R. L. FK.)

CHERTSEY, an urban district of Surrey, Eng., 21 mi. S.W. of London by road. Pop. (1961) 40,376. Area 15.6 sq.mi. It lies on the right bank of the Thames, which is crossed by a bridge of seven arches built of Purbeck stone in 1785. The first religious settlement in Surrey, a Benedictine abbey, was founded in 666 at Chertsey (Cerotaesei, Certesy). Little remains of the abbey buildings, but the ground plan can be traced and the fish ponds are complete. In the reign of Edward the Confessor, Chertsey was a large village and became the head of Godley hundred. As the centre of an agricultural district, its markets were important and are still held. Fairs were granted to the abbots in 1129 and 1282, and a market on Mondays was obtained in the latter year—this market is now held on Saturdays. From Michaelmas to Lady day the curfew bell of St. Peter's parish church, founded in 1310, is still rung nightly. The poet Abraham Cowley died in Chertsey. Charles James Fox, the statesman, lived at St. Anne's Hill. Apart from the historic township of Chertsey, the urban district includes areas of modern development such as New Haw and Addlestone. Among the industries, engineering of varying types predominates balanced by agriculture and market gardening.

CHERUBIM, in the Old Testament, are hybrid creatures, with wings of birds, human or animal faces, regarded as attendants upon the divine throne or guardians of specially sacred places. Similar creatures are found in other oriental religions. In Jewish literature the cherubim appear as a class of angels, and in patristic times they were counted as one of the nine choirs of angels. *See* ANGEL.

CHERUBINI, (MARIA) LUIGI (CARLO ZENOBIO SALVATORE) (1760–1842), Italian composer who was one of the principal figures in the development of French opera during and after the Revolution. Born in Florence on Sept. 8, 1760, he received musical training from his father and from other teachers, among them Giuseppe Sarti, in the basic traditions of Italian music: first, the religious unity of Palestrinian counterpoint, then the vocal lyricism of 18th-century *opera seria*—a convention that embodied, almost ritualistically, the values of an aristocratic world that was in the process of disintegration. He composed quantities of church music but then turned to opera, completing 13 by 1788. He was appointed composer to the king, George III, in 1785 for a year during his visit to London and in the following year he settled more or less permanently in Paris. In 1805 he visited Vienna, where his operas *Lodoïska* and *Faniska* were produced. In 1822 he was appointed director of the newly founded Paris conservatory, whose reputation his strict rule did much to establish. Cherubini died in Paris on March 15, 1842.

Cherubini's career offers the paradox of an innate conservative who lived through, and was in some ways representative of, a revolutionary era. Though the operas he wrote from the time he settled in Paris (1786) do not relinquish heroic and aristocratic grandeur, they followed Gluck in seeking themes that were morally relevant to a changing world. The new heroism was centred not in titular rank but within the spirit of the men and women who were creating the future. This is why Cherubini, like Gluck (and Mozart), reconciled the objective splendour of classical lyricism with the internal drama of sonata style. He carried the Horror and Escape and Rescue opera into a realm of inner experience that could appeal to Beethoven, who studied the score of *Les Deux Journées* before writing *Fidelio*. Yet along with this Beethovenian drama Cherubini preserved a classical purity of line that suggests Berlioz—especially the superb vision of the world remade in *Les Troyens*. What is missing from Cherubini's music is, on the one hand, the dramatic cogency, the inner incandescence, that informs Beethoven's *Fidelio* as it informs his purely instrumental movements; or, on the other hand, the enormous melodic span and lyrical subtlety that are the essence of Berlioz. It is not Cherubini's fault that, after *Fidelio* and *Les Troyens*, his operas seem unnecessary; and it is the misfortune of present-day audiences that they find it difficult to respond to what operas such as *Lodoïska* (1791), *Medée* (1797) and *Les Deux Journées* (1800) have to offer intrinsically. Though their virtues have been obliterated by the genius of greater men, they are real virtues, powerfully embodying the experience of the Tory democrat. It is not an accident that their force should be dependent on their classical restraint.

This vital conservatism is found also in Cherubini's nontheatrical music. The best of his string quartets (1814–37) have not the disturbing vehemence or wit of Beethoven's early and middle period works in this medium, let alone the (to Cherubini) utterly baffling and original profundity of Beethoven's last quartets. But their classical sobriety is not merely academic, and the drama within their lyricism is not the less trenchant for being operatically conceived.

Cherubini was, however, essentially a vocal composer; and when in later life he devoted less time to opera composition he turned not to instrumental music but to music for the church. This somewhat surprising development was precipitated by an invitation he received in the summer of 1808 to write a mass for the consecration of a church on the country estate of the prince de Chimay. Despite his early training in Roman liturgical style, the mature Cherubini, as a man of the Revolution, was not mystically inclined. But his operas, insofar as they were concerned with human potentiality and the creation of a new world, implied a belief in something outside himself; and the relationship between his liturgical and operatic manners exactly parallels the relationship between the ecclesiastical and secular styles of Berlioz. Their church music is a vision of a world of re-created grandeur aware of, yet triumphant over, human fallibility and chaos. Cherubini's two Requiems (especially the one in D minor, for male voices) are impressive and personal works. It is irrelevant to complain that the pressure of experience behind their ordered lucidity seems slight when they are compared with Berlioz's tremendous *Requiem* or that they do not scale the purgatorial heights and depths of Beethoven's Mass in D.

Cherubini's conservatism assumed a more damaging form in his celebrated *Cours de contrepoint et de la fugue* (1835) written with the help of his pupil Jacques François Fromental Halévy, for in this work he tends to allow reverence for the past to destroy his awareness of the creative life of musical structures, his own included. This may have been part of the basic fear of life that made him shy away from men like Beethoven and Berlioz, who seemed so close to him yet were so irrevocably distant. This treatise has its value, however, for from it generations of composers have learned facility in their craft. The pity is that Cherubini's criteria of academic correctness should have subconsciously influenced the response of later generations to his own music, which, though not of Beethovenian or Berliozian vitality, was modern in its own day and became truly creative again in its influence in the 20th century.

See R. Hohenemser, *L. Cherubini: sein Leben und seine Werke* (1913). (W. H. M.)

CHÉRUEL, (PIERRE) ADOLPHE (1809–1891), French historian, revered for pioneer work on the reign of Louis XIV, was born in Rouen on Jan. 17, 1809. He pursued an academic career and rose to the highest posts. His early work was concerned with Norman history or with the general history of France; but an epoch-making edition of the *Mémoires* of the duc de Saint-Simon (20 vol., 1856–58) was followed by editions of older memoirs and diaries and by the publication of Cardinal Mazarin's letters (6 vol., 1872–91; completed with 3 vol. ed. by G. d'Avenel, 1891–1906), which transformed the historiography of the *Fronde*.

In his most important original works, *Histoire de France pendant la minorité de Louis XIV* (4 vol., 1879–80) and *Histoire de France sous le ministère de Mazarin, 1651–1661* (3 vol., 1882), Chéruel took full advantage of his long researches. He died in Paris on May 1, 1891.

CHERUSCI, an ancient German tribe living on both sides of the middle Visurgis (Weser) river, extending eastward to the Albis (Elbe) river, whose prince Arminius (*q.v.*) inflicted a severe defeat on the Roman general P. Quinctilius Varus in A.D. 9. They appear at that time to have been the leading tribe of northern Germany, but after Arminius' death they were weakened by repeated wars with the Chatti (*q.v.*). The Romans gave them a king in A.D. 47 and supplied them with financial aid against the Chatti (*c.* 85) in Domitian's reign.

See Tacitus, *Annals*, i, ii, xi, 16 and xii, 28; *Germania*, 36. (G. E. F. C.)

CHESAPEAKE, a city of southeastern Virginia, U.S., was formed by the merger of South Norfolk and Norfolk county, effective Jan. 1, 1963. It is bounded by Portsmouth, Norfolk and the new city of Virginia Beach (which came into existence on the same date with the merger of the city of that name and Princess Anne county) and by the state boundary with North Carolina. In area (342 sq.mi.) it is the largest city in the state and one of the largest in the nation. The population is over 75,000. It adopted the council-manager plan of government, which South Norfolk had had from 1947. The name was chosen by popular vote.

Within the city limits are 47,000 ac. of fertile farm and truck land and a vast sector of Great Dismal swamp, with its wild game including deer, black bear and wild cat. The city is also an industrial centre, being a large producer of fertilizer, and cement manufacture, lumbering and grain storage are important. It is on deep water and is traversed by inland waterways, and is a storage site for several major petroleum companies. (R. K. T. L.)

CHESAPEAKE BAY, the largest inlet (180 mi. long and 3 to 27 mi. wide) in the Atlantic coastal plain of the U.S., created by the submergence of the lower courses of the Susquehanna river and its tributaries. The southern part of the bay is bordered by Virginia, its northern part by Maryland; its entrance is flanked by Cape Charles in the north and Cape Henry in the south. Besides the Susquehanna, major rivers emptying into the bay include the James, York, Rappahannock, Potomac and Patuxent from the west, and the Wicomico, Nanticoke, Choptank and Chester from the east. Most of the irregular eastern shore of the bay is low and marshy; the straighter western shore consists, for long distances, of cliffs. The first European settlement in the bay area, Jamestown (*q.v.*), was founded in 1607. One year later Capt. John Smith explored and mapped the bay and its estuaries, and soon afterward, settlers came to the bay's easily accessible, well protected shores.

Baltimore, Md., the chief port on the upper bay, handles a great variety of cargoes. The Chesapeake and Delaware canal connecting the head of the bay with the Delaware river estuary shortens the sea routes to Baltimore from the north and from Europe. The port group of Norfolk, Va., at the mouth of the James river, exports coal and tobacco. Norfolk is also an important naval base. Oysters, crabs and many species of fish in the bay form the basis for commercial fishing from many small ports. The bay also has attracted recreational activities.

Prior to 1952 the only way to cross the bay was by ferry. In that year, however, a 4.2 mi. long highway bridge was opened to span the upper bay near Annapolis, Md. Twelve years later the 17.6 mi. long Chesapeake Bay bridge-tunnel was opened across the lower bay connecting the Norfolk area with Cape Charles at the tip of the Delmarva peninsula. The bridge-tunnel complex consists over most of its length of low (30 ft. above the water) trestle bridges carrying a 28 ft. wide motor highway. Four man-made islands anchor the ends of two tunnels, each more than a mile long, built beneath the two main shipping channels—Thimble Shoal channel near Norfolk and Chesapeake channel near the centre of the bay mouth. Near the north end of the bridge-tunnel complex, flanking Fisherman Island off Cape Charles, high bridges were built across the North channel (75 ft. clearance) and Fisherman inlet (40 ft. clearance). (F. O. A.; X.)

CHESELDEN, WILLIAM (1688–1752), English surgeon, one of the most famous and rapid operators in the preanesthetic period, was born at Somerby, Leicestershire, on Oct. 19, 1688. He studied anatomy in London under William Cowper (1666–1709), and in 1713 published his *Anatomy of the Human Body*. He became surgeon at St. Thomas' and St. George's hospitals, London. Cheselden is famous for his "lateral operation for the stone," which he first performed in 1727.

He also effected a great advance in ophthalmic surgery by his operation for the treatment of certain forms of blindness by the production of an "artificial pupil." He attended Sir Isaac Newton in his last illness, and was a friend of Alexander Pope and of Sir Hans Sloane. He died at Bath on April 10, 1752.

See F. H. Garrison, *Introduction to the History of Medicine*, p. 343 (1929).

CHESHIRE, a northwest maritime county of England bounded on the north by Lancashire and Yorkshire and the Irish sea, on the east by Derbyshire, on the south by Staffordshire, Shropshire and Flintshire and on the west by Denbighshire and Flintshire. Area (land and inland water) 1,015.2 sq.mi.

Physical Features.—Almost the whole of Cheshire forms part of the central lowland area of England, the only exception being a narrow strip along the eastern boundary of the county where the land rises to nearly 2,000 ft. to form part of the Pennines (*q.v.*). The low undulating Cheshire plain forms the southern and western parts of the county. It is bisected by the north-south hills of the mid-Cheshire ridge which in the Peckforton hills reaches 746 ft. The western portion of the plain is drained by the Dee, which forms the county boundary in the southwest, and the Gowy, a tributary of the Mersey (*q.v.*). East of the ridge the plain is drained by the Weaver, Dane and Bollin, all flowing into the Mersey which, for much of its length, forms the northern county boundary. The low plateau of Wirral forms a peninsula about 8 mi. wide between the estuaries of the Dee and Mersey.

With the exception of a small area of Lower Lias Slates near Audlem in the extreme south, the whole of the Cheshire plain is underlain by Triassic strata. The central ridge of hills is formed of Keuper Sandstone and this formation reappears in ridges northwest of Macclesfield and along the northern border of the county between Runcorn and Altrincham and in the Birkenhead area. West of the central ridge the predominant formation is Bunter Sandstone, while to the east and dominating the geological pattern of the county are the Keuper Marls extending to the Pennine foothills. There the Bunter Sandstone reappears soon to give way to rocks of the Carboniferous series of which the Pennines are formed. The predominant rock formation in this highland region is Millstone Grit, while a tongue of Coal Measures extends northward from Macclesfield, east of Stockport, to join the main body of the Lancashire coal field. Coal-bearing strata are also found at Neston in the Wirral, but, as in east Cheshire, the coal is no longer mined. By far the most important mineral deposits are the rock-salt beds which are present in the Keuper Marl strata of the east Cheshire plain. Apart from the central ridge and eastern hills, practically all the geological strata are overlain by drift deposits chiefly composed of glacial clays, sands and gravels which in places have a thickness of several hundred feet. Narrow strips along the banks of the major rivers are covered with alluvium and river gravel, while peat is present in isolated areas in the east Cheshire plain, and, in the north, in Delamere and along the lowlands of the Mersey between Runcorn and Ashton-upon-Mersey. Areas of blown sand occur in north Wirral and west of Sale. The glacial clays produce a heavy soil, difficult to plow, while the soils developed on sands and gravels are more amenable to cultivation. The intricate pattern of the sand and clay deposits has created a great variety of soil type throughout the county, which in general is extremely fertile. (AR. C. HE.)

History.—The first substantial settlements in Cheshire, the hill forts of Bronze and Iron Age near Helsby and at Eddisbury and Bickerton, were sited on the lightly wooded mid-Cheshire ridge. Cheshire came into prominence with the establishment (*c.* A.D. 71) of the Roman legionary fortress at Deva (Chester), designed as a base for the conquest of north Wales and the defense of the northwest. The departure of the legions left Cheshire remote and isolated. In 830 the Anglo-Saxons pushing northwestward defeated the Celts and brought Cheshire into the kingdom of Mercia. Cheshire first emerged as a distinctive administrative unit upon the subdivision of Mercia in the 10th century. During the 9th and 10th centuries Wirral was invaded by Norsemen whose settlements are recorded in the many Norse place names of the peninsula (*e.g.*, Meols, Frankby, Thingwall and Thurstaston). The county established by the Normans was much larger than modern Cheshire and included Lancashire south of the Ribble and large parts of the present Flintshire and Denbighshire. By the end of the 13th century Cheshire had been reduced to its modern dimensions by the creation of separate administrations in Lancashire and north Wales. The Chester earldom, created in 1071 and given by William the Conquerer to Hugh of Avranches, passed to the crown in 1241 and the county became a palatinate with control over its own administration, both legal and fiscal (*see* Chester, Earls of). In the reign of Henry VIII these privileges were progressively abridged until only the palatine courts still functioned and, with their disappearance in 1830, only the title of County Palatine remains. In 1403 Cheshire was the headquarters of Hotspur (Sir Henry Percy; *q.v.*), who roused the people by telling them that Richard II was still alive. At the beginning of the Wars of the Roses Margaret collected a body of supporters from among the Cheshire gentry and Lancastrian uprisings occurred as late as 1464.

During the Civil War the county was divided, Chester being loyalist while Nantwich supported parliament. The king's forces were defeated at Rowton Moor outside Chester in 1646. After the Civil War Cheshire's history was one of steady economic progress in both agriculture and industry, punctuated by such events as the discovery of rock salt in 1670, and the introduction of cotton textiles in the 18th century and chemicals in the 19th. (E. S. Si.)

Population and Administration.—The population of Cheshire was 1,367,860 in 1961. It shows a high degree of concentration and two areas, the Wirral peninsula and the southern fringe of Manchester, account for nearly two-thirds of the total. In these areas Cheshire becomes part of the Merseyside and Southeast Lancashire conurbations respectively. In the remainder of the county the population is also largely urbanized and only 15% of the total lives in rural areas. The major towns are: Birkenhead; Stockport; Wallasey; Chester; Crewe; Bebington; Sale; Altrincham; Ellesmere Port; Macclesfield; Hyde; Stalybridge; Congleton (*qq.v.*); and Dukinfield.

Cheshire contains four county boroughs, Chester, which is the county town, Birkenhead, Wallasey and Stockport, which are responsible for all services normally provided by a local authority. The remainder of the county is administered by the county council whose area is subdivided into 10 noncounty boroughs, 22 urban districts and 10 rural districts. Many of the county council's powers are delegated to these district councils. Part of the administrative county (almost the whole of Tintwistle rural district and a considerable portion of Macclesfield rural district) is included in the area of the Peak District (*q.v.*) national park.

Cheshire is in the Wales and Chester circuit and the assizes are held at Chester. Its court of quarter sessions sits both at Chester and Knutsford. All the county boroughs, and also the boroughs of Crewe and Macclesfield, have separate commissions of the peace. Ecclesiastically, the county is almost entirely in the diocese of Chester, except for small parts in Manchester, St. Asaph and Lichfield. Sixteen members are returned to parliament, six for the boroughs and ten for county constituencies. (Ar. C. He.)

Industries and Communications.—The greater part of Cheshire supports a highly productive agriculture in which dairying is the dominant enterprise. Its largest centres of population and industry, in Wirral and to the south of Manchester, are peripheral rather than central to the county, their location furthering the impression of a rural shire.

Agriculture.—Farming can be grouped according to three major land categories: southern and western grassy plain, northern arable land and poorer eastern marginal farmland. Each has its own regional expression and all are concerned with dairying. Cheshire has a higher density of dairy cattle (27 per 100 ac.) than any other county. The most widespread type of farming is grassland dairying, practised in Wirral and the drift covered plains to the east and west of the central ridge. In these areas the predominance of heavy, water-retentive soils favours grassland more than arable, and Cheshire has been for centuries renowned for its grass, cattle and cheese. These areas with their small thorn-hedged fields support in summer large herds of dairy cattle, chiefly Friesians and Ayrshires. By the early 1960s more sown grasses and fodder crops were being grown than before World War II, though grassland still predominated. Amid pleasant green fields stand the scattered farmsteads, each of considerable size. The farmhouse, occasionally a half-timbered Elizabethan dwelling, sometimes a gracious Georgian house, more often a solid brick Victorian structure, is usually ranged with the stock buildings in an open square around a yard. The buildings are large and provide lying and shelter for considerable numbers of cattle for about five months of the year. Cheese making, once widespread, is practised on few farms today; instead, milk is collected daily to supply the Merseyside and Manchester conurbations and the Potteries.

The light and loamy soils of the drift-free Triassic sandstones and sandy drifts of north central Cheshire are extensively plowed for crops. However, this arable region is still concerned with dairying. Temporary grasses are commoner than permanent pasture, oats and roots are grown as feed for dairy cattle, and the sale of liquid milk is the main source of income. In addition the sale of potatoes and wheat provides the farmer with a further revenue, early potatoes being of particular importance on the light soils of the Delamere-Frodsham area.

In the east of the county, where the gritstones and shales of the Pennine slopes give rise to thin acid soils, the land is largely in grazing but is much inferior to that of the plain. Small dairy farms, which also raise sheep and beef cattle to diversify their economy, are the most characteristic. The area is one of poor marginal farms in contrast to the productive holdings of both the grassy plain and the northern arable region.

Industry.—Cheshire is by no means entirely concerned with farming, for the majority of its people live in industrial towns. In the northeast, towns such as Stockport, Hyde and Stalybridge are part of the textile province of Lancashire. The expanding conurbation of Manchester has leaped the Mersey and the Cheshire towns of Sale, Altrincham, Cheadle and Gatley (*qq.v.*) which function largely as satellite industrial centres and dormitory suburbs for Manchester. Further afield, Hazel Grove, Bramhall and Wilmslow also fall within the Manchester commuter network.

The towns of the Cheshire salt field exhibit a more autochthonous growth based on the exploitation of this mineral resource and its increasing use in heavy chemical industries. Northwich and Runcorn (*qq.v.*) are particularly important chemical towns, while Middlewich, Winsford and Sandbach are lesser centres also concerned with salt or chemicals. In the east of the county, and separate from the cotton manufacturing region peripheral to Manchester, the "isolated" industrial town of Macclesfield, with the lesser centre of Congleton, is important for silk textiles and textile machinery. Another "isolated" industrial town is the rail junction of Crewe. The advantages of its site in the south of the county are entirely man made; the establishment of locomotive works at the junction led to the growth of the town which, together with the transport facilities, attracted other manufactures, in particular those of motor vehicles and aircraft engines.

Along the Mersey shores of the Wirral peninsula is a further industrial region where two factors led to the growth and concentration of industry: the facilities of Birkenhead docks and the deep water sites afforded by the Manchester Ship canal. Industries such as flour milling, oil-seed crushing, soap (Port Sunlight) and margarine manufacture and oil refining (Stanlow) have developed along quayside sites. On the Mersey shore are also the great Birkenhead shipyards and chemical, paper and engineering works. The remaining gaps of open land are rapidly being built upon, one being earmarked as the site for a motor vehicle plant. In addition to housing workers in these industries, north Wirral is a dormitory suburb of the Merseyside conurbation.

Communications.—Eleven important national traffic routes cross Cheshire from north to south and east to west, and are interconnected by an extensive system of minor roads. Numerous road improvement schemes were undertaken, notably the building of a bridge across the Mersey at Runcorn (replacing the Edwardian Transporter bridge) and the construction of that part of the East of Birmingham-Preston motorway which passes from south to north through the county. Downstream in the narrows of the

Mersey, between Liverpool and Birkenhead, the Mersey tunnel (opened in 1934) carries heavy goods and passenger traffic.

Crewe, which is centrally situated in the county, is one of the most important railway junctions in England with repair shops. The major lines passing through it run north and south while rail communications between east and west are poor. Electrification of many of the major railways was carried after 1960 while a diesel service operated on others. The county is also served by a system of waterways, the most important being the Manchester Ship canal, which extends 36½ mi. from Manchester to Eastham along the south bank of the Mersey and is capable of handling ocean-going vessels up to 15,000 tons. Just inside the county is the largest municipally owned airport in England, which is operated by Manchester city council at Ringway. (E. S. St.)

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CHESHUNT, an urban district in the East Hertfordshire parliamentary division of Hertfordshire, Eng., in the Lea valley, 13 mi. N. of London and 9 mi. S.S.E. of Hertford by road. Pop. (1961) 35,297. It contains Cheshunt, Waltham Cross and Goff's Oak. At Waltham Cross stands one of the three remaining crosses erected in memory of Queen Eleanor (d. 1290). Cardinal Wolsey once owned the Great house. In Cedars park, given to Cheshunt in 1921, stood Theobalds palace, where James I died in 1625. One of the entrances to Theobalds park, on the other side of the Great Cambridge road, is old Temple Bar, moved there from Fleet street, London, in 1878. The training college for the Countess of Huntingdon's Connexion (a nonconformist sect which came there from Trevecca, Brecknockshire, in 1792) was moved to Cambridge in 1904, where it is known as Cheshunt college (Congregational). Bishops' college in Cheshunt is administered by the Church of England. Cheshunt is a centre for market and greenhouse gardening; it has a horticultural research station.

CHESIL BANK (O.E., *ceosol*, "pebble bank"), a remarkable beach of shingle on the coast of Dorsetshire, Eng. It is separated from the mainland for 8 mi. by an inlet called the Fleet, famous for its swannery, and continues in all for 18 mi. southeastward from near Abbotsbury, terminating at the Isle of Portland (*q.v.*). At the Portland end it is 35 ft. above spring-tide level, and 200 yd. wide, while at the landward end the width is 170 yd. and the pebbles are less in size. The beach was formed by general drift of shingle along this coast from west to east.

CHESNEY, FRANCIS RAWDON (1789–1872), British soldier, explorer and middle east traveler whose fame rests on his projects for the Suez canal and for an overland route to India by the Euphrates valley. The son of Capt. Alexander Chesney, who had served under Lord Rawdon (later marquis of Hastings) in the American Revolution, Francis Rawdon was born at Annalong, County Down, Ire., on March 16, 1789. After a cadetship at Woolwich he was gazetted to the royal artillery in 1805 and later rose to be a general. During a tour of military duty at Constantinople in 1829, he formulated plans for the Suez canal that were the basis of Ferdinand de Lesseps' undertaking completed in 1868.

After a daring journey from Anah on the Euphrates to the Persian gulf, Chesney in 1831 suggested the overland route to India and with the support of the East India company pressed the proposal on the British government. In 1835 he was sent in command of a small expedition to test the navigability of the Euphrates. In spite of much opposition from the Egyptian pasha, he transported two steamers in sections from the Mediterranean to the middle Euphrates, reaching Bushire on the Persian gulf in the summer of 1836. For this journey he received the Royal Geographical society's gold medal. Military duties in Hong Kong delayed publication of his book on the expedition until 1850. He retired from the army in 1847 and, though he went to the middle east again in 1856 and 1862, he made his home in Ireland until his death at Mourne on Jan. 30, 1872. His chief works are *The Expedition for the Survey of the Rivers Euphrates and Tigris* (1850), *Observations on . . . Firearms* (1852) and *The Russo-Turkish Campaigns of 1828 and 1829* (1854).

See *The Life of Gen. F. R. Chesney* by his wife and daughter, ed. by S. Lane-Poole (1885). (K. M.)

CHESS, a game for two players using a board and special pieces. From its pre-eminence among intellectual pastimes, it is called "the royal game." Probably originating in India during or before the 7th century (see *Origin of Chess*, below), chess spread to Persia, to Arabia and thence to western Europe. Its name and the term "checkmate" are sometimes said to derive from the Persian *shah*, "king," and *shah mat*, "the king is dead." The growth of an extensive occidental chess literature and the rise of international tournaments have standardized the game throughout Europe and America, but this has not affected the variants that have evolved in the countries east of India, as, for example, shogi (*q.v.*) in Japan.

This article is divided into six main divisions dealing with the various aspects of chess, as follows:

- I. The Game
  - 1. The Board
  - 2. The Pieces
  - 3. Notations
  - 4. Object of Play
  - 5. Value of the Pieces
  - 6. Drawn Games
- II. Laws of Chess
- III. History
  - 1. Origin of Chess
  - 2. Early and Medieval Times
  - 3. Development in Play
  - 4. The World Championship
  - 5. Fédération Internationale des Échecs
  - 6. Literature
- IV. Theories of Play
- V. Illustrative Games
- VI. Chess Problems

I. THE GAME

1. The Board.—The chessboard comprises 64 squares, coloured alternately light and dark, in a large square. The players, designated White and Black, sit on opposite sides. In printed diagrams the Black side is by convention at the top. The board is placed so that each player finds a light square in the corner nearest his right hand. A row of eight squares parallel to the White and Black sides is called a rank; a row at right angles to the ranks is a file.

2. The Pieces.—Each player has 16 pieces, which are placed on the board at the beginning of a game as shown in fig. 1. The pieces are distinguished by their shapes into six kinds: king, queen, rook, bishop, knight, pawn. The king moves in any direction, one square at a time. The queen, rook and bishop are "long-range" pieces, moving any distance along an unobstructed line. The rook moves only on the ranks and files, the bishop only on the diagonals. The queen combines the powers of rook and bishop and thus moves on any open line. The knight's move is made up of two different steps. It takes one step of one single square along the file or rank and then, still moving away from the square that it has left, takes one step along the diagonal (*see* fig. 4). This is not a line move, but a move from point to point, and therefore cannot be obstructed by any neighbouring

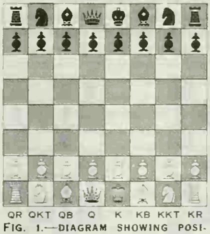


FIG. 1.—DIAGRAM SHOWING POSITION OF CHESSMEN AT BEGINNING OF GAME

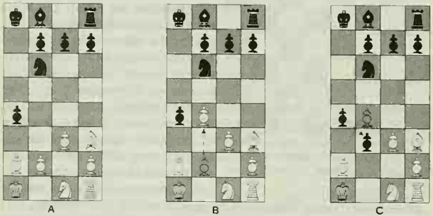
Queen's rook (QR); queen's knight (QKt); queen's bishop (QB); queen (Q); king (K); king's bishop (KB); king's knight (KKt); king's rook (KR). The pieces in front of the principal pieces are the pawns (P) pieces. The term "piece" is often used in a restricted sense to exclude pawns. Any piece not a pawn captures in the same way as it moves; that is, it may capture an adverse man standing on a square to which it can legally move. The capturing piece replaces the captured on the same square, and the captured man is removed from the board.

The pawn has several peculiarities. It moves only forward, and when not capturing advances only on the file. For the first advance from its initial square on the second rank, the pawn has the option of moving one or two squares, but thereafter may move only one square at a time (*see* fig. 2). If it reaches the eighth rank, farthest from the owner, the pawn is immediately replaced by a queen, rook, bishop or knight of the same colour, at the option of the owner. This promotion is also called queening, since the usual choice is a queen, the most powerful piece. A pawn may promote even though the piece chosen to replace it has not previously disappeared from the board by capture; *e.g.*, a player may have two or more queens. The pawn alone captures differently from its noncapturing move. It captures to either square that is adjacent and diagonally forward. If a pawn makes the double advance for its first move, an adverse pawn that could have captured it, had the first pawn moved only one square, may capture it *en passant*, "in passing"; but this "e.p." capture may be made only on the immediate turn, not later.

Castling is a compound move of the king and one rook (formerly called "castle") that may be made, if at all, only once in a game. It is legal if neither the king nor the rook has yet moved; if all the squares between them on the rank are vacant and no adverse piece commands the two squares nearest the king on the side on which castling is to be carried out; and if the king is not in check. The move is executed by moving the king two squares toward the rook, and then placing the rook on the square passed over by the king (*see* fig. 3). Either the KR or the QR may be used in castling.

3. Notations.—In the descriptive notation (*see* fig. 5), each file is given the name of the piece originally posted on it, and the ranks are numbered from 1 to 8 away from the player. Each rank thus has a dual designation, according to the colour of the moving piece. A move is written in the form "P—QB4," the initial of the moving piece followed by the designation of the square moved to. The abbreviation "Kt" for knight is often replaced by "S" or "N." Indication of K-side or Q-side is omitted when no ambiguity would result; *e.g.*, "B—B4" when only one bishop can reach either of the B4 squares. The symbol "×" as in "P×P" indicates a capture and is read "takes." This notation was condensed in the middle of the 19th century from the earlier florid style; *e.g.*, "King's pawn to his fourth."

In the algebraic notation, the files are lettered A to H, from White's left to right. The ranks, from White to Black, are numbered 1 to 8. Each of the 64 squares thus has its own designation, a letter and a number. A move is written in the form "Pc2-c4," the initial of the moving piece followed by the square of departure and the square of arrival. The initial of the pawn, however, is usually omitted, as is also, in condensed style, the square of departure. The above move may be written as "c2 – c4" or even as "c4." Symbols used are as follows: (×) or (:) takes; (o-o) castles on K-side; (o-o-o) castles on Q-side; (†) or (+) check; (‡) or (#) checkmate; (!) best, or a good move; (?) questionable, or a poor move; (!?) is this best?



A B C

FIG. 2.—EN PASSANT

(A) Theoretical positions (right half of board). White's move. (B) White's pawn moves two squares (P–KB4). Dotted image indicates previous position. (C) Black captures White pawn *en passant* (P X P)

Game records are kept in columnar form, as below. White moves first, after which the players alternate in making one move at a time. The moves are numbered serially, both a White move and a Black reply having the same number.

Descriptive		Algebraic	
White	Black	White	Black
1 P — K4	P — K4	1 e2 — e4	e7 — e5
2 Kt — KB3	Kt — QB3	2 Sg1 — f3	Sb8 — c6
3 B — B4	B — B4	3 Bf1 — c4	Bf8 — c5
4 P — B3	Kt — B3!	4 c2 — c3	Sg8 — f6!
5 P — Q4	P × P	5 d2 — d4	e5 — d4:
6 P × P	B — Kt5ch	6 c3 — d4:	Bc5 — b4†

In annotation, moves are written linearly, thus: (descriptive) 1 P—K4, P—K4; 2 Kt—KB3, Kt—QB3; 3 B—B4, B—B4; 4 P—QKt4, B×P; 5 P—B3; (algebraic) 1 e4, e5; 2 Sf3, Sc6; 3 Bc4, Bc5; 4 b4, Bb4:; 5 c3. Occasionally, the descriptive notation is written in fractional form, the White moves being above the line and the Black moves below, thus:

$$1\ \frac{\text{P} - \text{K4}}{\text{P} - \text{K4}} \qquad 2\ \frac{\text{Kt} - \text{KB3}}{\text{Kt} - \text{QB3}}$$

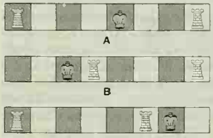


FIG. 3.—CASTLING

(A) Positions before castling; (B) castling with queen's rook; (C) castling with king's rook

In French and German, respectively, the names of the pieces are: king, *roi, König;* queen, *dame, Dame;* rook, *tour, Turm;* bishop, *fou, Läufer;* knight, *cavalier, Springer;* pawn, *pion, Bauer;* the game is chess, *les échecs, Schach.*

4. Object of Play.—The game is won by capturing the adverse king. The capture is never consummated; when the king is attacked and cannot escape, he is said to be checkmated and the game ends forthwith. Many games end by resignation of a player who sees that he cannot escape eventual defeat.

A threat to capture the adverse king is a check; a check must of course be averted or the game forfeited. The only ways of meeting a check are to move the king, capture the attacker or interpose on the line of check given by a distant queen, rook or bishop.

Check by discovery may be given by a long-range piece, by removal of a piece standing on a line between it and the adverse king. A piece that cannot move without discovering check upon its own king is said to be pinned. Even if completely immobilized by pin, a piece may exert check on the adverse king, for if the captures were actually consummated, the pinned piece would capture the adverse king one move ahead of the loss of its own king.

5. Value of the Pieces.—With only the kings otherwise left on the board, checkmate can be forced by a single major piece, queen or rook, or by two bishops, or by a bishop and a knight, but not by two knights or any single minor piece. (But a king accompanied by "officious friends," pawns that block rather than protect him, is sometimes mated by a single knight or bishop.) A single pawn cannot give mate, but wins if it can be promoted. Two rooks normally draw against a queen, and may win. Two bishops can draw against a queen. But a queen wins against one rook or two minor pieces including a knight. One minor piece draws against a rook.

With additional pieces on the board, however, any material superiority, even one pawn, spells potential victory. The superior fighting power can usually increase its own margin of advantage. In terms of the pawn as 1, the fighting power of the pieces is approximately: knight 3, bishop 3, rook 5, queen 9. This scale gives a measure of whether material equality is disturbed by an exchange of captures of unlike pieces. The phrase "winning the exchange" is applied particularly to winning a rook for a minor

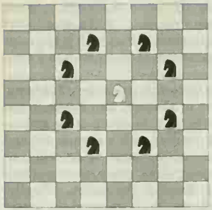


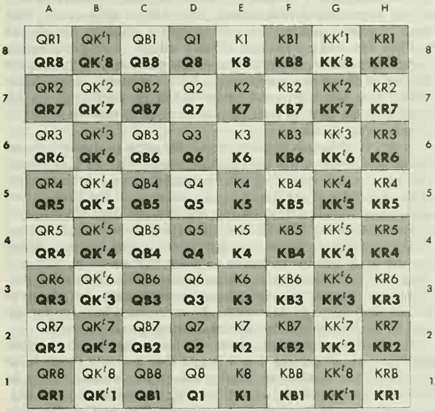
FIG. 4.—THE POSSIBLE MOVES OF A KNIGHT
The White knight may move onto any of the squares occupied by the Black knights

piece. Any such gain in relative power is potentially decisive. The more disparate the pieces exchanged, however, the more the outcome is affected by the particular position. For example, the merits of one rook *v.* five pawns cannot be stated in general, as there is no "general position." Positional considerations often override the abstract evaluations. Sacrifices of material are often made for positional advantage. The knight and bishop are rated equal, but a bishop is more favoured by the position than a knight, and two bishops are almost always stronger than two knights.

6. Drawn Games.—A game may be abandoned as drawn for any of the following reasons. Insufficient force: the pieces remaining on the board do not suffice to force checkmate. Stalemate: the player in turn to move has no legal move but is not in check. Perpetual check: a player demonstrates that he can check the adverse king without cessation, and declares that he will do so. Agreement: the players agree to abandon the game. Recurrence: if the same position of all forces recurs three times, with the same player to move on each occasion, that player may claim a draw. Fifty-move rule: when the player whose turn it is to move proves that at least 50 moves have been played by each side without a capture of a piece and without a pawn move's having been made. This number of 50 moves may be increased to an agreed total in certain positions provided that these have been laid down before the game (*e.g.*, it is possible to mate with two knights in 66 moves so long as the opponent has a pawn with which to avoid stalemate).

II. LAWS OF CHESS

All countries outside the orient follow the laws of chess as formulated by the World Chess federation (see *Fédération Internationale des Échecs*, below). These include not only the basic



	A	B	C	D	E	F	G	H	
8	QR1 **QR8**	QK^{t}1 **QK^{t}8**	QB1 **QB8**	Q1 **Q8**	K1 **K8**	KB1 **KB8**	KK^{t}1 **KK^{t}8**	KR1 **KR8**	8
7	QR2 **QR7**	QK^{t}2 **QK^{t}7**	QB2 **QB7**	Q2 **Q7**	K2 **K7**	KB2 **KB7**	KK^{t}2 **KK^{t}7**	KR2 **KR7**	7
6	QR3 **QR6**	QK^{t}3 **QK^{t}6**	QB3 **QB6**	Q3 **Q6**	K3 **K6**	KB3 **KB6**	KK^{t}3 **KK^{t}6**	KR3 **KR6**	6
5	QR4 **QR5**	QK^{t}4 **QK^{t}5**	QB4 **QB5**	Q4 **Q5**	K4 **K5**	KB4 **KB5**	KK^{t}4 **KK^{t}5**	KR4 **KR5**	5
4	QR5 **QR4**	QK^{t}5 **QK^{t}4**	QB5 **QB4**	Q5 **Q4**	K5 **K4**	KB5 **KB4**	KK^{t}5 **KK^{t}4**	KR5 **KR4**	4
3	QR6 **QR3**	QK^{t}6 **QK^{t}3**	QB6 **QB3**	Q6 **Q3**	K6 **K3**	KB6 **KB3**	KK^{t}6 **KK^{t}3**	KR6 **KR3**	3
2	QR7 **QR2**	QK^{t}7 **QK^{t}2**	QB7 **QB2**	Q7 **Q2**	K7 **K2**	KB7 **KB2**	KK^{t}7 **KK^{t}2**	KR7 **KR2**	2
1	QR8 **QR1**	QK^{t}8 **QK^{t}1**	QB8 **QB1**	Q8 **Q1**	K8 **K1**	KB8 **KB1**	KK^{t}8 **KK^{t}1**	KR8 **KR1**	1
	A	B	C	D	E	F	G	H	

FIG. 5.—DESCRIPTIVE AND ALGEBRAIC SYSTEMS OF NOTATION
The descriptive system names the file after the piece on the first rank, as the "KR file" at the extreme right. The ranks are counted away from the player whose piece moves. In the algebraic system the files are lettered A to H, from White's left to right, and the ranks are numbered 1 to 8 from White to Black. In diagrams the bottom edge is always the White side. Heavy type indicates system from White's side; lighter type is system as seen from Black's side

rules but the special regulations for official tournaments and matches. The more important of these regulations are as follows:

If he first warns his opponent, the player having the move is permitted to adjust one or more of the pieces. Except for this, if the player having the move touches one or more pieces, he must move or take the first piece he has touched which can be moved or taken. No penalty is entailed if the opponent makes no claim before himself touching a piece, or if none of the moves that are indicated above can legally be made.

A completed legal move may not be retracted. A move is completed: (1) in the case of transfer of a piece to a vacant square, when the player has taken his hand from the piece; (2) in the case of capture, when the captured piece has been removed from the chessboard and the player, having placed his own piece on its new square, has taken his hand from the piece; (3) in the case of castling, when the player, having moved the rook to the square crossed by the king, has taken his hand from the rook—when the player has taken his hand from the king, the move is not yet completed, but the player has lost the right to make any move other than castling; (4) in the case of promotion of a pawn, when the pawn has been removed from the chessboard and the player, having placed a new piece on the promotion square, has taken his hand from the piece—if the player has taken his hand from the pawn that has reached the promotion square, the move is not yet completed, but the player has lost the right of making a different move with the pawn.

If, during a game, it is found that an illegal move has been made, the position shall be restored to what it was before the illegal move was made; the game shall then continue, the player making a legal move with the piece that he touched when he made an illegal move. If it proves impossible to set up the correct position, the game shall be annulled and a fresh game played. If, in the course of a game, one or more of the pieces have been accidentally displaced and incorrectly replaced, the position shall be restored to what it was before the mistake and the game shall continue. If it proves impossible to set up the correct position, the game shall be annulled and a fresh game played.

If, in the course of a game, it is found that the initial position of the pieces was incorrect, the game shall be annulled. If, in the course of a game, it is found that the chessboard has been wrongly placed, the position that has been reached shall be transferred to a chessboard correctly placed and the game shall continue. If, after an adjournment (*see* below), the position has been set up incorrectly, it shall then be restored to what it was at adjournment and the game shall continue.

Each player must make a given number of moves in a given period of time; these two factors shall be specified in advance. Time is kept on each player by means of separate clocks. A player's clock is set going when it becomes his turn to move; he may stop it only after he has made his move. The White player's clock is started at the time scheduled for commencement of the game, regardless of whether both of the players are present.

If a game is not finished by the closing time for the session, it is adjourned. The player having the move takes what time he wishes for thought, writes his move on a slip of paper and seals it in an envelope which he hands to the referee; his clock is then stopped. At resumption of play, the referee adjusts the clocks, sets up the position as it was left at adjournment, opens the envelope, makes the indicated move and starts the opponent's clock.

A game is lost by a player who has not made the prescribed number of moves in the specified time; who arrives at the chessboard more than one hour late; who, after an adjournment, is found to have sealed an illegal move or a move so imprecise that it is impossible to establish its true meaning; or who, during the game, refuses to comply with the laws of chess. If both players arrive at the chessboard more than one hour late, or if both refuse to comply with the laws of chess, neither player shall receive any credit for this game; it shall be declared as lost by both of them.

III. HISTORY

1. Origin of Chess.—The invention of chess has been variously ascribed to the Greeks, Romans, Babylonians, Scythians, Egyptians, Jews, Persians, Chinese, Hindus, Arabians, Araucanians, Castilians, Irish and Welsh. Some have even tried to fix upon particular individuals as the originators of the game; among others, upon Japheth, Shem, King Solomon, the wife of Ravan, king of Ceylon, Xerxes, Palamedes, Aristotle, Semiramis, Zenobia, Attalus (d. *c.* 200 B.C.), the mandarin Han-sing, the Brahman Sissa and Shatrenscha, stated to be a celebrated Persian astronomer. Many of these ascriptions are fabulous, others rest upon little authority, and some of them proceed from easily traceable errors, as where the Roman games of *ludus latrunculorum* and *ludus calculorum*, both board games played with pieces of different values, the Welsh recreation of *tawlbwrdd* (throw-board) and the ancient Irish pastime of *fithcheall* are assumed to be identical with chess; so far as the Romans and Welsh are concerned, the contrary can be proved, while from what little is known of the Irish game it appears not to have been a sedentary game at all.

N. Bland, in his *Persian Chess* (1850), endeavoured to prove that the Persians were the inventors of chess, maintaining that the game, born in Persia, found a home in India, whence after a series of ages it was brought back to its birthplace. The view which has obtained the most credence, however, is that which attributes the origin of chess to the Hindus. Thomas Hyde of Oxford, writing in 1694 (*De ludis orientalibus*), seems to have been the first to propound this theory, but he appears to have been ignorant of the game itself, and the Sanskrit records were not accessible in his time. About 1783–89 Sir William Jones, in an essay published in the second volume of *Asiatic Researches*, argued that Hindustan was the cradle of chess, the game having been known there from time immemorial by the name of *chaturanga*, that is, the four *angas*, or members of an army, which are said in the Amara-kosha, a 4th-century vocabulary of Sanskrit roots, to be elephants, horses, chariots and foot soldiers. As applicable to real armies, the term *chaturanga* is frequently used by the epic poets of India. Sir William Jones's essay is substantially a translation of the Bhawishya purana, in which is given a description of a four-handed game of chess played with dice. A pundit named Rhadhakant informed him that this was mentioned in the oldest lawbooks, and also that it was invented by the wife of Ravan, king of Lanka (Ceylon), in the second age of the world in order to amuse that monarch while Rama was besieging his metropolis. This account claims for chess an existence of 4,000 or 5,000 years. Jones, however, grounded his opinions as to the Hindu origin of chess upon the testimony of the Persians and not upon the above manuscript, while he considered the game described therein to be more modern than the Persian game. Though sure that the latter came from India and was invented there, he admitted that he could not find any account of it in the classical writings of the Brahmans. He laid it down that chess, under the Sanskrit name *chaturanga*, was exported from India into Persia in the 6th century A.D.; that by a verbal corruption the old Persians changed the name into *chatrang*, but that when their country was soon afterward occupied by the Arabs, who had neither the initial nor final letter of the word in their alphabet, they altered it further into *shatranj*, which name found its way later into modern Persian and ultimately into the dialects of India.

H. J. R. Murray, in his monumental *History of Chess* (1913), came to the conclusion that chess is a descendant of an Indian game played in the 7th century.

Altogether, therefore, the best authorities agree that chess existed in India before it is known to have been played anywhere else. In this supposition they are strengthened by the names of the game and of some of the pieces. *Shatranj*, as the British orientalist Duncan Forbes, author of *The History of Chess* (1860), pointed out, is a foreign word among the Persians and Arabians, whereas its natural derivation from the term *chaturanga* is obvious. Again *al-fil*, the Arabic name of the bishop, means the elephant, otherwise *alephhind*, the Indian ox. The earliest authority on chess is Masudi, an Arabic author writing *c.* 950 who states that *shatranj* had existed long before his time.

2. Early and Medieval Times.—The dimness which shrouds the origin of chess naturally obscures also its early history. It has been seen that chess crossed over from India into Persia and became known in the latter country by the name of *shatranj*. Some have understood that word to mean "the play of the king"; but undoubtedly Sir William Jones's derivation carries with it the most plausibility. How and when the game was introduced into Persia there is no means of knowing.

The Persian poet Firdausi, in his historical poem the *Shahnama*, gives an account of the introduction of *shatranj* into Persia in the reign of Khosrau I Anushirvan (531–579), to whom came ambassadors from the sovereign of Hind (India) with a chessboard and men, asking him to solve the secrets of the game, if he could, or pay tribute. The king asked for seven days' grace, during which time the wise men vainly tried to discover the secret. Finally, the king's minister took the pieces home and discovered the secret in a day and a night. He then journeyed to India with a game of his own invention, *nard*, which the Indians could not reconstruct.

Other Persian and Arabian writers state that *shatranj* came into Persia from India, and there appears to be a consensus that may be considered to settle the question. Thus the game passed from the Hindus to the Persians and thence to the Arabs and from them, directly or indirectly, to various parts of Europe, at a time which cannot be definitely fixed, but which was either in or before the 10th century.

As to how chess was introduced into western and central Europe nothing is really known. The Spaniards very likely received it from their Muslim conquerors, the Italians not improbably from the Byzantines, and in either case it would pass northward to France, going on thence to Scandinavia and England. Some say that chess was introduced into Europe at the time of the crusades, the theory being that the Christian warriors learned to play it at Constantinople. This is negated by a curious epistle of St. Peter Damian (Pietro Damiani), cardinal bishop of Ostia, to Pope Alexander II written *c.* 1061, which, assuming its authenticity, shows that chess was known in Italy before the date of the first crusade. The cardinal, as it seems, had imposed a penance upon a bishop whom he had found diverting himself at chess; and in his letter to the pope he repeats the language he had held to the erring prelate, viz., "Was it right, I say, and consistent with thy duty, to sport away thy evenings amidst the vanity of chess, and defile the hand which offers up the body of the Lord, and the tongue that mediates between God and man, with the pollution of a sacrilegious game?" Among those who took an unfavourable view of the game may be mentioned John Huss (1369–1415), who, when in prison, deplored his having played at chess, whereby he had lost time and run the risk of being subject to violent passions.

Among authentic early records of the game may be quoted the *Alexiad* of the Byzantine princess Anna Comnena, in which she relates how her father, the emperor Alexius, used to divert his mind from the cares of state by playing at chess with his relatives. This emperor died in 1118.

Concerning chess in England there is the usual confusion between legend and truth. Snorri Sturluson relates that as Canute was playing at chess with Earl Ulf, a quarrel arose, which resulted in the upsetting of the board by the latter, with the further consequence of his being murdered in church a few days afterward by Canute's orders. The Ramsey Chronicle relates how Bishop Utheric, coming to Canute at night upon urgent business, found the monarch and his courtiers amusing themselves at dice and chess. There is nothing intrinsically improbable in this last narrative, except that the date is suspiciously early for chess, as Canute died in 1035. Moreover, allowance must be made for the ease with which chroniclers described other games as chess.

As regards the individual pieces, the king seems to have had the same move as at present, but it is said that he could formerly be captured. His castling privilege is a European invention; but he formerly leaped two and even three squares, and also to his Kt2. Castling dates no further back than the first half of the 16th century. The queen has suffered curious changes in name, sex and power. In *shatranj* the piece was called *farz* or *firz* (also *farzan*, *farzin* and *farzi*), signifying a "counselor," "minister" or "general." This was Latinized into *farzia* or *fercia*. The French slightly altered the latter form into *fierce*, *fierge* and, as some say, *vierge* ("virgin"), which, if true, might explain its becoming a female. Another and much more probable account has it that whereas formerly a pawn on reaching an eighth square became a *farzin* and not any other piece, which promotion was of the same kind as at draughts (in French, *dames*), so she became a *dame* or queen as in the latter game, and thence *dama*, *donna*, etc. There are old Latin manuscripts in which the terms *ferzia* and *regina* are used indifferently.

The queen formerly moved only one square diagonally and was consequently the weakest piece on the board. The immense power now possessed by her seems to have been conferred as late as about the middle of the 15th century. Thus under the old system the queens could never meet each other, for they operated on diagonals of different colours. The bishop's scope of action was also formerly very limited; he could move only two squares diagonally and had no power over the intermediate square, which he could leap over whether it was occupied or not. This limitation of his powers prevailed in Europe until the 15th century. This piece, according to Forbes, was called among the Persians *pil*, "elephant," but the Arabs, not having the letter *p* in their alphabet, wrote it *fil*, or with their definite article *al-fil*, whence *alphilus*, *alfinus*, *alifiere*, the latter being the word used by the Italians, while the French perhaps get their *fol* and *fou* from the same source. The pawns formerly could move only one square at starting; their powers in this respect were increased about the early part of the 16th century. It was customary for them on arriving at an eighth square to be exchanged only for a *farzin* (queen) and no other piece; the rooks (so called from the Indian *rukh* and Persian *rokh*, meaning "a soldier") and the knights appear to have always had the same powers as at present. As to the chessboards, they were uncoloured, and it is not until the 13th century that we hear of checkered boards being used in Europe.

3. Development in Play.—The change of *shatranj* into modern chess took place most probably first in France, and thence made its way into Spain early in the 15th century, where the new game was called *Axedrez de la dama*, being also adopted by the Italians under the name of *scacci alla rabiosa*. The time of the first important writer on modern chess, the Spaniard Ruy López de Sigura (1561), is also the period when the latest improvement, castling, was introduced, for his book, *Libro de la invencion liberal y arte del juego del Axedrez* ("Book of the Liberal Invention and Art of Playing Chess"), though treating of it as already in use, also gives the old mode of play, which allowed the king a leap of two or three squares. Shortly afterward the old *shatranj* disappeared altogether. López was the first who merits the name of chess analyst. At this time flourished the flower of the Spanish and Italian schools of chess—the former represented by Ruy López, Alfonso Ceron, Santa Maria, Busnardo and Carlos Avalos, the latter by Giovanni Leonardo da Cutri (Il Puttino) and Paolo Boi (Il Syracusano). In the years 1562–75 both Italian masters visited Spain and defeated their Spanish antagonists. During the whole 17th century there was but one worthy to be mentioned, Gioachino Greco (Il Calabrese).

The middle of the 18th century inaugurated a new era in chess. The leading man of this time was Philidor (real name Francois André Danican; 1726–95). He was trained by M. de Kermar, sieur de Légal, the star of the Café de la Régence in Paris, which was the centre of French chess until early in the 20th century. In 1747 Philidor visited England and defeated the Arabian player, Phillip Stamma, by 8 games to 1 and 1 draw. In 1749 he published his *Analyze des échecs*, a book which went through more editions and was more translated than any other work upon the game. During more than half a century Philidor traveled much but never went to Italy, the only country where he could have found opponents of first-rate skill; for instance, Ercole del Rio, G. B. Lolli and D. L. Ponziani.

Blindfold chess play, already exhibited in the 11th century by Arabian and Persian experts, was taken up afresh by Philidor, who played on many occasions three games simultaneously without sight of board or men. These exhibitions were given in London, at the Chess club in St. James's street.

As eminent players of this period must be mentioned Count P. J. van Zuylen van Nyevelt (1743–1826) and the German player Johann Allgaier (1763–1823), after whom a well-known brilliant variation of the king's gambit is named. Philidor was succeeded by A. L. H. Lebreton Deschapelles (1780–1847), who was also a famous whist player. The only player who is known to have fought Deschapelles not unsuccessfully on even terms is John Cochrane. When he lost a match (1821) to William Lewis, Deschapelles had conceded the odds of "pawn and move," the Englishman winning one and drawing the two others. Deschapelles's greatest pupil, and one of the strongest players France ever possessed, was L. C. Mahé de la Bourdonnais (1797–1840). His most memorable achievement was his contest with the English champion Alexander Macdonnell, the French player winning in the proportion of 3 to 2.

The English school of chess began about the beginning of the 19th century, and J H. Sarratt was its first leader. He flourished until 1820 and was followed by his great pupil W. Lewis (1787–1870). Macdonnell (1798–1835) has been already mentioned. To the same period belong also Capt. W. D. Evans, the inventor in 1824 of the "Evans gambit" (White 4 P — QKt4 instead of P — B3 in the standard opening illustrated in *Notations*, above), who died at an advanced age in 1872; George Perigal (d. 1854), who played in the correspondence matches against Edinburgh and Paris; George Walker (1803–79), chess editor of *Bell's Life* from 1835 to 1873; and Cochrane (1798–1878), who met every strong player from Deschapelles down. In the same period Germany possessed but one good player, Julius Mendheim of Berlin.

The fifth decade of the 19th century is marked by the fact that the leadership passed from the French school to the English. After the death of La Bourdonnais, P. C. Fournié de Saint-Amant became the leading player in France; he visited England in the early part of 1843 and successfully met the best English players, including Howard Staunton; but the latter soon took his revenge, for in Nov. and Dec. 1843 a great match between Staunton and Saint-Amant took place in Paris, the English champion winning by 11 games to 6 with 4 draws. During the succeeding eight years Staunton maintained his reputation by defeating H. W. Popert, Bernard Horwitz and D. Harrwitz. Staunton was defeated by Adolf Anderssen (1818–79) at the London tournament in 1851, and this concluded his career.

In the ten years 1830–40 a new school arose in Berlin, the seven leaders of which have been called "the Pleiades." These were Ludwig Bledow (1795–1846), P. R. von Bilguer (1815–40), W. Hanstein (1810–50), C. Mayet (1810–68), K Schorn (1802–50), Horwitz (1809–85) and T. von Heydebrand und der Lasa, afterward Prussian (and later German) minister at Copenhagen. As belonging to the same period must be mentioned the three Hungarian players V. Grimm, J. Szen and J. Löwenthal.

Among the great masters since the middle of the 19th century, Paul Morphy (1837–84), an American, has seldom been surpassed as a chess player. His career was short but brilliant. Born in New Orleans, La., he was taught chess by his father when only ten years of age, and in two years' time became a strong player. When not quite 13 he played three games with Löwenthal and won two of them, the other being drawn. Competing in the New York city congress of 1857, he won the first prize. In 1858 he visited England and there defeated S. S. Boden, G. W. Medley, A. Mongredien, the Rev. John Owen, H. E. Bird and others. He also beat Löwenthal by 9 games to 3 and 2 draws. In the same year he played a match at Paris with Harrwitz, winning by 5 to 2 and 1 drawn; later he obtained a victory over Anderssen. On two or three occasions he played blindfolded against eight strong players simultaneously, each time with great success. He returned to the U.S. in 1859 and continued to play, but with decreasing interest in the game, until 1866.

Wilhelm Steinitz (1836–1900) took the sixth prize at the London congress of 1862. He defeated J. H. Blackburne (1841–1924) in a match by 7 to 1 and 2 draws. In 1866 he beat Anderssen in a match by 8 games to 6. He carried off the first prize in the British Chess association handicap in 1868 and in the London grand tourney in 1872, also defeating J. H. Zukertort in a match by 7 games to 1 and 4 draws. In 1873 he carried off the first prize at the Vienna congress; and in 1876 he defeated Blackburne, winning seven games right off.

In Philidor's age it was considered almost incredible that he should be able to play three simultaneous games without seeing board or men, but Louis Paulsen, Blackburne and Zukertort often played 10 to 12 such games, while as many as 28 and 29 were so played by Alexander Alekhine (*q.v.*) and Richard Réti, respectively, in 1925. Again, Alekhine played 32 in 1933, and Georges Koltanowski played 34 in 1937. Then, in 1943, Miguel Najdorf exceeded all performances with 40 at Buenos Aires, and in 1947 he played 45 at São Paulo.

In 1876 England was in the van of the world's chess army. English-born players then were Boden, Amos Burn, Macdonnell, Bird, Blackburne and William Norwood Potter; while among naturalized English players were Löwenthal, Zukertort (who died in 1888), Horwitz and Steinitz (who in 1883 moved to the U.S. and became a citizen there). This predominance passed into the hands of the German chess masters toward the end of the century when such great figures as Emanuel Lasker, the world champion, and Siegbert Tarrasch, even greater as theorist than as player, were the world's leading exponents.

Germany and the central European countries held the leading place until the 1930s when this supremacy was challenged by the United States which, in the period 1931–37, won all four of the scheduled international team tournaments (see *Fédération Internationale des Échecs*, below). Meanwhile, the U.S.S.R., under the stimulus of powerful state aid, developed a vast quantity of outstanding players such as Mikhail Botvinnik, Vassily Smyslov, David Bronstein, Alexander Kotov and Isaac Boleslavsky. By 1945 the U.S.S.R. was clearly the strongest chess-playing country, and this was confirmed by its defeating the U.S. in a radio match by the overwhelming score of 15½–4½. Following this, the U.S.S.R., with the addition of such players as E. Geller, T. Petrosian, M. Taimanov, B. Spassky and M. Tal, easily kept its predominance.

4. The World Championship.—The strongest players of their time, regarded therefore by later generations as "world champions," were: 1747–95, Philidor, France; 1815–20, Deschapelles, France; 1820–40, La Bourdonnais, France; 1843–51, Staunton, England; 1851–58, Anderssen, Germany; 1858–59, Morphy, United States; 1862–66, Anderssen, Germany. In 1866 Anderssen was defeated in a match by Steinitz of Austria, who then laid claim to the title "world champion"—rightly, for he was undoubtedly the strongest player of his day. Steinitz successfully defended his title in formal matches against Blackburne, Zukertort, M. I. Tchigorin (twice) and Isidor Gunsberg. His reign of 28 years was brought to a close in 1894, when he was defeated by a young German player, Emanuel Lasker.

Lasker held the title almost as long as Steinitz, whom he defeated again in a return match two years later. Other challengers who failed were Frank Marshall, Tarrasch, David Janowski and Carl Schlechter. Recognized as the logical challenger from *c.* 1914 on was José Raoul Capablanca of Cuba, but a match was not arranged until 1921. With Capablanca leading 4–0, and 10 draws, Lasker resigned the championship. Capablanca held the title for six years. In 1927 he lost it to Alekhine in a struggle lasting nearly three months, at Buenos Aires. The score was 6–3, with 25 draws, the longest title match up to that time.

Alekhine, a Russian who acquired French citizenship, was defeated in 1935 by Max Euwe of the Netherlands, by the score of 9–8 with 13 draws. Two years later he regained the title in a return match, winning 11–6 with 13 draws. Alekhine twice defeated Ewfim Bogoljubow in challenge matches, 1929 and 1934. The death of Alekhine in 1946 left the title vacant.

Then the World Chess federation (*see* below) took charge of affairs. It organized a match tournament between five contenders for the title out of which Botvinnik of the U.S.S.R. emerged as a decisive winner with 14 points, followed by Smyslov (U.S.S.R.) with 11, Samuel Reshevsky (U.S.A.) and Paul Keres (U.S.S.R.) with 10½ each and Euwe (Netherlands) with 4.

Up to this period the world championship had been a somewhat haphazard contest in which the holder of the title was allowed to choose his own opponent and was as like as not to refuse playing the rightful contender. But the World Chess federation proceeded to hold a three-year cycle of tournaments in order to select the best candidate. In the first year zonal tournaments were held all over the world; in the next, an interzonal event including the leading players from the zonal tournaments; and in the third year a candidates' tournament the winner of which played a challenge match with the world champion for the title. In 1950 Bronstein won the candidates' tournament at Budapest, but Botvinnik successfully defended his title by drawing a match with his challenger in 1951 in Moscow. In 1953 Smyslov was the winner of a candidates' tournament at Zürich, and in the following year once again Botvinnik drew his match. In 1956 Smyslov won the tournament at Amsterdam and in 1957 also won the match with Botvinnik and became the new world champion. Botvinnik regained the championship in 1958, lost to Mikhail Tal, 23-year-old Latvian, in 1960 and again regained it in 1961. In 1958, 14-year-old Robert Fischer, U.S. open chess champion, won the U.S. national tourney, with Samuel Reshevsky runner-up.

Two other world championship events were organized by the World Chess federation—the women's world championship and the junior world championship (for players under 21). Vera Menchik had been the regular winner of the women's title before World War II but was killed in a bombing raid in England. After the war a cycle similar to that determining the male championship was organized and the two holders of the championship were both Russian: Ludmila Rudenko won the title in Jan. 1950 and lost it in a match to Elisaveta Bykova by the score of 6–8 in 1953. The first holder of the junior title was B. Ivkov (Yugoslavia) who won a tournament held at Birmingham in 1951. In 1953 the junior world champion was O. Panno (Argentina), in 1955 B. Spassky (U.S.S.R.), in 1957 W. Lombardy (U.S.) and in 1959 C. Bielicki (Argentina).

5. Fédération Internationale des Echecs.—The World Chess federation (or F.I.D.E. as it is usually known after the French initials) is an international chess organization to which all countries in Europe and nearly all countries in North and South America are affiliated. It controls all world chess events and is in charge of the enunciation and revision of the rules of the game.

Every year the federation holds a congress to discuss international affairs, at which a delegate from each affiliated country attends. Once every two years an international team tournament is held under F.I.D.E. auspices, with each country represented by a team of four players with two reserves. At the first tournament of this kind, held in London in 1927, the three leading teams were (1) Hungary, (2) Denmark and (3) Great Britain.

International Team Tournaments

Year	Where held	First	Second	Third
1927 . .	London	Hungary	Denmark	Great Britain
1930 . .	Hamburg	Poland	Hungary	Germany
1931 . .	Prague	U.S.	Poland	Czechoslovakia
1933 . .	Folkestone	U.S.	Czechoslovakia	Sweden
1935 . .	Warsaw	U.S.	Sweden	Poland
1937 . .	Stockholm	U.S.	Hungary	Poland
1939 . .	Buenos Aires	Germany	Poland	Estonia
1950 . .	Dubrovnik	Yugoslavia	Argentina	Germany
1952 . .	Helsinki	U.S.S.R.	Argentina	Yugoslavia
1954 . .	Amsterdam	U.S.S.R.	Argentina	Yugoslavia
1956 . .	Moscow	U.S.S.R.	Yugoslavia-Hungary (tied)	
1958 . .	Munich	U.S.S.R.	Yugoslavia	Argentina
1960 . .	Leipzig	U.S.S.R.	U.S.	Yugoslavia

International team tournaments were not held during World War II.

6. Literature.—The literature of chess is extensive; indeed, it has been calculated that the total number of books on chess exceeds that on all other games put together. Probably the systems of notation that enable one to record games accounts for this.

However, the most celebrated of the earlier works purporting to be about chess, that of the Dominican friar Jacobus de Cessolis (13th century), is really a moralization that uses chess for its argument. This was translated into English under the title of *The Game and the Playe of Chesse* and printed by William Caxton in 1474. Shortly afterward appeared the first important contribution to chess theory by Luis Ramirez de Lucena, a Spaniard whose work on the end game remains valid to this day. He was followed in the next century by Damiano (Damiano da Odemira), Ruy López and G. C. Polerio, their chief contribution being to opening theory.

In the 17th century the books by Alessandro Salvio, Gustavus Selenus and Greco were the most popular, in particular the last named; and again the emphasis was on the openings. By the 18th century the number of chess books was increasing considerably, and the names of Stamma, Carlo Cozio, Lolli and Ponziani all have an honoured place in the list. But the most important of all, possibly the most important of all time, was that of Philidor, whose influence on the theory of the game can hardly be overestimated. His *Analyze des échecs* (1749), and the numerous editions of the work that followed, contain truths that in some respects anticipated many modern discoveries.

The early decades of the 19th century were dominated first by such English writers as Sarratt and Lewis and then by the Germans Bilguer and Heydebrand und der Lasa. The works of Staunton, *The Chess Player's Handbook* (1847), *The Chess Player's Companion* (1849) and *Chess Praxis* (1860), achieved great popularity and remained standard textbooks until the 20th century.

The advent of modern theory was marked by Steinitz' *Modern Chess Instructor*, 2 vol. (1889–95). Also important were a number of works by James Mason, notably *The Art of Chess* (1895). The theories of Steinitz were further elucidated and popularized by Lasker (*Common Sense in Chess*, 1896) and by Tarrasch (*Dreihundert Schachpartieen*, 1895). The reaction to all this came in the writings of the school of the hypermoderns such as Réti, Aron Nimzowitsch and S. Tartakower in the early 20th century (see *Bibliography* below for specific instances). From the 1920s books on chess have appeared in ever-increasing profusion.

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IV. THEORIES OF PLAY

One of Philidor's contributions was to draw attention to the importance of pawns as fighting units. He formulated the classic pattern of attack against the castled king—the advance of pawns to break up the pawns sheltering the enemy king and so open lines for the infiltration of pieces. The hundred years after the publication of his *Analyze des échecs* saw the discovery of myriad permutations of the so-called "direct attack" and the rise of great masters of combination play, culminating in Anderssen. (See *Illustrative Game No. 1.*) By "combination" is understood the calculation of specific variations of play, in search of a way to force a more or less immediate decision.

The characteristic of the games of this era was the sacrifice, and the dominating motive was the desire to attack as quickly as possible. The analysis of openings was largely concerned with gambits—sacrifices of pawns, sometimes of pieces, made to precipitate rapid contact with the enemy. Some even held that the Evans gambit was the only debut worthy of a gentleman, since this opening is particularly apt to lead to a slugging contest.

In 1858–59 Morphy created a sensation by trouncing all the masters who would meet him. His play introduced a new note, one that even today is basic in the teaching of beginners. Although second to none in combinative skill, Morphy delayed attacking until he had completed his development. By simply bringing out his knights and bishops, posting the queen safe from harassment and castling, Morphy repeatedly achieved a won game after a dozen moves.

So effective was this procedure against the current fashion of attacking prematurely that it crystallized into a formula: move each centre pawn once, each bishop and knight once, get the queen off the back row, castle—before moving any piece a second time. The task of developing is not actually so easy: the opponent exerts threats that have to be parried. But it remains true that any relative loss of time in the opening can lead to a quick catastrophe. (See *Illustrative Game No. 2.*)

Rapid development, combinative attack—these principles seemed to be all-embracing and all-sufficient. Then came the pugnacious Austrian, Steinitz, whose play often violated classic principles. Yet with it he was able to win the world championship and to hold it longer than any other player. Steinitz lived to influence the theory of play more profoundly than any other player. His theories, at first seemingly antithetical to classic principles, were presently seen to be supplementary.

Steinitz started from the premise that there is no combination without positional advantage. That is, a specific winning sequence of moves cannot be found if there is no superiority on which to base it. The player should therefore concern himself primarily with analyzing the position to detect its points of strength and weakness. On this score, Steinitz contributed a great deal of analysis on the nature of weaknesses and the specific meaning of permanent as opposed to transient weaknesses. The objective of play, he said, is to gain a decisive positional superiority by "the accumulation of small advantages." An adverse weakness must be "nursed" and magnified until it becomes fatal; then the combination will spring of itself from the position. (See *Illustrative Game No. 3.*)

In pursuit of local advantages, Steinitz often moved the same piece several times in the opening before completing his development. He demonstrated that the demands of the "close" game are somewhat different from those of the "open" game. It is indeed necessary to develop rapidly if centre pawns are exchanged early, opening lines of attack. But a slower development is feasible if the centre is kept closed; here it is often more important to get a single piece to its most effective post than to move all the pieces off the back row. Especially in his later years, Steinitz preferred to maneuver behind the lines before breaking the centre, so as to gain the maximum advantage from the break when it came. (See *Illustrative Game No. 4.*) This "hedgehog" policy forced upon him the necessity of defending accurately and economically against attack by a more developed opponent, and his games are instructive for the resources of defense. Steinitz was never so happy as when sustaining a furious onslaught upon his king; not fearing such attacks, he would accept all gambits. He said "When in doubt, take a pawn" and "A pawn is worth a little trouble."

The slow tempo of the Steinitz campaign was not for every taste, and it remained for Tarrasch to show how to quicken it and open lines for direct attack without relinquishing vital positional advantages. Tarrasch made great contributions to the theory. In play as well as in writings he showed how positional weaknesses may be forced upon a player if he commands less terrain than his opponent. He formulated the theory of the centre. The opening, he said, is to be understood as a fight for control of the squares d4, d5, e4, e5 (Q4, Q5, K4, K5). A piece standing in the centre has its maximum range, and the centre is the vital avenue of communication between the wings of the army. At first the centre must be controlled by pawns, to prevent its occupation by adverse pieces. The player who controls the greater number or the more advanced of central squares has an advantage. (See *Illustrative Game No. 6.*)

A consequence of the Steinitz-Tarrasch analysis was that the opening 1 P–K4 came to be played much less in master tournaments, in favour of 1 P–Q4. The latter is the more likely to lead to a close game. The growing body of knowledge of opening variations tends to indicate that White retains the advantage of the first move longer in a close than in an open game. The queen's gambit (sacrifice of a pawn for advantage of position) came to be a dreaded weapon. It was said, half-jocularly, that "After 1 P–Q4, Black's game is in its last throes." However, Black's prospects brightened in the 20th century with the discovery of several new defensive systems.

In 1913 a young Russian master, Nimzowitsch (1886–1935), published articles assailing some of the cardinal points of the Tarrasch creed. After World War I he published *Mein System* and other books expounding certain ideas, as "centralization," "overprotection," "the homeopathic process." In definition these ideas do not seem to be out of the Steinitz-Tarrasch tradition, but their realization sometimes involves moves condemned by it. Nevertheless, Nimzowitsch achieved some notable tournament successes and carried the Tarrasch principle of constraint to the extraordinary length of complete blockade. (See *Illustrative Game No. 7.*) A curious conclusion is that, while the actual advance of a pawn wing may prove weakening, the mere inability to advance it at will is a positive weakness, often of decisive moment.

Nimzowitsch is credited with founding the self-styled hypermodern school, of which the avowed exponents were Tartakower, Réti and Bogoljubow. Réti (d. 1929) stated the principle of this school to be: "The golden rule is that there is no golden rule." Thus, any attempt to formulate its further principles is interdicted! In practice, the hypermoderns often go to great lengths to avoid releasing the tension in the centre, or even advancing the centre pawns at all, until pieces have been brought to bear upon it. This often involves the fianchetto (moving the pawn from Kt2 to open a path for the bishop) of one bishop or both. (See *Illustrative Game No. 8.*)

The hypermoderns claim Capablanca and Alekhine as exponents of hypermodern play, although both these world champions repudiated any conscious adherence. The Alekhine defense is cited as an example of relying on the evaluation of a particular position rather than upon general principles. After 1 P–K4, Kt–KB3; 2 P – K5, Kt – Q4; 3 P – QB4, Kt – Kt3; 4 P – Q4, White has three pawns in the centre, one being on the fifth rank, while Black has developed only a knight. By all classical precept, Black has wasted valuable time. Yet it has been abundantly demonstrated that, if White is not careful, his advance pawns will prove to be not an advantage but a liability.

While acknowledging the basic truths of the theory of the hypermodern school neither Capablanca nor Alekhine ever went so far as Nimzowitsch, Réti or Tartakower in their disavowal of the classical precepts of Tarrasch. In fact, these two great world champions pursued their own courses with a confidence in their genius that was fully justified by results. Capablanca was the more classically serene (see *Illustrative Game No. 9*), while Alekhine's colourful imagination produced a bewildering number of masterpieces (see *Illustrative Game No. 10*).

By 1930 the theories of the hypermoderns had become commonly accepted by the average master, and for the next 20 years a style was developing that reflected Capablanca's influence in its striving after perfection in technique and Alekhine's in its openings. The Russian school tended to follow Alekhine, but some members of it also consciously strove after a return to the methods of the great Russian master of the 19th century, Tchigorin. Tchigorin's influence is clearly present in the games of Botvinnik; together with a marked depth of strategy that was that world champion's particular contribution to 20th-century style in chess. (See *Illustrative Game No. 11.*)

It should always be remembered that, while schools may pass and fashions come and go, fundamental positional truths remain the same throughout the centuries. (See *Illustrative Game No. 12.*)

V. ILLUSTRATIVE GAMES

Illustrative Game No. 1.—Anderssen (1818–79) won first place in the first modern international tournament, London, 1851. His games are memorable for their slashing attacks and combinative brilliance. The famous game below was dubbed the "Immortal Partie."

White Anderssen	Black Kieseritzki	White Anderssen	Black Kieseritzki
1 P – K4	P – K4	13 P – R5	Q – Kt4
2 P – KB4	P × P	14 Q – B3	Kt – Kt1 (*c*)
3 B – B4	P – QKt4	15 B × P	Q – B3
4 B × KtP	Q – R5ch	16 Kt – B3	B – B4 (*d*)
5 K – B1	Kt – KB3	17 Kt – Q5	Q × P (*e*)
6 Kt – KB3	Q – R3	18 B – Q6 (*f*)	B × R
7 P – Q3	Kt – R4 (*a*)	19 P – K5	Q × Rch
8 Kt – R4	P – QB3	20 K – K2	KT – QR3 (*g*)
9 Kt – B5	Q – Kt4	21 Kt × Pch	K – Q1
10 P – KKt4	Kt – B3	22 Q – B6ch	Kt × Q
11 R – Kt1 (*b*)	P × B	23 B – K7 mate	
12 P – KR4	Q – Kt3		

(*a*) Threatening Kt – Kt6ch. But this light-horse attack is backed by insufficient means. Black should have made a developing move, as B – Kt2 or even B – R3. (*b*) Commencing a combination based on the precarious position of the Black queen. (*c*) The only move to save the queen. (*d*) Perhaps better was B – Kt2 to keep out the terrible knight. But there is no move to parry all of White's threats. (*e*) Staying on the diagonal to defend KKt2. (*f*) The key move of the combination. Now if 18 . . . Q × Rch; 19 K – K2, Q × R then 20 Kt × Pch, K – Q1; 21 B – B7 mate. Or if 18 . . . B × B; 19 Kt × Bch, K – Q1 then 20 Q × P and mate cannot be averted. (*g*) To prevent the mate given in note (*f*).

Illustrative Game No. 2.—When Morphy went to Europe in 1858 he met some unpleasant experiences with European masters jealous of their laurels. But Anderssen came out of retirement to play and lose a match to him in 1859 and was generous in praise of the American genius. The following game was the seventh of the match.

White Morphy	Black Anderssen	White Morphy	Black Anderssen
1 P – K4	P – Q4	14 Q × Kt	Q × B
2 P × P	Q × P	15 B – Q3 (*f*)	B – Kt5
3 Kt – QB3	Q – QR4	16 Kt – Kt5 (*g*)	KR – Q1
4 P – Q4	P – K4	17 Q – Kt4 (*h*)	B – B1
5 P × P	Q × Pch	18 KR – K1	P – QR4
6 B – K2	B – QKt5	19 Q – K7	Q × Q
7 Kt – B3 (*a*)	B × Ktch	20 R × Q (*i*)	Kt – Q4
8 P × B	Q × Pch	21 B × Pch	K – R1 (*j*)
9 B – Q2	Q – B4 (*b*)	22 R × KBP	Kt – B6
10 R – QKt1 (*c*)	Kt – QB3	23 R – K1	Kt × P
11 Castles	Kt – B3	24 R – B4	R – R3
12 B – KB4	Castles (*d*)	25 B – Q3	Resigns
13 B × P (*e*)	Kt – Q5		

(*a*) He could save the pawn and also develop by B – Q2, but he is perfectly willing to let Black waste further time to win it. (*b*) Black has won a pawn but lost the game. (*c*) Threatening B – Kt4 and also holding back the Black QB. (*d*) Giving back the pawn in order to get his king to safety. If 12 . . . Kt — Q4 then 13 R — Kt5 wins a piece. (*e*) More than regaining his pawn, for now he threatens B — Q6. (*f*) White's advantage is greater than it may seem. He has the "good" bishop for a K-side attack, while Black's "bad" bishop cannot even be moved out to release the QR. Black indeed tries to develop it, but the effort is quickly refuted. (*g*) Threatening 17 Kt × RP, Kt × Kt; 18 Q × B. (*h*) Maintaining the threat and also attacking the QKtP. To avoid immediate loss of a pawn Black is forced to retreat his bishop. (*i*) The exchange of queens has brought Black no relief. Useless to defend the KBP is 20 . . . R — B1, for then 22 Kt × BP, R × Kt; 23 B — B4 wins the exchange. (*j*) Forced, for if K — B1 then 22 R × Pch, K — K1; 23 R — K1ch leads to mate.

Illustrative Game No. 3.—In 1885 Zukertort and Steinitz met in the first official match for the world's championship. Since Steinitz had become a resident of the United States, the match was played in New York, St. Louis and New Orleans. Steinitz won it by a score of 10–5, with 5 draws.

White Steinitz	Black Zukertort	White Steinitz	Black Zukertort
1 P — K4	P — K4	18 Kt — Kt3	B — K3
2 Kt — KB3	Kt — QB3	19 R — K1	Kt — Kt2
3 B — Kt5	Kt — B3	20 P — KR4 (*e*)	Q — Q2
4 Castles	Kt × P	21 P — R5	B — B2
5 R — K1	Kt — Q3	22 P × P	B × P!
6 Kt × P	Kt × Kt	23 Q — K3	K — B2
7 R × Ktch	B — K2	24 Q — B4	R — K1
8 Kt — B3	Castles	25 R — K3	Kt — K3 (*f*)
9 B — Q3	B — B3	26 Q — KKt4	Kt — B1
10 R — K3	P — KKt3 (*a*)	27 Kt — B5	B — B4
11 P — QKt3	R — K1	28 Kt — R6ch	K — Kt2
12 Q — B3	B — Kt4 (*b*)	29 B × B (*g*)	Q × Q
13 R × Rch	Kt × R	30 Kt × Q	R × R
14 B — Kt2	P — QB3	31 BP × R	Kt × B
15 Kt — K4 (*c*)	B — K2	32 Kt × P (*h*)	
16 Q — K3	P — Q4	White won	
17 Q — Q4 (*d*)	P — B3		

(*a*) According to Steinitz, the K-side pawns when under attack should not be moved unless there is no alternative. In his notes to this game he states that he considered this move a deliberate challenge to his theory. (*b*) Manifestly antipositional. The bishop is vitally needed at Kt2 to protect the holes in the pawn structure. (*c*) Nailing down the weakness of Black's KB3. (*d*) To force the following advance, which is a further weakening of the pawn wing. (*e*) An attacking move seen in many Steinitz games, made to loosen up the compromised pawns still further. (*f*) "From the 14th move until this moment Black, on the defense, has played good chess. Now White has no immediate threats and Black . . . is thrown on his own initiative . . . he has to originate a plan. But that is exactly what Zukertort did not understand . . . His right plan was to keep attention riveted on his weak points KB4, QB4 and KB3, and . . . work towards a draw by exchanging perilous pieces . . ." (Emanuel Lasker, *Manual of Chess*, new ed., David McKay Co., Inc., New York, 1947). (*g*) Actually, Steinitz checked with the knight several times, to gain time, before making this move. (*h*) "All" that Steinitz has to show for his exertions is the win of a pawn. But this is enough to win the ending.

Illustrative Game No. 4.—Before completing his development, Steinitz moves his QKt three times, only to exchange it a few moves later. His games are full of such long-winded maneuvers, in pursuit of modest but lasting positional advantages. Observe how carefully he refrains from P—Q4 until the move is decisive.

Havana, 1892

White Steinitz	Black Tchigorin	White Steinitz	Black Tchigorin
1 P — K4	P — K4	16 B — Kt3 (*i*)	Q — B3
2 Kt — KB3	Kt — QB3	17 Q — K2	B — Q2
3 B — Kt5	Kt — B3	18 B — K3	K — R1
4 P — Q3 (*a*)	P — Q3	19 Castles (Q)	QR — K1
5 P — B3 (*b*)	P — KKt3 (*c*)	20 Q — B1 (*j*)	P — QR4
6 QKt — Q2	B — Kt2	21 P — Q4 (*k*)	P × P
7 Kt — B1	Castles	22 Kt × P	B × Kt
8 B — QR4 (*d*)	Kt — Q2	23 R × B!	Kt × R
9 Kt — K3 (*e*)	Kt — B4	24 R × Pch! (*l*)	K × R
10 B — B2	Kt — K3 (*f*)	25 Q — R1ch	K — Kt2
11 P — KR4 (*g*)	Kt — K2	26 B — R6ch	K — B3
12 P — R5	P — Q4 (*h*)	27 Q — R4ch	K — K4
13 RP × P	BP × P	28 Q × Ktch	K — B4
14 P × P	Kt × P	29 Q — B4 mate	
15 Kt × Kt	Q × Kt		

(*a*) At variance from the then fashionable practice of playing P — Q4 as soon as possible. (*b*) This pawn formation was frequently adopted by Steinitz after 1 P — K4. Its object is only remotely to enforce P — Q4; the primary purpose is to neutralize any effort by Black to break the centre. (*c*) The king's fianchetto was formerly much played against the Ruy Lopez, but it has dropped out of master practice as a result of Steinitz' victories against it. (*d*) Another of Steinitz' innovations was this maneuver B — Kt5 — R4 — B2 to preserve the KB, "the thorn of the Ruy Lopez." (*e*) The virtue of this post is that it discourages 9 . . . P — B4, for after 10 P × P Black could not retake with the rook, and so keep the file open. (*f*) Again P — B4 would be premature; *e.g.*, 11 P × P, B × P; 12 Kt × B, R × Kt?; 13 P — Q4. (*g*) This typical Steinitz attack is the more powerful since he has delayed castling and still has his rook on the file. (*h*) "The logical reaction against a wing advance is a break in the centre." Black expects to profit from opening lines against his "undeveloped" opponent. (*i*) But it is White who profits. To avoid the opening of the diagonal upon his king, Black might have tried 13 . . . RP × P but then would have had to reckon with an attack on the open KR file. (*j*) Meeting the immediate threat of Kt — B5. But the move also has a subtle attacking purpose. (*k*) This long-delayed advance is now devastating. Black can scarcely avoid the exchanges that follow, because of the awkward situation of his queen, knight and QB. (*l*) An unpleasant surprise. After 24 B × Ktch, R — B3 Black could still put up a defense.

Illustrative Game No. 5.—Though Lasker was a follower of Steinitz, he regarded a chess game as being primarily a struggle. It has been said that he made moves which he knew to be inferior if they helped him to arrive at those tense and complicated positions in which he was supreme. He himself did not confirm this, but the will to win and the coolness and resourcefulness under fire which he showed in such games as the following tend to make this statement plausible.

Cambridge Springs, 1904

White Lasker	Black Napier	White Lasker	Black Napier
1 P — K4	P — QB4	19 B — B5	P × RP (*h*)
2 Kt — QB3	Kt — QB3	20 B — B4	P × P (*i*)
3 Kt — B3	P — KKt3	21 B × P	Kt — K5
4 P — Q4	P × P	22 B × R	B × P
5 Kt × P	B — Kt2	23 R — QKt1	B — B6ch
6 B — K3	P — Q3	24 K — B1	B — KKt5 (*j*)
7 P — KR3 (*a*)	Kt — B3	25 B × KRP (*k*)	B × B
8 P — KKt4	Castles (*b*)	26 R × B	Kt — Kt6ch
9 P — Kt5	Kt — K1	27 K — Kt2	Kt × R
10 P — KR4	Kt — B2	28 R × P	P — R4
11 P — B4	P — K4	29 R — Kt3	B — Kt2
12 Kt(4) — K2	P — Q4 (*c*)	30 R — KR3	Kt — Kt6
13 KP × P	Kt — Q5	31 K — B3	R — R3
14 Kt × Kt	Kt × P (*d*)	32 K × P	Kt — K7ch
15 Kt — B5 (*e*)	Kt × Kt	33 K — B5	Kt — B6
16 Q × Q	R × Q	34 P — R3	Kt — R5
17 Kt — K7ch	K — R1 (*f*)	35 B — K3	Resigns
18 P — R5 (*g*)	R — K1		

(*a*) The usual move is B — K2. The text move is the prelude to a pawn attack on the K-side. Now a flank attack when the centre is open is a violation of the principles which Lasker himself has expounded. But, as opposed to this, it gives him the type of game that he desires. (*b*) Black's best plan is a counterattack in the centre. In preparation for this, the king must first be removed from the centre. It is therefore proper to castle, in spite of the threatening attack. (*c*) This is attractive, but it would have been even stronger if Napier had delayed it, having first strengthened his game with B — Kt5. (*d*) An unpleasant surprise. After 15 Kt × Kt, Black plays P × Kt. (*e*) Lasker has foreseen this; he parries with his own surprise which seemingly wins a piece. Napier, in his turn, has foreseen this answer; he knows that he will not lose it. (*f*) Black's knight is safe; e.g., 18 P × Kt, P × P; 19 B — Q4, B × B; 20 P × B, R — K1; and has the advantage. If 18 Kt × B, Kt — Q4; with the better game. (*g*) White continues with the attack on the K-side. The immediate threat is: 19 RP × P, P × P; 20 Kt × Pch, K — Kt1; 21 B — B4ch, Kt — Q4; 22 B × Ktch, R × B; 23 Kt — K7ch. (*h*) The knight is still invulnerable; *e.g.*, 20 P × Kt, B — B1; 21 B — Kt5, R × Kt; 22 B × R, B × B; with a favourable game despite the loss of the exchange. White returns to his K-side attack. (*i*) Passive measures are not adequate. Black, in his turn, goes back to his own attack. (*j*) White is now a rook ahead, but Black has four immediate threats: R × B; Kt × B; Kt — Q7ch; Kt — Kt6ch. Besides this, White's king is in an exposed position. At this point, once again, he takes up his K-side attack. (*k*) With this move White surrenders all of his material advantage, but he sees that, if he does, his onslaught will, at last, be irresistible.

Illustrative Game No. 6.—Tarrasch was a prolific writer as well as a master player. He made large contributions to the Steinitz theory of positional play. Here he gives a classic demonstration of what ills may follow "surrender of the centre."

Gothenburg, 1920

	White Breyer	Black Tarrasch
1	P — Q4	P — Q4
2	P — K3	Kt — KB3
3	Kt — KB3	P — K3
4	QKt — Q2	B — Q3
5	P — B4	P — QKt3
6	Q — B2 (*a*)	B — Kt2
7	P — B5	P × P
8	P × P	B — K2 (*b*)
9	P — QKt4	Castles
10	B — Kt2	P — QR4
11	P — Kt5 (*c*)	P — B3
12	P — QR4	QKt — Q2
13	B — Q4	R — K1 (*d*)
14	R — B1	B — KB1
15	Q — Kt2	Kt — Kt5
16	P — R3	Kt — R3
17	Kt — Kt3	P — B3
18	Q — R3	P — K4
19	B — B3	Q — B2 (*e*)
20	B — Kt2	KR — B1
21	Q — R2 (*f*)	Q — Q1 (*g*)
22	P — Kt6	B — K2 (*h*)
23	Q — Kt1	Q — B1
24	Q — B2	Kt — B2 (*i*)
25	P — R4	Kt — Q1
26	P — Kt3	Kt — K3
27	B — KR3 (*j*)	Kt(3) × P
28	Kt × Kt	Kt × Kt
29	B — R3	Kt — Q6ch
30	Q × Kt	B × B
31	B × R	R × B
32	R — R1	B — Kt5ch
33	Kt — Q2	P — K5 (*k*)
34	Q — Kt3	P — QB4
35	K — Q1	P — B5
36	Q — R2	Q — Q3
37	K — K2 (*l*)	B — R3
38	P — Kt7	R — Kt1
39	K — Q1	R × P
40	P — B3	K — R1
41	P × P	P × P
42	K — B1	Q × P
43	Kt — B1	Q — K8ch
44	K — B2	Q — B6ch
45	K — Q1	Q — Q6ch
46	K — B1	R — Q2
	Resigns	

(*a*) Black can stop P — B5 by P — B4 or QKt — Q2 or Q — K2. Instead of this, he deliberately provokes it. (*b*) He has given White a phalanx of pawns on the Q-side in order to himself achieve the eventual control of the centre. (*c*) P — QR3 is better. Tarrasch now is able to concentrate on the QBP. (*d*) This prepares for P — K4, to drive back White's QB from the defense of the QBP. (*e*) New pressure on the QBP. The immediate threat is P × P followed by B × P. (*f*) Makes P — Kt6 possible. If 21 P — Kt6, Kt × KtP; 22 P × Kt, B × Q; and wins. (*g*) if 21 . . . P × P; 22 P — B6 wins. (*h*) Black prepares a new attack on the QBP. The queen will go to B1 while the knight on R3 will get to K3. (*i*) White seems to have no defense, but ingeniously finds a new resource. (*j*) The knights are pinned. If Black captures the QBP, he loses the exchange. But, as it happens, Tarrasch is prepared to do this. (*k*) As he has foreseen, he is the exchange down, but he has powerful pressure as well as the passed QBP. (*l*) White is helpless.

Illustrative Game No. 7.—The importance of maintaining sufficient space to maneuver is discussed by Nimzowitsch in his book *Die Blockade* (1925). He won several notable games by strangling the entire adverse army.

Copenhagen, 1923

	White Sämisch	Black Nimzowitsch
1	P — Q4	Kt — KB3
2	P — QB4	P — K3
3	Kt — KB3	P — QKt3
4	P — KKt3	B — Kt2
5	B — Kt2	B — K2
6	Kt — B3	Castles
7	Castles	P — Q4
8	Kt — K5	P — B3 (*a*)
9	P × P (*b*)	BP × P
10	B — B4 (*c*)	P — QR3
11	R — B1 (*d*)	P — QKt4
12	Q — Kt3	Kt — B3
13	Kt × Kt	B × Kt
14	P — KR3	Q — Q2
15	K — R2	Kt — R4 (*e*)
16	B — Q2	P — B4! (*f*)
17	Q — Q1	P — Kt5 (*g*)
18	Kt — Kt1	B — QKt4
19	R — Kt1 (*h*)	B — Q3
20	P — K4	BP × P!
21	Q × Kt	R × P (*i*)
22	Q — Kt5	QR — KB1
23	K — R1	QR — B4
24	Q — K3	B — Q6 (*j*)
25	QR — K1	P — R3 (*k*)
	Resigns	

(*a*) The opening is all "book" so far. The natural move P — B4 has been shown to be somewhat hazardous. The object of P — B3 is to relieve the uncomfortable pin on the QB. Also played in this position is Q — B1. (*b*) In order to leave the Black QB locked behind its own centre pawns. (*c*) This post for the bishop is always dubious after its retreat to Kt3 has been blocked by the pawn advance. (*d*) The method of restraining the Black Q-side pawns here attempted by White is shown to be futile. Necessary was the mechanical blockade, P — QR3 and P — QKt4. (*e*) White is laboriously preparing a pawn advance, but the misplaced bishop allows Black to strike first. (*f*) Threatening after due preparation to move P — B5 and smash the compromised king position. White's unmoved KP is an obstacle to bringing the Q-side pieces over to the defense, hence White's ensuing plan to advance it. (*g*) Exacting heavy toll for White's failure to block the pawn, and his omission of moving the KP. The knight is forced back home, where it remains stalemated for the rest of the game. (*h*) At last White threatens to move P — K4, discovering attack on the knight by the queen. Black, having already won great superiority in space, ignores the threat. (*i*) "Two pawns, and a rook on the seventh rank, all for one knight!" remarks Nimzowitsch. (*j*) Shutting off access to the haven QKt3 and threatening R — K7. (*k*) "Announcing the *Zugzwang*." White has no moves left; *e.g.*, 26 B — QB1, B × Kt, or 26 K — R2, QR — B6, or 26 QR moves, R — K7. After exhausting his pawn moves, White will be forced to move a piece and commence losing material.

Illustrative Game No. 8.—At move 8, Réti illustrates "the golden rule is that there is no golden rule" by switching from a "hypermodern" formation to a "classical."

New York city, 1924

	White Réti	Black Bogoljubow
1	Kt — KB3	Kt — KB3
2	P — B4 (*a*)	P — K3
3	P — KKt3	P — Q4
4	B — Kt2	B — Q3
5	Castles	Castles
6	P — Kt3	R — K1
7	B — Kt2	QKt — Q2
8	P — Q4 (*b*)	P — B3 (*c*)
9	QKt — Q2	Kt — K5 (*d*)
10	Kt × Kt	P × Kt
11	Kt — K5	P — KB4
12	P — B3 (*e*)	P × P
13	B × P (*f*)	Q — B2 (*g*)
14	Kt × Kt	B × Kt
15	P — K4	P — K4 (*h*)
16	P — B5	B — KB1
17	Q — B2 (*i*)	P × QP
18	P × P	QR — Q1 (*j*)
19	B — R5 (*k*)	R — K4
20	B × P	R × P
21	R × R	B × R
22	Q × B	R × B
23	R — KB1	Q — Q1 (*l*)
24	B — B7ch	K — R1
25	B — K8!	Resigns (*m*)

(*a*) The opening moves of the so-called Réti system. (*b*) One idea of the system is to avoid blocking the diagonal of the QB, making the break in the centre by P — Q3 and P — K4. But Réti perceives that reversion to the "normal position" of the queen's gambit declined is strongest against the formation adopted by Black. (*c*) Forced in order to retreat B — B2 in case White plays P — B5. This advance is powerful when Black cannot counter with P — K4. If the bishop were forced to retreat to B1, White would have time for P — QKt4 and Kt — K5, with strangling effect. (*d*) Subsequent analysis indicates P — K4 to be Black's best move, but it is insufficient to overcome White's positional superiority. (*e*) White forces open the centre to capitalize the superior position of his pieces. (*f*) Of course not P × P, as the KP is to be used as a battering-ram. (*g*) One of Black's problems is to develop his QB. This move certainly seems to have better prospects than 13 . . . Kt × Kt; 14 P × Kt, B — B4ch; 15 K — Kt2, because White would then gain command of the open Q-file. (*h*) He must not allow P — K5, and P × P would leave his KP isolated. "Black appears to have surmounted the greater part of his early difficulty and it calls for exceptionally fine play on the part of White to make the hidden advantages of his position count so rapidly and convincingly." (A. Alekhine, "New York International Tournament, 1924," *American Chess Bulletin*, April 1, 1925.) (*i*) Guarding his QB5 to threaten P × QP, and also threatening P × KBP. If Black now plays P × KP then B × P and White wins either the KP or the KRP. (*j*) Indirectly guarding the QP; *e.g.*, 19B × QP, B × KBP. (*k*) Initiating a beautiful combination that won this game the first brilliancy prize. (*l*) No better is 23 . . . Q — K2; 24 B — B7ch, K — R1; 25 B — Q5, Q — B3; 26 Q — B8. (*m*) To avert mate he must give up at least the bishop.

Illustrative Game No. 9.—The classical serenity of Capablanca's style had a profound influence on the masters of succeeding generations. Traces of this are clearly discernible in the games of such great players as Keres, Smyslov and Laszlo Szabo. Unlike those of other titleholders, Capablanca's games give an impression of an almost effortless ease.

New York, 1916

	White Janowski	Black Capablanca
1	P — Q4	Kt — KB3
2	Kt — KB3	P — Q4
3	P — B4	P — B3
4	Kt — B3	B — B4
5	Q — Kt3	Q — Kt3
6	Q × Q	P × Q
7	P × P	Kt × P
8	Kt × Kt	P × Kt (*a*)
9	P — K3	Kt — B3
10	B — Q2	B — Q2 (*b*)
11	B — K2 (*c*)	P — K3
12	Castles (K)	B — Q3
13	KR — B1	K — K2
14	B — B3	KR — QB1
15	P — QR3	Kt — R4 (*d*)
16	Kt — Q2	P — B4
17	P — KKt3	P — QKt4
18	P — B3	Kt — B5
19	B × Kt (*e*)	KtP × B (*f*)
20	P — K4	K — B2
21	P — K5	B — K2
22	P — B4 (*g*)	P — QKt4
23	K — B2	R — R5
24	K — K3	KR — QR1
25	QR — Kt1	P — R3
26	Kt — B3	P — Kt4
27	Kt — K1	R — KKt1
28	K — B3	P × P
29	P × P	R(5) — R1
30	Kt — Kt2	R — Kt5
31	R — Kt1	QR — KKt1
32	B — K1	P — Kt5 (*h*)
33	P × P	B — QR5 (*i*)
34	R — QR1	B — B7
35	B — Kt3	B — K5ch
36	K — B2	P — R4 (*j*)
37	R — R7	B × Kt
38	R × B	P — R5
39	B × P	R × Rch
40	K — B3	R × RP
41	B × B	R — R6ch
42	K — B2	R — QKt6
43	B — Kt5ch	K — Kt3
44	R — K7	R × Pch
45	K — B3	R — QR1
46	R × Pch	K — R2
	Resigns	

(*a*) Black has the open QR file. This is offset by the pawns on the QKt file; but he has a plan to make these weak pawns stronger. (*b*) After 10 . . . P — K3; 11 Kt — R4, thus obtaining the two bishops. The text not only makes 11 . . . P — K3 possible; it supports the advance of the QKtP. Black is planning Kt — R4, P — QKt4, Kt — B5. (*c*) Black's last move should have told him his intentions. B — Kt5, here or on the next few moves, would hamper the plan, but Janowski does not see this. (*d*) If 16 B × Kt, Black plays P × B; his double pawns are straightened out, and although he has lost his open R-file, he has the advantage of two bishops. (*e*) White is hoping to get relief by P — K4. He is still averse to giving Black two bishops, but he keeps the knight in order to support the KP. (*f*) Black has kept the open R-file, the QBP is powerful and there is a latent threat in the remaining QKtP. (*g*) Janowski's last two moves really are not as strong as they seem. In fact, he has created a new target for Black. When it is duly prepared, the KKtP will offer a threat that complements the one on the Q-side. Capablanca now will attack on one side and then on the other. (*h*) Back again to the Q-side, but the two wings of his attack now are so well co-ordinated that this move helps to bring the QB over to the K-side. (*i*) White cannot stop the bishop from reaching QB7; *e.g.*, 34 QR — B1, R × Pch wins. (*j*) Decisive; *e.g.*, 37 Kt — K3, P — R5. If 37 Kt — R4, B × Kt; 38 B × B, R × Pch; 39 K — K3, R × R; 40 R — R7ch, K — Kt3; 41 K × R, R — Kt5ch; and wins.

Illustrative Game No. 10.—No player in the long history of chess ever quite equaled Alekhine in imaginative richness and variety of attack.

The following game is only one out of some hundreds of the same quality.

Semmering, 1926

White Davidson	Black Alekhine	White Davidson	Black Alekhine
1 P — Q4	P — Q4	19 Kt(4) — B3	B — Kt3
2 Kt — KB3	Kt — KB3	20 B — KKt5 (*i*)	Q — B4
3 P — B4	P — B3	21 Kt — B3 (*j*)	Kt — K4
4 P — K3	P — K3	22 Kt × Kt (*k*)	Q × Kt(4)
5 Kt — B3	QKt — Q2	23 B — K3	B — B2
6 Q — B2 (*a*)	B — Q3	24 Kt — K2	Q — R7ch
7 B — Q3	Castles	25 K — B1	B × P
8 Castles	Q — K2	26 P × B	Q × RPch
9 P — K4	P × BP	27 K — Kt1	B — R7ch
10 B × P	P — K4 (*b*)	28 K — R1	Kt — B5
11 R — Q1	P × P	29 Kt × Kt (*l*)	B × Ktch
12 Kt × P (*c*)	Kt — Kt3	30 K — Kt1	B — R7ch
13 B — B1	R — Q1 (*d*)	31 K — R1	Q — B6ch
14 P — KR3	B — B2 (*e*)	32 K × B	R — K4
15 B — K3	R — K1 (*f*)	33 Q — B5	R × Q
16 B — Q3	Kt — R4 (*g*)	34 B × R	Q — R4ch (*m*)
17 Kt(3) — K2	P — Kt3	35 K — Kt2	Q × B
18 R — K1	Kt — Q2 (*h*)	and Black won	

(*a*) The usual move is 6 B — Q3. Black plays to take advantage of the queen going off the Q-file. (*b*) Black's position is commonly reached with the White queen on Q1 and QB on Kt5. Because of this difference Black now threatens to win a pawn; *e.g.*, 11 . . . P × P; 12 Kt × P, B × Pch; 13 K × B, Q — Q3ch. (*c*) In the light of older principles (see *Illustrative Game No. 6*), one might suppose that White, having a centre pawn, has a superior game. This position, however, is an example of the hypermodern doctrine that an advanced pawn in the centre may also be a disadvantage. It is important to have control of the centre; it is not important to have mere physical possession. As Réti says, this particular pawn has no future. "White will never be able to move P — B4. Also, the KP can never serve here as a support for White's pieces, as this will be made impossible by Black's pawns at QB3 and later at KKt3. Thus there remains of the centre pawn's properties only the undesirable one that it hinders the effectiveness of its own pieces." (R. Réti, *Masters of the Chess Board*, trans. by M. A. Schwendemann, new ed., G. Bell & Sons, Ltd., London, 1953.) (*d*) Two moves later the rook will go to K1, but this is no loss of tempo for the text induces White to weaken his K-position, the threat being 14 . . . B × Pch; 15 K × B, R × Kt; 16 R × R, Q — K4ch. (*e*) Threatens 15 . . . R × Kt; 16 R × R; Q — K4. This provokes 15 B — K3. At first glance this seems a good developing move; the bishop seems well placed; but Alekhine sets out to bring all of White's pieces to the centre. He sees that in this position they will get in each other's way; they will also offer a number of targets for attack. (*f*) Brings another White piece to the centre. (*g*) Threatens Kt — B5. When pawns are unequally distributed on both flanks, two bishops are a great advantage. (*h*) Threatens 19 . . . Kt — K4 and 20 . . . Kt × B. (*i*) He tries to keep the bishop; hemmed in by the pawn at Q4, the other bishop is less effective. (*j*) He also tries to keep the queen. After 21 Q × Q, Kt × Q; 22 Kt — B1, P — B3; 23 B — Q2, Kt × B; 24 Kt × Kt, Kt — Kt6; 25 P — K5, B — KB4 White would stand at a decisive disadvantage. (*k*) But he must exchange the knights. He cannot allow 22 . . . Kt × Kt; 23 P × Kt, but any other way of avoiding this is immediately disastrous. (*l*) After 29 B × Kt, Black has a mate in three; *e.g.*, 29 . . . B — Kt6ch; 30 . . . Q — R7ch; to be followed by Q × BP mate. (*m*) Having the choice of bishops, he takes the more effective one.

Illustrative Game No. 11.—In his youth Botvinnik, too, was a follower of Capablanca, but his style became increasingly more complicated.

Primarily a positional player, Botvinnik will often accept a positional inferiority, as he does in the following game, in order to obtain a tactical initiative.

Moscow, 1941

White Botvinnik	Black Boleslavsky	White Botvinnik	Black Boleslavsky
1 P — K4	P — K3	34 R — QKt1 (*i*)	K — B2
2 P — Q4	P — Q4	35 P — Kt5	K — K3
3 Kt — Q2 (*a*)	P — QB4	36 P — Kt6	R — B1
4 KP × P	KP × P	37 P — R3	R — QKt1
5 B — Kt5ch	Kt — B3	38 K — R2	K — Q4
6 KKt — B3	B — Q3	39 K — Kt3	K — B3
7 P × P	B × BP	40 K — Kt4 (*j*)	K — Kt2 (*k*)
8 Castles	Kt — K2	41 R — K1	R — Kt1
9 Kt — Kt3	B — Kt3	42 R — K6	K — R3
10 B — K3 (*b*)	B × B	43 K — Kt5	K — Kt2
11 B × Ktch	P × B	44 P — R4	K — R3
12 P × B (*c*)	Castles	45 P — R5	K — Kt2
13 Q — Q2	Q — Kt3	46 P — Kt4	K — R3
14 Q — B3 (*d*)	R — Kt1	47 K — R4	K — Kt2
15 QR — Kt1	R — K1	48 P — R6 (*l*)	P × P
16 KR — K1	Kt — Kt3	49 R × P	R — Kt2
17 Kt — B5	B — Kt5	50 K — R5	K — R3
18 Kt — Q4	Kt — K4	51 R — QB6	R — K2
19 P — Kt4	QR — Q1	52 R — B7	R — K4ch
20 P — K4 (*e*)	P × P	53 P — Kt5	K × P
21 R × P	P — QR4 (*f*)	54 R × P	K × B3
22 P — QR3	P × P	55 K — R6	K — Q3
23 P × P	P — B3	56 P — Kt6	R — K8
24 QR — K1	K — R1	57 R — KB7	K — K3
25 K — R1	B — Q2	58 R — B2	R — R8
26 Kt × B	R × Kt	59 P — Kt7	R — R8ch
27 Q × P	Q — Q1	60 K — Kt6	R — Kt8ch
28 Kt — B3	R — QB2	61 K — R7	R — R8ch
29 Kt × Kt	P × Kt (*g*)	62 K — Kt8	K — K2
30 Q × Rch (*h*)	Q × Q	63 R — K2ch	K — Q2
31 R × P	Q — KKt1	64 R — K4	R — R7
32 R — K8	R × P	65 K — B7 (*m*)	Resigns
33 R × Qch	K × R		

(*a*) When Botvinnik is Black, he invariably plays 4 . . . B — Kt5 after 3 Kt — QB3. When he is White, he plays 3 Kt — Q2, so as not to show his rivals how they ought to proceed against his favourite defense. (*b*) Black has an isolated QP; White's own pawns are connected; but he sees that, after this exchange of bishops, he will control his Q4 and QB5. (*c*) To obtain his objective, Botvinnik has connected Black's isolated QP and has given himself an isolated KP. (*d*) Black can never get his pawn to QB4; he has the wrong-coloured bishop. White will bring his knights to magnificent posts at QB5 and Q4. (*e*) Getting rid of his isolated KP; at the same time he increases his command of the board and his rook pre-empts the K-file. (*f*) A tempting trap. 22 Q — KKt3 seems to win two pieces for a rook, but on 22 . . . P × P; 23 Kt(4) — Kt3, R — Q4; 24 Q × B, R × Kt; 25 Kt × R, Q × Ktch; 26 K — R1, Q × P; 27 QR — K1, P — B3, it is dubious if White has any advantage; 24 QR — K1, R × Kt; 25 Kt × R, Q × Ktch; 26 K — R1, B — K3; 27 R × Kt, Q × P is no better. This time Botvinnik ignores the tactical and holds onto positional advantage. (*g*) He cannot take the queen; *e.g.*, 29 . . . R × Q; 30 Kt — B7ch, K — Kt1; 31 Kt × Q, R × Kt; 32 P — B4 and the passed pawns win easily. (*h*) Seeing a won ending, White continues to simplify. (*i*) He will force the Black king to the Q-side, after which he will induce a breach in the pawns on the K-side. (*j*) If 40 . . . R × P; 41 R × Rch, K × R; 42 K — B5 and gets the pawns. (*k*) Freeing the rook to protect the K-side pawns. (*l*) Finally forcing a breach in the barrier. On 48 . . . P — Kt3; 49 R — Q7ch wins even more rapidly. (*m*) All "book." On 65 . . . R — B7ch; 66 K — Kt6, R — Kt7ch; 67 K — B6, R — B7ch; 68 K — Kt5, R — Kt7ch; 69 R — K4.

Illustrative Game No. 12.—No matter how much the technique of chess advances—and it has progressed a great deal as a result of the very large number of tournaments held since the beginning of the 20th century—the basic principles always remain the same.

In the following game Smyslov, twice Botvinnik's challenger for the world title and finally his conqueror, demonstrates the vital importance of control of the centre.

Zürich candidates' tournament, 1953

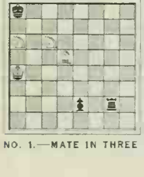
White Keres	Black Smyslov	White Keres	Black Smyslov
1 P — QB4	Kt — KB3	16 Kt — K5 (*e*)	Kt × Kt
2 Kt — QB3	P — K3	17 R × Kt	B — KB3
3 Kt — B3	P — B4 (*a*)	18 R — R5 (*f*)	P — Kt3
4 P — K3	B — K2	19 R(B3) —	
5 P — QKt3	Castles	R3 (*g*)	P × P (*h*)
6 B — Kt2	P — QKt3	20 R × P	P — B6
7 P — Q4 (*b*)	P × P (*c*)	21 Q — B1	Q × P (*i*)
8 P × P	P — Q4	22 Q — R6	KR — Q1
9 B — Q3	Kt — B3	23 B — B1	B — Kt2
10 Castles	B — Kt2	24 Q — Kt5	Q — B3
11 R — B1 (*d*)	R — B1	25 Q — Kt4	P — B7
12 R — K1	Kt — QKt5	26 B — K2	R — Q5 (*j*)
13 B — B1	Kt — K5	27 P — B4	R — Q8ch
14 P — QR3	Kt × Kt	28 B × R	Q — Q5cb
15 R × Kt	Kt — B3	Resigns	

(*a*) Already Black has conceived the plan of attacking on Q5. How consistently he carries this out the course of the game will show. (*b*) Showing his hand rather too early. It would be better to play first 7 B — K2, and then 8 Castles. In so doing his game would have more elasticity. (*c*) This and his next move constitute a necessary transposition into a kind of queen's gambit. For if 7 . . . B — Kt2; 8 P — Q5, and White controls the centre. (*d*) After 11 Q — K2, Kt — QKt5 the situation would be embarrassing for White. (*e*) The beginning of a fierce K-side attack that can be thwarted only by the utmost accuracy in defense and vigour in counterattack. (*f*) Putting his all into the attack; but if he retreats with 18 R — K1, then Black gains the upper hand by 18 . . . P × P; 19 R × P, B — Q4. (*g*) Though this move is most impressive it is not overwhelming in reality since Black need not accept the sacrifice. (*h*) Coolly and correctly played. Bad would be 19 . . . P × R; 20 Q × P, R — K1; 21 P — R4, when White's attack cannot be met. (*i*) Black increases his control of the Q5 square; and with good reason since 21 . . . P × B leads to mate after 22 Q — R6, Q × P; 23 R — Kt7ch, B × R; 24 Q — R7. Now, however, Black has time to make a flight square for his king while further centralizing his pieces. (*j*) Nothing could be more pleasing in its harmonious logic than the manner in which Smyslov finishes off this game. Once more he emphasizes and utilizes his control of Q5. Why he encourages White to advance his KBP soon becomes evident.

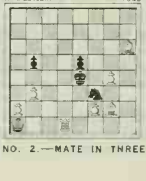
VI. CHESS PROBLEMS

Chess problems are artificial positions permitting mate in a specified number of moves against any defense, with play involving elements of strategy or beauty. In no. 1, player and problemist alike would see the need of advancing the White king to Kt6. The player would be satisfied to win easily in four moves by 1 K–Kt5, avoiding Black's promotion check; whereas the problemist would mate in three by 1 K–R5, leaving Kt5 open for the threat of 2 Kt–Q4ch and 3 Kt–Kt5 mate, while the seemingly powerful 1 . . . P–K8 (Q)ch is to be countered by the quiet 2 K–Kt6, with mate following on the next move even if Black continues checking.

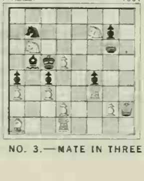
The first recorded problems were Arabian *mansubat* (betting problems), the earliest known manuscript being a collection by al-Adli, *c.* A.D. 840. It was lost, but much of its contents was preserved in later collections, notably one compiled by someone who signed himself "Bonus Socius." The national library at Florence has a copy of his manuscript, believed to date from the late 13th century, containing 194 problems. The modern period, however, dates only from 1840 when the problems of an Englishman, the Rev. H. Bolton, a Belgian, A. d'Orville, and the German master player A. Anderssen heralded a great revival of interest. A collection published in Paris in 1846 by A. Alexandre contained 2,000 problems and seemed to leave little for the future to attempt. Yet at this very time the establishment of many chess magazines and columns provided a sufficient stimulus to encourage the study of problems on unprecedented lines.


C S KIPPING 1911

NO. 1.—MATE IN THREE


H A LOVEDAY 1845

NO. 2.—MATE IN THREE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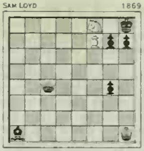
NO. 3.—MATE IN THREE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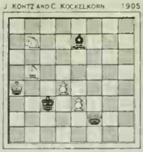
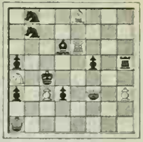

J KOHTZ AND C KOCKELKORN 1905

NO. 5.—MATE IN FOUR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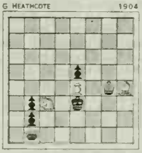
NO. 6.—MATE IN THREE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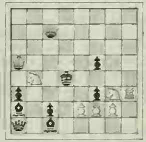
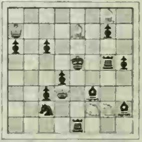
NO. 7.—MATE IN THREE


J VASTA 1942

NO. 8.—MATE IN THREE


W BRON 1952

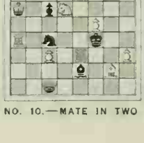
NO. 9.—MATE IN THREE

The years 1845–61 marked the discovery of many important themes. The Rev. H. A. Loveday, English chaplain at Delhi, published the historic Indian problem (no. 2) in 1845. The ambush 1 B–B1, 2 R–Q2, by which stalemate is avoided and mate attained, trite as it appears today, took the problem world by storm. (Originally published as a four-move problem, it had another Black pawn on QKt3, with very inaccurate play.) W. Grimshaw of England, A. Novotny of Austria and J. Plachutta of Germany experimented with the interference themes which bear their names, while F. Healey of England published his Bristol problem (no. 3) in 1861, with its surprising clearance key 1 R–KR1, preparing for 2 Q–Kt1 and 3 Q–KKt1 mate in certain contingencies.

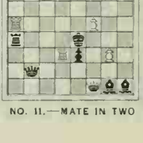
In the U.S., Sam Loyd (1841–1911) composed a great number of celebrated problems such as no. 4 with its striking key Q–KB1, necessary so as to be able to occupy QKt1, Q3 or KB5 according to the Black bishop's moves. He discovered many new themes, as did his compatriots W. A. Shinkman and O. Wurzburg.

In three- and four-move problems Bohemian (Czech) composers long stood unrivaled in the blending of several lines of play, each terminating in a pure and economical mate (model). This doctrine of economy in the use of White force was first advocated about 1865 by A. Konig, the founder of the Bohemian school. His principles found ready acceptance in the work of J. Dobrusky and J. Pospisil and were carried farther by K. Traxler, L. Vetesnik, Z. Mach and others in Bohemia. The cult of the "model" mate spread all over Europe and composers of other schools made every effort to blend Bohemian principles with their own strategic ideas. Among the more successful were M. Feigl and K. Erlin (Austria), V. Marin (Spain), J. Fridlizius (Sweden), J. Scheel (Norway) and the great British composers G. Heathcote and P. F. Blake.

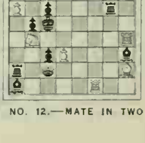
A school sprang up in Germany after the publication in 1903 of *Das Indische Problem* by J. Kohtz. He drew attention to the thematic problems of 1845–61 and encouraged fresh study of all the interference themes. This German problem renaissance had many distinguished members: W. von Holzhausen, F. Kohnlein, F. Sackmann and later A. Kraemer, F. Palatz and others. In no. 5, the sacrifice key Kt–Q6 decoys the Black bishop so that it can no longer play to Kt4. When it now defends against 2 Q–K2


C MANSFIELD 1917

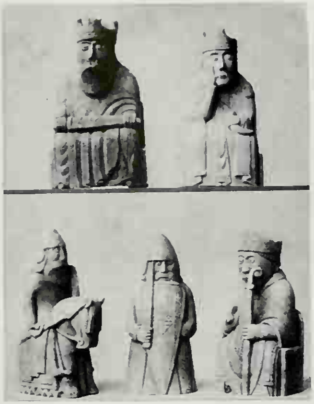
NO. 10.—MATE IN TWO


A ELLERMAN 1925

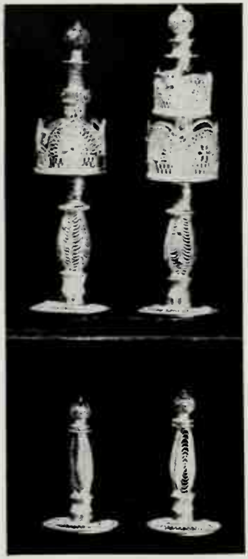
NO. 11.—MATE IN TWO


L I LOSHINSKY 1930

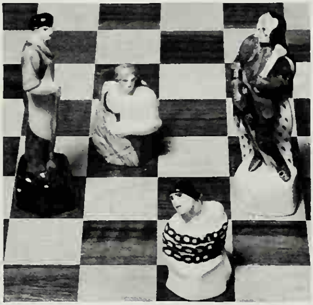
NO. 12.—MATE IN TWO



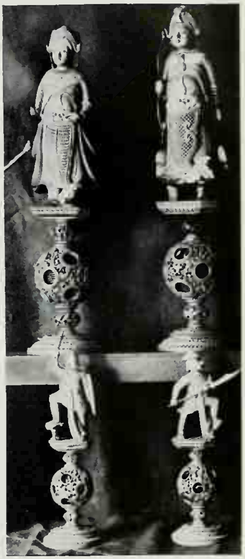
Kings (top) and knight, rook and bishop (bottom) from a walrus ivory chess set of Viking origin excavated on the Island of Lewis, Scotland, 1831



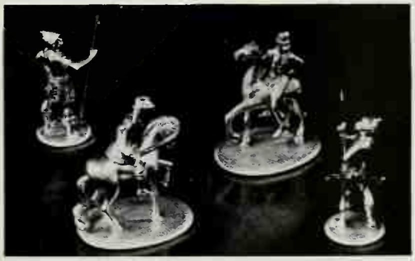
King and queen (top) and pawns (bottom) from a gold and silver filigree chess set in the standard French style of the 18th century. Collection of Alex Hammond



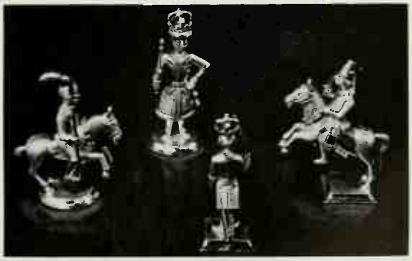
Kings (left and right) and pawns (centre) from a Soviet chess set of hard porcelain representing Communists *v.* Capitalists. 20th century



King and queen (top) and pawns (bottom) from a Cantonese chess set of carved ivory



Knights (centre) and pawns (left and right) from a set of silver and silver-gilt chess pieces representing a battle between the Romans and the Barbarians. Attributed to Andreas Schluter, German. Early 18th century

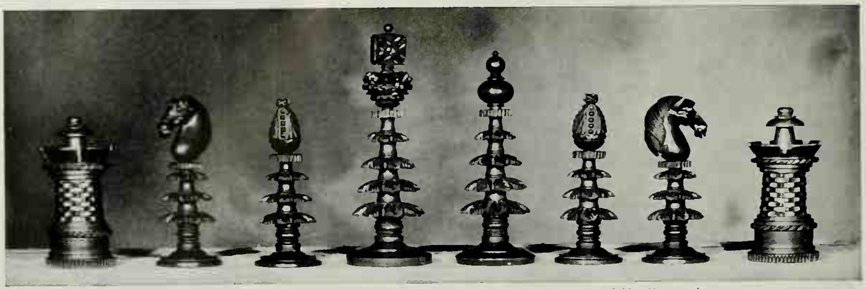


Kings (centre) and knights (left and right) from a set of silver and silver-gilt chess pieces representing Frederick the Great opposing Maria Theresa. About 1750

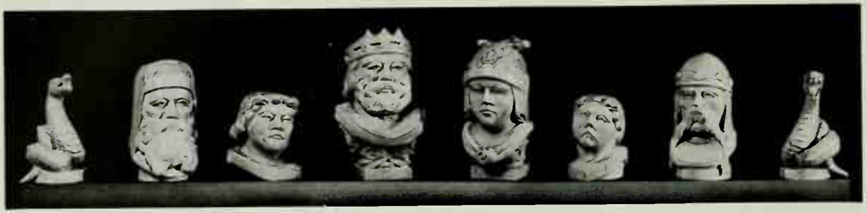
REPRESENTATIVE CHESS PIECES FROM THE 12TH TO THE 20TH CENTURIES

BY COURTESY OF (TOP LEFT, TOP RIGHT) ALEX HAMMOND; (TOP CENTRE) THE TRUSTEES OF THE BRITISH MUSEUM; (CENTRE, BOTTOM LEFT, BOTTOM RIGHT) THE METROPOLITAN MUSEUM OF ART. GIFTS OF GUSTAVUS A. PFEIFFER

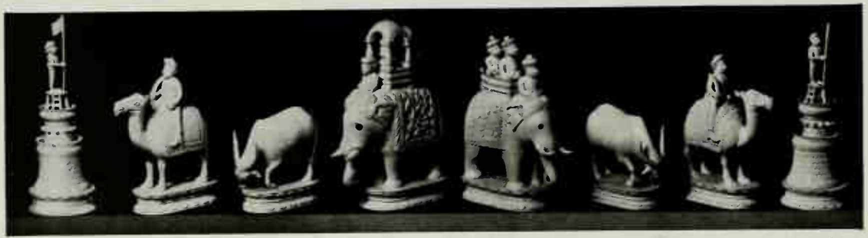
CHESS PIECE



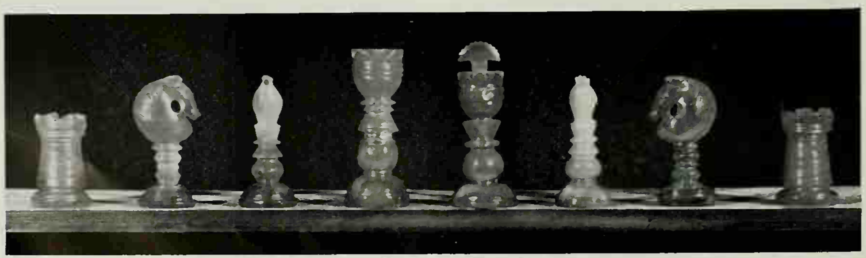
Major pieces from an ebony and ivory chess set turned on an ornamental lathe. 19th century. In the collection of Alex Hammond



Carved ivory chessmen (major pieces) from a French chess set representing Mor tals v. Immortals. In the collection of Alex Hammond



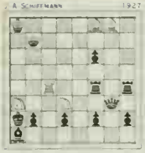
Indian chessmen (major pieces) from a carved and painted ivory chess set representing Englishmen of the East India Company v. the Inoians. Delhi, India. About 1780. In the collection of Alex Hammond



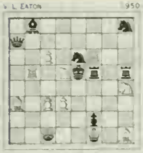
Major pieces from an English chess set turned in moss agate. About 1800. In the collection of Alex Hammond

TURNED AND CARVED CHESS PIECES

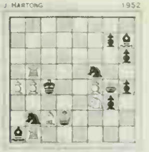
BY COURTESY OF ALEX HAMMOND



NO. 13.—MATE IN TWO



NO. 14.—MATE IN TWO



NO. 15.—MATE IN TWO

by 2 . . . B – B5. White is enabled to capture it. This decoy to a vulnerable point on a line Kohtz called the Roman theme.

No. 6 shows a famous Bohemian problem blending five model mates with two queen sacrifices: key R – K2, threat 2 Q × QPch. If P × R; 2 Kt – Kt6ch. If Kt – B4; 2 Q – Q5ch. If R × P; 2 R – K4ch. The lightweight gem no. 7 has an unexpected key and four models, the first two lines leading to a beautiful "echo," or repeated mate: key Kt – R2, P × Kt; 2 Q – B2. If K – Q7; 2 K – B3. If K – K7; 2 Kt – Kt4. If K – Q5; 2 B – B2ch. No. 8 combines three elegant pin models: key R – R5 (threat 2 Kt × P [B5]ch). If B – Kt4; 2 R – R4ch. If B – K3; 2 Kt × P(B2)ch. If B – QB5; 2 Q – KKt7ch. No. 9, by a Russian composer, shows four popular queen sacrifices, each leading to a model mate: key Kt – R4, threat 2 Q – B5ch. If B – Kt5; 2 Q – K4ch. If Kt – K6; 2 Q × Pch. If R – K5; 2 Q – Kt5ch.

While of less depth than longer problems, two-movers enjoyed increasing popularity after the productions of T. Taverner appeared in England in the 1880s and 1890s. A. F. Mackenzie, the blind composer of Jamaica, gave two-move problems fresh vitality at the end of the century, drawing attention to the cross-check theme, where Black checks, such as those of the knight in no. 10 (key, B – K4), are countered without capture of the checking piece. Subsequently interferences and pinnings and unpinnings, and then the changed mate, have provided the two-move problem with original materials. The establishment (1913–24) by J. F. Magee, Jr., of the Good Companion club of Philadelphia encouraged these two-move forms widely, calling into action many younger men, such as G. Guidelli and A. Mari of Italy, A. Ellerman of Argentina and C. Mansfield of England. Later, new paths were blazed by composers of the U.S.S.R., such as M. M. Barulin, L. I. Kubbel and L. I. Loshinsky. Ellerman's masterpiece, no. 11 (key, R – Q7), illustrates unpinning and other features. No. 12 (key, R – QKt1) has three pairs of mutual interferences between Black rooks and bishops. One of the finest keys in a two-move problem (Q – B3) occurs in no. 13, by J. A. Schiffmann (Rumania).

After 1940 emphasis was often placed on defensive play. In no. 14, by a U.S. composer (key, Q – R6), an aimless move of the Black knight on K3 allows 2 Kt – QKt6 mate; but five moves of the knight can forestall this, forcing five new mates. Defensive play of another character is seen in no. 15 by a Dutch composer (key, B – Q1, with eight mates accurately forced).

A large classified collection of more than 150,000 problems was initiated by Alain White, U.S. composer, who edited *The Christmas Series* of more than 30 books (1905 *et seq.*). His collection passed under the control of C. S. Kipping of England. Many national problem societies exist—the British Chess Problem Society (founded in 1919) has encouraged the study of problems by arranging tournaments for composers and solvers.

This article has not attempted to trace the story of problems other than direct mates. But the existence should not be overlooked of such important forms as the self-mate (in which the loser wins) or the many original "fairy" types invented and popularized by T. R. Dawson and others (often using freak pieces).

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CHESS PIECE.

CHESS PIECE. More than 500 different patterns of chess pieces have been recorded. These, like the game itself, are probably derived from the "four arms" of the Indian army—*i.e.*, chariots, elephants, horses and infantry—although the stumpy, angular shapes of early pieces were variously misinterpreted in the game's long journey westward. The grading of pieces by modeling them into recognizable figures developed gradually in about the 11th century. Each chess-playing country produced its own designs and these were usually naturalistic, except where Muslim rule restricted them to symmetrical shapes that would avoid representation of man or animal, or where considerations of cost limited them to such simple wood turnings as could be sold in England for 8*d.* a set in the reign of Elizabeth I. The queen was a European interpretation of the raja's vizier, and the bishop of the English set (the original elephant) appeared in other European countries in entirely different guises, such as a jester in France.

Early European chess pieces at their finest were made in precious metals, jeweled and enameled, the kings and queens clad in royal regalia, the knights in armour and the pawns arrayed as foot soldiers. The cabinet pieces found today, however, derive mainly from the 18th and early 19th centuries. The ancient Hindu theme of martial strategy is evident in early 18th-century European sets, which have portrait busts of opposing leaders and their aides to commemorate military victories.

From the early 18th century until the 1830s the East India company imported lavishly carved chessmen in red and white ivory, the opposing sides being the company and Indians. Rajas and viziers were represented by laden elephants, those of the rajas bearing howdahs; company knights rode horses and the Indians were mounted on dromedaries. During the second half of the 18th century the company's bishops and pawns in these sets sometimes wore top hats. The pieces were mounted on thin disks until the 1780s, when short turned pedestals became usual. In some sets the horses' heads of the knights suggested prancing animals, with forelegs waving in the air.

The Chinese also exported chess pieces to western countries. In early sets each piece might be mounted on an openwork pedestal containing several loosely revolving concentric hollow fretted balls, the number varying with the importance of the piece: as many as seven were allowed for a king and three for a pawn. These balls supported a variety of figures, usually Chinese fighting men. The oriental faces and almond eyes distinguish them from similar sets, including the fretted balls, which were made in England during the mid-19th century. The Chinese themselves preferred draughtlike pieces inscribed with different marks.

As chess playing became more widespread from about 1820 there was a greater demand for less ornate pieces, the bodies of kings and queens being reduced to truncated cones, and during the 1830s cylindrical bodies with elaborately carved surfaces were usual. These continued until about 1860, when they were superseded by the Staunton chess pieces, the standard design of the 20th century, originated by Howard Staunton, who registered the pattern in 1849.

Chess pieces in ceramics date from 1758, when Meissen introduced porcelain sets in which the castles were represented by elephants and the knights by riderless horses. From 1783 Wedgwood modeled sets in jasper from figures, designed by the sculptor J. Flaxman, of players in Shakespeare's *Macbeth* and these continue in production.

See also CHESS. (G. B. H.)

CHEST: *see* CABINET FURNITURE.

CHESTER, EARLS OF.

CHESTER, EARLS OF. The English title of earl of Chester was first held by HUGH (*c.* 1047–1101), viscount of Avranches, to whom his kinsman William I entrusted the security of Cheshire in 1071. The Domesday survey shows that Earl Hugh ranked high among the greater landowners of Norman England. Within the county of Cheshire the earls came to enjoy semi-regal powers, which largely exempted it from the scope of the king's government, although not until after it had passed to the crown was Cheshire officially, but infrequently, termed a county palatine. The earls' immense influence, however, depended primarily on the great estates of the honour of Chester, which extended into more than 20 shires, notably Lincolnshire and the midland counties. Earl Hugh, who founded Chester abbey, was followed by his son, RICHARD (d. 1120), and then by his nephew RANULF le Meschin (d. *c.* 1129), viscount of Bayeux, who had acquired the honour of Carlisle. His son, the proud and unscrupulous RANULF de Gernons (*c.* 1100–53) played a most important but wholly self-seeking part in the civil wars of Stephen's reign; the battle of Lincoln (1141) was almost a personal issue between the earl and the king. HUGH de Kevelioc (1147–81), son of Ranulf, joined the rebellion against Henry II in 1173. The peak of the family fortunes was reached under his son, RANULF de Blundeville (*c.* 1172–1232), who used the style of duke of Brittany and earl of Richmond in right of his wife, Constance of Brittany. His loyalty to King John and the infant Henry III was richly rewarded with the earldom of Lincoln (1217) and custody of the honours of Richmond, Leicester and Lancaster. He took the cross in 1218 and distinguished himself at the siege of Damietta; at his death his estates were divided among his four sisters or their heirs. Cheshire and the earldom passed to his nephew JOHN the Scot (*c.* 1207–37), earl of Huntingdon, and then, after long negotiations, were annexed to the crown by 1241. The Lord Edward (afterward Edward I) was created earl of Chester in 1254, and since 1301 the title has never been held by anyone other than the heir apparent of the monarch, and has regularly been one of the titles of successive princes of Wales.

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CHESTER, a city, county borough (1888) and the county town of Cheshire, Eng., and a county in itself, 18 mi. S.S.E. of Liverpool by road and the Mersey tunnel. Pop. (1961) 59,268. Chester, with a medieval aspect, lies in a bend of the Dee river on a small sandstone ridge, 6 mi. above the point at which the river opens out into a wide, shallow estuary. It is an important railway centre.

History.—Possibly Suetonius Paulinus built a small fort in this spot to defend the crossing of the Dee, when he advanced into north Wales in A.D. 61; and the force planted there may have remained. In about A.D. 78 the advance was renewed under Gnaeus Julius Agricola, and the 20th legion was stationed there to subdue the tribes of north Wales. From its key position in relation to the north Wales coastal route and to the defenses of the northern frontier, Chester, the Roman Deva or Castra Devana ("camp on the Dee") became the chief western legionary fortress. Many Roman inscriptions and remains were found, and the north and east walls stand in great part on Roman foundations. In 1929 a stone-built amphitheatre of the late 1st century A.D., the largest in England, was discovered outside the east wall. Deva was probably deserted in the second half of the 4th or beginning of the 5th century. In about 615 Aethelfrith, king of Northumbria, defeated a Welsh army there and apparently the fortress was then ruined.

In 907 Aethelflaed fortified the position as a Mercian defensive post and in the 10th century Chester (the Anglo-Saxon Legaceaster, abbreviated Ceaster, hence its modern name) became a place of importance, with its own mint. The Domesday Book account of the city includes a description of the Saxon laws under which it was governed in the time of Edward the Confessor.

Chester was the last English city to yield to William the Conqueror (1070), who in 1071 set up a palatine earldom there. From 1071 until 1237 Chester castle was the seat of government of a line of seven powerful earls. In the second half of the 12th century Ranulf de Blundeville, earl of Chester, met Henry II's policy of extending the control of the central government over the great feudal franchises by applying to himself new principles of sovereignty, so that what was later called the county palatine of Chester came into being. Henry III annexed the earldom to the crown in 1241 and in 1254 conferred it on his son Edward. (*See* CHESTER, EARLS OF.) The establishment of royal control at Chester made possible Edward I's conquest of north Wales. Chester played a vital part as Edward's supply base during the Welsh wars (1275–84); and, because of this function, the separate organization of the county palatine was preserved. It was to continue until Henry VIII's reign. Chester was royalist in the Civil Wars, and was intermittently besieged for over two years, finally surrendering on Feb. 3, 1646, after the battle of Rowton Moor fought about 3 mi. S.E.

The earliest extant charter, granted by Henry II in 1176, empowered the burgesses to trade with Ireland as freely as they had done in the reign of Henry I. By a charter of about 1200–02 Earl Ranulf de Blundeville granted the citizens recognition of their guild merchant. Chester had its own purely urban sheriffs before 1150 and by 1238 had a mayor. In 1300 Edward I granted the citizens the fee farm of the city at a yearly rent of £100. By "the Great Charter" of 1506 Henry VII constituted Chester a county, incorporated the governing body and granted the city its own quarter sessions. This charter, confirmed by later sovereigns, permitted the citizens annually to elect the governing body, a privilege seldom exercised before 1835.

The port of Chester reached the height of its importance in the second half of the 13th and the first half of the 14th century. Its trade was always largely with Ireland. Grain, hides and fish were imported from Ireland, and large quantities of wine from Gascony. From the mid-14th century the gradual silting up of the Dee caused trade to decline. Consequently, in 1486 the fee-farm rent was reduced to £20.

In the 16th century there was some revival and trade with Spain, primarily with Basque ports. The principal imports were iron, wine, oil and fruit. From Portugal came wine, cork, sugar and spices. In 1553 a company of merchant venturers for trading to Spain and Portugal received a royal charter of incorporation. Imports of raw hides from Ireland account for the importance of the tanners, glovers and other leather crafts in Chester. In the 18th century there were considerable imports of Irish linen. Apparently Chester's chief exports were cloth, lead and tanned hides. The failure of schemes for improving the navigation of the Dee and the rise of Liverpool caused Chester finally to lose its position as a port in the 18th and early 19th century.

The Cathedral.—The bishops of Mercia apparently had a seat at Chester, but the city ceased to be episcopal until 1075 when Peter, bishop of Lichfield, removed his seat to Chester, making the collegiate church of St. John his cathedral. His successor removed the see to Coventry in 1102, and Chester remained part of the diocese of Coventry and Lichfield until 1541. The present church of St. John, with massive Norman arcades, transitional triforium and Early English clerestory, represents the crossing and nave of the collegiate church.

The present cathedral buildings, though restored in the 19th century under the supervision of Sir G. G. Scott and Sir A. Blomfield, are those of the medieval abbey of St. Werburgh. Hugh Lupus, first Norman earl, found there a Saxon monastery of secular canons, and in its place, with the help of St. Anselm of Bec, he founded a great Benedictine abbey. By his charter of 1093, Hugh richly endowed it and granted it the right to hold an annual fair for three days at the feast of St. Werburgh. Although there was often friction between the abbey and the city, tradition asserts that the Chester mystery plays, which were performed by the city guilds, were translated from the French in 1327–28 by Ranulf Higdon (or Higden), a monk of St. Werburgh's. The abbey was dissolved in 1540, and in 1541 Henry VIII made Chester a bishopric and founded the cathedral church of Christ and the Virgin Mary. The present diocese covers only Cheshire.

The cathedral church, built of red sandstone, is cruciform, with a central tower and nave (145 ft.) of six bays. The peculiar plan, with a short nave, very small north transept and large south transept with aisles, is the outcome of its position, as the conventual buildings to the north and the city to the west prevented expansion in these directions. The north transept and northwest tower remain from the Norman church, and on the west of the cloisters is a Norman undercroft.

A great rebuilding of the monastery was begun in Edward I's reign, and the refectory, parlour, chapter house and Lady chapel are mainly Early English. The choir, a fine example of Early English and Decorated work, is enhanced by magnificent carved wooden stalls of the late 14th century. The south transept and nave are mainly Decorated, with later additions. The 14th-century abbey gateway remains.

The Town.—St. Peter's, founded in 907, which occupies part of the site of the Roman principia or headquarters building, St. Mary's, built in the Perpendicular style, whose foundation dates back at least to the early 12th century, and St. John's (*see* above) are noteworthy churches.

The four main streets, following the line of the Roman streets, radiate at right angles from the Cross and terminate in the four gates. A unique feature of these streets are "the Rows," consisting of a double tier of shops, one at ground level and the other at first-floor level, each provided with a footpath, the upper one being set over the ground-level shops and covered by projection of the second stories of the buildings. The Rows and the ancient timber-framed houses give the city a picturesque and individual character. Examples of fine timbered houses of the 16th and 17th centuries are Stanley palace, Bishop Lloyd's house and Leche house in Watergate street and the Bear and Billet in Lower Bridge street. Medieval crypts exist under several shops.

Chester is the only city in England that still possesses its walls intact (12–40 ft. high) in their entire circuit of 2 mi. The gates have been rebuilt at various dates since 1768, the north and east gates on the sites of the Roman gates. The castle was mainly rebuilt between 1789 and 1813, but the square, early 13th-century Agricola tower remains. The 13th-century Old Dee bridge was Chester's only bridge until the Grosvenor bridge was built in 1832. The latter carries the main route to north Wales across the Dee and has a single stone span of 200 ft. Farther up the river the suspension bridge connects with the suburb of Queen's Park. The causeway which crosses the river diagonally from the Old Dee bridge is said to have once provided power for the famous Mills of Dee, demolished in 1909. The Roodee, a level tract by the river, has been used as a racecourse since the 16th century. An annual race meeting is held there in May.

The Grosvenor museum contains the finest collection of Roman inscribed stones in England, and also other local antiquities and a natural history section. The King's school, founded by Henry VIII in 1544, was reorganized in 1873.

PRESS ILLUSTRATED SERVICE

"THE ROWS," 16TH- AND 17TH-CENTURY DOUBLE TIER SHOPS, CHESTER, ENG.

Development has been mainly in light industry. Manufactures include paint, electrical switchgear, metal window frames and lead. There is a considerable tourist industry. Chester is also a military centre, being the headquarters of western command.

Chester was not represented in parliament until 1547. It returned two members from 1547 until 1885, when its representation was reduced to one. The city of Chester parliamentary division includes the rural district of Chester.

See also references under "Chester" in the Index volume.

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CHESTER, an industrial city of Delaware county in southeastern Pennsylvania, U.S., is located on the Delaware river 15 mi. S.W. of Philadelphia and is a part of the Philadelphia metropolitan area. Pop. (1960) 63,658. One of the oldest communities in the state, it was a thriving settlement long before William Penn established Philadelphia. The Swedish crown granted the Chester area to a bodyguard of the governor of New Sweden in 1644 and after 1655 Dutch settlers joined the Swedes to establish the town of Upland. William Markham, Penn's deputy governor, located his seat of government there when he arrived on the Delaware in 1681 to establish the colony of Pennsylvania and when Penn arrived he convened there the first general assembly of the province. Meanwhile Penn renamed the community Chester, reputedly in honour of his friend Lord Chester. From this era dates the Caleb Pusey house, built in 1683 and the oldest English-built house in Pennsylvania remaining intact. Chester was incorporated as a borough in 1701 and chartered as a city in 1866.

After Penn moved his government upriver to Philadelphia, Chester fell quickly into eclipse. It was only after 1850, when the city became an adjunct of rapidly industrializing Philadelphia, that rapid growth began. Shipbuilding, steel, chemicals and paper products are among the principal industries. The John Roach Co., founded at Chester in 1872, was one of the first iron or steel shipbuilding enterprises in the United States. Foreign immigration and later a large influx of Negroes swelled the Chester population, which remains largely crowded into narrow streets near the river front. Farther north and west are the better residential sections of the city, as well as the campus of the Pennsylvania Military college, a private college founded in 1821. On the edge of the city is the Crozer Theological seminary (Baptist), founded in 1867. (R. F. We.)

CHESTERFIELD, PHILIP DORMER STANHOPE, 4th Earl of (1694–1773), English statesman, diplomat and wit, now chiefly remembered as the author of the famous *Letters to His Son*. He was born in London on Sept. 22, 1694, the son of Philip Stanhope, 3rd earl (1673–1726), and Elizabeth Savile, daughter of the sagacious "trimmer," George Savile, marquess of Halifax. The strongest early influences were those of his grandmother, the marchioness of Halifax, and of his tutor, the Huguenot Jouneau; the former taught him manners; the latter gave him a lifelong interest in classical and French civilization. He matriculated at Trinity hall, Cambridge, on Aug. 8, 1712, and for about 18 months enjoyed the usual roistering life of the young gallant. He left without taking a degree and went abroad. At Antwerp he met the duke and duchess of Marlborough. She praised his good sense and wit; the young man admired the duke's dignity and desire to please. At Paris, under Louis XIV, he perceived his own lack of finish as a man of the world. The art of capturing the admiration of men and women became all-important to him, and he linked it with powers of persuasion and with grace in speech and writing.

He returned to London in Dec. 1714 to be presented by his influential kinsman, Gen. James Stanhope, to George I. He became member of parliament for St. Germans, Cornwall, but had to go abroad in Aug. 1715 to avoid the consequences of having spoken in the house of commons when under age. In Paris he attached himself to the English ambassador, Lord Stair, and learned the rudiments of diplomacy. He came back to England in 1716, was elected member for Lostwithiel in 1722 and, on the death of his father in 1726, became 4th earl of Chesterfield.

His 12 years' service as gentleman (afterward, lord) of the bedchamber to the prince who had become George II resulted in his appointment in April 1728 as English ambassador to The Hague. Through his close friendship with the grand pensionary, Simon van Slingelandt, he managed in 1728 to obtain Dutch support for the treaty of Seville. He also initiated discussions for the marriage of the prince of Orange to George II's eldest daughter, Anne. For these services he received the Garter (1730) and became lord steward (1730). In the following year he negotiated the second treaty of Vienna, but shortly afterward resigned his embassy to return home to regain his health and recoup his finances. His stay in Holland was memorable not only for the great impression made by his winning manners and skillful diplomacy, but for a more personal reason. As a result of an affair with a governess, Elizabeth du Bouchet, the child who was to be the recipient of Chesterfield's famous *Letters to His Son* was born in 1732. He was illegitimate but was given the name of Philip Stanhope.

In England, Chesterfield took up his parliamentary career again, and so strongly opposed Sir Robert Walpole's Excise bill that he sacrificed (1733) his office of lord steward in defeating the measure. In spite of marriage to the king's half sister, Melusina von der Schulenburg, countess of Walsingham, in Sept. 1733, Chesterfield lost favour at court. For the next ten years he was one of the most effective leaders of the opposition. His acid contributions to *Fog's Journal* (1736), *Common Sense* (1737) and *Old England* (1743) all served to intensify the king's dislike. Even when Walpole and Lord John Carteret had fallen and the Pelhams had come into office, they had to overcome strong objections from George II before they could offer Chesterfield "honourable Irish exile"—the viceroyalty of Ireland.

Before he took up the post, Chesterfield was sent (Jan. 1745) to The Hague to obtain Dutch support for the part England played in the War of the Austrian Succession. In Ireland his work was an unqualified success. He held office there (Aug. 1745–April 1746) only for the length of the young pretender's stay in Scotland and England, but managed to maintain George's authority by a policy of toleration toward Roman Catholics and by recruiting four extra regiments of Protestants from northern Ireland. Poverty seemed to him the worst of Irish ills, and he won general support for his vigorous economic measures, encouraging agricultural improvement and the linen, glass and paper industries. Chesterfield found the task of ruling congenial and enjoyed acting as a benevolent despot.

He was far less happy when he became secretary of state in Oct. 1746. With Henry Pelham, he pressed for immediate peace with France but could not overcome the opposition of the king and the duke of Newcastle. A competent administrator, he was subjected to the fussy meddling of Newcastle; he resigned in Feb. 1748 and refused a dukedom, but pressed for and obtained royal favours for two relatives.

He had begun building Chesterfield house, London, in 1747, as a centre of polite life and as a symbol of good taste, but, ironically, he was overcome by deafness and found himself isolated in the society he loved. He gradually retired from public life, and his last great service to the nation took place in 1751 when he helped to bring about a reform of the calendar by a brilliant speech introducing the Calendar (New Style) bill, which came into force in 1752.

Chesterfield's relations with the leading literary figures of the day were cordial. He won their praise for his wit and urbanity, and was on familiar terms with Pope, Swift, Lord Bolingbroke, Voltaire and Montesquieu. He was also the patron of many struggling authors. One of them, Samuel Johnson, planned to produce an English dictionary, and Chesterfield gave him an interview and £10. Seven years passed before the project came to Chesterfield's notice again; then he wrote two articles in the *World* recommending the dictionary. Johnson found out their author's name and composed (Feb. 1755) his famous letter attacking patrons. Opinions differ as to the merits of his case, but it is certain that he was unfair to Chesterfield.

Johnson did Chesterfield's reputation another disservice when he described the *Letters to His Son* as teaching "the morals of a whore, and the manners of a dancing master." The phrase neatly summarizes something less than a half-truth, and Chesterfield's outlook is better understood from his own Letter XCI, in which he advises his son: ". . . first, to do your duty towards God and man, without which, everything else signifies nothing; secondly, to acquire great knowledge, without which you will be a very contemptible man, though you may be a very honest one; and lastly to be very well bred, without which you will be a very disagreeable, unpleasing man, though you should be an honest and a learned one." Chesterfield intended his son for the diplomatic service and drew on his own experience for methods of fashioning a boy who had scholarly tastes but was naturally gauche. The emphasis on deportment is better known than any other side of his teaching, though his advice to his son to enjoy a liaison with a woman of refinement (instead of promiscuous relationships) has been frequently noted and condemned. To understand his point of view, it is necessary to recall the prevailing code of the Restoration and Augustan periods. Chesterfield can then be appreciated as a man of discrimination, one who admired the French attitude to sexual relationships as much as he respected French achievements in literature and social life. The strongest charge against his philosophy of life is that it leads to a concentration on place and power, on worldly aims. At the same time, this may well have led to the instant and perennial success of the *Letters to His Son*. Here is a rational view of life, coolly, elegantly and wittily presented; it wins acceptance, whether grudging or whole-hearted, by its directness, its shrewd assessments and its pleasing style based on the conventions of well-bred conversation.

Chesterfield took delight in forming the character of the young, and he wrote further letters in the same vein to his godson and to Lord Huntingdon. He also composed many hundreds of letters to other correspondents, always accommodating himself to the interests and character of the recipient. In letters of state he keeps lucidly to the matter in hand; in private letters the tone varies from elaborate courtliness to playful trifling. Only in two letters to Lord Bute is there strong feeling, and it is typical of the man that this should have been aroused by the court's attitude toward his son's illegitimacy.

Chesterfield bore his deafness, his isolation and his disappointment over his son's career and death (1768) with stoicism. He even jested at his own physical decline: "Tyrawley and I have been dead these two years, but we don't choose to have it known." Dying in London on March 24, 1773, he showed to the end a courteous regard for others and a cool acceptance of man's many infirmities.

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(C. J. L. P.)

CHESTERFIELD, a market town and municipal borough of Derbyshire, Eng., 12 mi. S.S.E. of Sheffield by road, lies at the junction of the Rother and Hipper rivers. Pop. (1961) 67,833. Area 13.2 sq.mi. Roman lead mines were found there. In 1204 King John granted it the privileges of a free borough, although the town probably already had prescriptive borough rights. It was incorporated by Elizabeth I in 1598. In 1266 Chesterfield was the scene of a battle between the royal forces and the barons, and during the Civil War in the 17th century the parliamentarians suffered a defeat there.

The 14th-century parish church of St. Mary and All Saints (chiefly Decorated) has a lead-covered wooden spire 228 ft. high, which because of timber warping is twisted nearly 8 ft. out of the perpendicular. The Stephenson Memorial hall (1870), used as a civic theatre, commemorates George Stephenson (*q.v.*), the engineer, who lived at Tapton house (now a secondary school) and is buried in Holy Trinity church. The grammar school, now the Chesterfield school, was founded in 1594. The Revolution house at Old Whittington, formerly the Cock and Pynot inn and restored in 17th-century style in 1938, when it was acquired by the corporation, was the place where the earl of Devonshire and other conspirators met in 1688 to plan the overthrow of James II.

Chesterfield's industries include mining and agricultural and mechanical engineering; iron, steel and brass founding; tanning; the manufacture of cardboard boxes, steel tubes, railway freight cars, surgical dressings, electric lamps, gas governors, pottery and decorated glassware, furniture and confectionery. In the neighbourhood are ironstone and sandstone quarries; chemicals, nonbituminous fuels and refractories are also manufactured.

CHESTER-LE-STREET, an urban district of County Durham, Eng., near the Wear river, 7 mi. N. of Durham by road. Pop. (1961) 18,948. Area 4.2 sq.mi. Chester-le-Street (Coneangium) was a Roman station, where many Roman and pre-Roman relics were excavated, including the probable headquarters of the camp commandant or governor. As Cunecastre it became the seat of the bishop of Bernicia in 883 and the body of St. Cuthbert, brought by monks from Holy Island, reposed there until the see and shrine were removed to Durham in 995. The church of SS. Mary and Cuthbert contains the 14 Lumley funerary monuments, most of them Elizabethan forgeries.

The Durham coal field employs a large section of the population. In the town there are two factories manufacturing confectionery and dresses, and a large transport undertaking.

CHESTERTON, GILBERT KEITH (1874–1936), English journalist and author, who was outstanding as critic, polemicist and rhetorical poet, and who was known for his exuberant personality and rotund figure, was born in London, May 29, 1874. He was educated at St. Paul's school, where, at an unusually early age, he gained the Milton prize for English verse. On leaving school, from 1892 to 1895 he studied art at the Slade school and English literature at University college, London; though he had a talent for draftsmanship, his natural bent was literary, and he went through the usual apprenticeship of free-lance journalism, occasional reviewing and work in a publisher's office. In 1900, after having produced a volume of poems, *The Wild Knight* (1900), which led to some critical expectation for the future, he became a regular contributor of signed articles to the *Speaker* and the *Daily News*. In 1901 he married Frances Blogg.

One of the last of his school reports (July 1892) at St. Paul's reads: "Not a quick brain, but possessed by a slowly moving tortuous imagination. Conduct always admirable." This was singularly unprophetic, for in debating and brilliant public lecturing, in journalism and fantastic fiction, his agile mind was perhaps the most prolific of his generation. He early developed the weapon of paradox to turn conventional platitudes on their heads and he was exasperatingly successful in "debunking" late Victorian decadence. But the paradox assumed its most significant role when, like the witty conceit of the metaphysical poets in the 17th century, it probed for his own day the profound ambiguities of Christian theology.

His earlier writings, to 1910, were concerned with three main areas of interest. First, his social criticism, largely scattered in his voluminous journalism, was gathered in *The Defendant* (1901), *Twelve Types* (1902) and *Heretics* (1905). This writing had been given intensity by his strong views on the South African War (though deeply patriotic, he was pro-Boer); and, in 1912, his social writing had an even darker intensity from his part in attacking political corruption in the "Marconi affair" (*see* LLOYD GEORGE OF DWYFOR, DAVID LLOYD GEORGE). The chapter in his *Autobiography* (1936), "The Case Against Corruption," is his most lucid expression of political integrity; he had begun his political thinking as a Liberal, but after a brief radical period became, with Hilaire Belloc, a "Distributist," phases in his thinking which were reflected in *What's Wrong With the World* (1910). "Distributism" he described as "a simple idea . . . to restore possession" of land, quoting with approval Francis Bacon's aphorism, "Money is like muck, not good except it be spread."

His second preoccupation in writing was with literary criticism. *Robert Browning* (1903) in the "English Men of Letters" series provided him with a congenially complex and paradoxical subject. *Charles Dickens* (1906) was a profounder work and was followed by a brilliant series of prefaces to the individual novels, *Appreciations and Criticisms of the Works of Charles Dickens* (1911); his sensitive exploration of "dignity and pathos" in *Pickwick Papers*, of the discordant ugliness of *Oliver Twist* and of the "serene irony" of *Great Expectations* remain his finest contributions to criticism, though his *George Bernard Shaw* (1909), the handbook *The Victorian Age in Literature* (1913), together with the studies of *William Blake* (1910) and the later monographs on *William Cobbett* (1925) and *Robert Louis Stevenson* (1927) have a spontaneity which place them above the works of many academic critics. He was frequently cavalier in his treatment of facts and sources; yet his *St. Thomas Aquinas* (1933) was highly praised by the great French medievalist Étienne Gilson.

This work was in fact the crowning product of his third major field of writing, theology and religious argument. He became a Roman Catholic in 1922 and though he had long argued the relation between theology and society (having already had the stimulus for some years of the brilliant group of Anglican sociologists of the Christian Social union, Bishop Charles Gore, Conrad Noel, Percy Dearmer and Canon Henry Scott Holland, wittily and affectionately described in the *Autobiography*), his conversion added edge to his controversial writing, notably *The Catholic Church and Conversion* (1926), his writings in *G. K.'s Weekly* and the late *Avowals and Denials* (1934). The most immediate (as it remained the most engaging) work which came from his conversion was *St. Francis of Assisi* (1923), a serene biography, followed by the essay in "historical theology," *The Everlasting Man* (1925).

Chesterton was equally prolific in three fields of creative writing, in verse, essays and short stories, to which must be added two plays. Under pressure from Bernard Shaw, Chesterton wrote his first play, *Magic*, for production at the Little theatre in 1913; it was not a success, nor was the later play *The Judgment of Dr. Johnson* (1927).

His verse is more successful. He was a master of ballad forms, whether in the grave and stirring "Lepanto" (1911), in the drinking songs of *The Flying Inn* (1914), in the tiny suggestion of a ballad off stage in "The Donkey," written in strict "fourteeners," or in the savage turn of "Elegy in a Country Churchyard," written at the height of his bitter attack on Rufus Isaacs and Lloyd George over the "Marconi affair." Indeed, when it was not uproariously comic, his verse was frankly partisan and didactic.

His essays developed his pawky, paradoxical irreverence to its ultimate point of real seriousness. At times the quirk is desired for its own odd sake; too frequently the self-evident is turned upside down for the mere fun of it. But at its best his style illuminates a truism and makes a commonplace mint-new. "A Defence of Nonsense" (1901; in *Stories, Essays and Poems*, "Everyman" series, 1935) shows him at his happiest: "Nonsense and faith (strange as the conjunction may seem) are the two supreme symbolic assertions of the truth that to draw out the soul of things with a syllogism is as impossible as to draw out Leviathan with a hook."

Most readers probably value his fictional writing most highly, and especially the Father Brown stories of detection. He had early produced *The Napoleon of Notting Hill* (1904), a romance of civil war in suburban London, which was followed by the loosely knit collection of short stories, *The Club of Queer Trades* (1905), *The Man Who Was Thursday* (1908) and *The Ball and the Cross* (1910). But the most successful association of fiction with his characteristic social judgments is to be found in the Father Brown series (*The Innocence of Father Brown* in 1911, followed by *The Wisdom . . . ,* 1914, *The Incredulity . . . ,* 1926, *The Secret . . . ,* 1927, and *The Scandal of Father Brown* in 1935). Though physically a child of Chesterton's own fancy, Father Brown was based on the mental characteristics of his friend, the Rev. (later Monsignor) John O'Connor, the "detection" turning upon the unique union of direct simplicity, innocence and priestly insight in Father Brown.

In any final assessment of Chesterton, however, it is likely to be not the writer, nor even the brilliant controversialist in print or in public debate, that will be ultimately memorable, but rather the man who was the focus of so many friendships with men as diverse and of such contradictory intellectual qualities as H. G. Wells, Shaw and Belloc. He had worked happily with Gore, Charles Masterman and Scott Holland; had earned the profound affection of Maurice Baring, Edmund Bentley and Max Beerbohm. There was indeed no effervescent group, few creative personalities, scarcely an important movement of the intellect, with which he was not closely associated, either in active collaboration or in vigorous opposition, for nearly half a century. He had written and spoken with unpopular force on the South African War: he was to live to pass brooding judgment on fascism in the 1930s. To read the *Autobiography* is to be most impressed not by the intellect, the proliferating ideas, but by the largeness of a personality whose laugh could be heard "many doors away" and which could direct its ridicule most successfully on itself. Chesterton died at Beaconsfield, Buckinghamshire, on June 14, 1936.

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CHESTNUT. This name is usually restricted to four species of the genus *Castanea* (family Fagaceae) whose burlike fruits contain two or three nuts. Other members of the genus, featuring small single-fruited burs borne in racemose clusters, are called chinquapins. Golden chinquapins with similar fruits, but with persistent foliage the undersurfaces of which are a golden yellow, belong to the genus *Castanopsis*, also of the Fagaceae. The horse chestnut (*q.v.*), a totally unrelated tree, is included in the genus *Aesculus* of the family Hippocastanaceae.

Chestnuts are moderately large to large trees characterized by alternate, simple, deciduous leaves with bristle-tipped margins. Their small, inconspicuous, unisexual flowers are borne in catkins. Many of the inflorescences are wholly staminate; others are bisexual with the pistillate flowers inserted only at the base of the rachis. The fruit, a nut, borne in clusters of two or three, is enclosed in a leathery husk clothed with multibranched spines.

Chestnuts are prolific seeders but during periods of prolonged drought seedlings often die out in large numbers. On the other hand, once young trees have become established they develop deep root systems, and older trees are capable of withstanding drought much better than most other species with which they are associated. Best development occurs on loose, porous, moderately dry soils which are either acid or neutral rather than alkaline. All species exhibit a remarkable capacity for vegetative reproductivity through the development of vigorous coppice sprouts arising from the root collar following the removal of the bole in harvesting operations.

Chestnuts play an important role in the forest economy of the regions in which they are endemic. Both wood and bark are richly endowed with tannin, a chemical complex which is extracted in commercial quantities and used in converting raw hides into leather. The fruits are an article of diet for both man and animal. The soft, firm, durable wood has many uses. Roundwood is especially suited for poles, posts, piling, crossties and mine props, while large logs are sawed into lumber for further remanufacturing into furniture, dimension timbers, planing-mill products and paneling.

European Chestnut.—The European chestnut, *C. sativa* (also termed Spanish chestnut), is probably the most important species. Seldom found over 4,000 ft. of elevation, it ranges through much of southern Europe, northern Africa and southern Asia east to the Caucasus. It has been successfully propagated in England, Scotland, India and Australia. During the 19th century it became widely established in eastern United States as well as on the Pacific coast. While most of the eastern trees have been destroyed, it is still frequently encountered in California and in the Pacific northwest. Trees of the European chestnut often attain massive proportions, and what was probably the largest of all was a tree at the foot of Mt. Etna in Sicily, that in 1850 was reputed to have had a girth of 204 ft. and to exceed an age of 2,000 years. It was later destroyed by volcanic action. This species is the principal source of the chestnuts consumed in Europe and the United States. The largest nuts, called marrons, are eaten raw, or they may be boiled or roasted. Those of lesser size are commonly allowed to dry and harden, after which they are milled into flour that is substituted for cereals in making soups, bread and other foodstuffs. The small nuts, when gathered, are fed to livestock.

J. HORACE MCFARLAND CO.

CHINESE CHESTNUT (CASTANEA MOLLISSIMA): (RIGHT) SPINY HUSK OPEN, EXPOSING NUTS

Japanese Chestnut.—The Japanese chestnut, *C. crenata*, is a tree of modest proportions found in the mountains of Japan, usually below an altitude of 3,000 ft. Trees in excess of 60 ft. in height or 36 in. in diameter are only rarely encountered. This species is an abundant fruiter, and, although the nuts are smaller and of poorer texture and flavour than those of the European chestnut, they are a common article of the Japanese diet. Their flavour, however, is decidedly improved by boiling or roasting. The Japanese chestnut was introduced into the United States in 1876, and became naturalized in some areas.

Chinese Chestnut.—The Chinese chestnut, *C. mollissima*, attains about the same stature as the Japanese species, and is often found in highlands up to elevations of 8,000 ft. The tree was initially introduced into the United States in 1853, but only after the U.S. department of agriculture became interested in its horticultural possibilities in 1906 were seeds imported and distributed in large quantities. The trees varied greatly in form and stature, but those of squat habit with large spreading crowns were preferred by pomologists.

The nuts, although not as large as the European marrons, are well formed and exceedingly tasty, and a number of varieties have been developed. Among the most popular of these are the Bartlett, Carr, Hobson, Milford, Reliance, Stokes, Yankee and Zimmerman.

American Chestnut.—The American chestnut, *C. dentata*, was once one of the nation's most valued timber trees. Its range extended from southern Maine west to southeastern Michigan, thence south and west to southwestern Florida and eastern Arkansas. It was particularly abundant in the Appalachian mountains below elevations of 3,000 ft. and was to be found over much of eastern United States except on the coastal plains. Growth was rapid on good sites and mature trees commonly attained a height of 100 ft. and a diameter of more than 42 in. (maximum 120 ft. × 10 ft.). Few American timbers enjoyed more diverse uses. As a core material in furniture panels it had no peer.

Chestnut Blight.—At the turn of the 20th century, however, the American chestnut became infected with a fungus disease, chestnut blight (*Endothia parasitica*), which was inadvertently introduced into the United States on planting stock brought in from the orient. Only a mild-mannered organism in its native realm, it proved to be a lethal parasite on not only the American chestnut, but upon the European chestnut which was being propagated in orchards as well. From the initial point of infection on Long Island, N.Y., the disease spread rapidly. In the short space of 35 years this species became the victim of one of the world's greatest forest tragedies. Early efforts to control the spread of the organism failed completely, and thousands upon thousands of dead trees and snags remained in silent testimony to the ravages of the disease. Occasional healthy trees, which are obviously blight resistant, are encountered at wide intervals, but little attempt has been made to propagate their progeny. Experiments reveal that hybrids of the American and Japanese chestnuts also exhibit considerable disease resistance, but little use has been made of them in forest plantings (*see* also Plant Diseases: *Fungi*).

See also Nut. (E. S. Hr.)

CHETTLE, HENRY (*c.* 1560–*c.* 1607), English dramatist in many respects typical of the versatile, popular writer of the Elizabethan age. He began his career as a printer and associated with literary men like Robert Greene and Thomas Nashe. He prepared for publication Greene's posthumous *Groatsworth of Wit* (1592), with its attack on Shakespeare as an "upstart crow," but offered Shakespeare compliments and an olive branch in his own *Kind-Heart's Dream* (entered in the Stationers' Register, 1592), a topical satire framed in a dream fable. His *Piers Plainness' Seven Years' Prenticeship,* a narrative blending pastoral and picaresque, appeared in 1595, and *England's Mourning Garment,* a lament for Queen Elizabeth I, in 1603. By 1598 he had written enough plays for Francis Meres in *Palladis Tamia* to commend him as one of our "best for comedy," and between 1598 and 1603 he is known to have had a hand in 49 plays. Of these only five were published: *The Downfall of Robert, Earl of Huntington* (1601), a play mainly by Anthony Munday revised by Chettle; *The Death of Robert, Earl of Huntington* (1601), written with Munday; *The Pleasant Comedy of Patient Grissill* (1603), with Thomas Dekker and William Haughton; *The Blind Beggar of Bednal-Green* (1659), with John Day; and *The Tragedy of Hoffman,* the only play extant which can be attributed to Chettle alone. A play of the popular revenge type, it enjoyed a revival shortly before its publication in 1631. Chettle also helped to revise the play of *Sir Thomas More,* the manuscript of which has one passage in his handwriting. He died not later than 1607, when Dekker's *A Knight's Conjuring* described his arrival in the Elysian fields.

See H. Jenkins, *The Life and Work of Henry Chettle* (1934). (Hd. J.)

CHEVAL-DE-FRISE, a military obstacle apparently originating in the Dutch War of Independence, was often used in field operations as a defense against cavalry, hence the name (French for "Friesland horse"), as the Dutch were weak in the mounted arm and had to check the enemy's cavalry by artificial obstacles. A single cheval-de-frise consisted of a long wooden beam or barrel with holes drilled through it at intervals for insertion of spears or other pointed weapons. Standing three or four feet above the ground, something like a huge carpenter's sawhorse, it presented a hedge of spears to the enemy. A line of chevaux-de-frise chained together could be used to close the breach of a fortress or to entangle the attackers of a fortified position. Felled trees were commonly used for this purpose in the 18th century, their branches pointing outward to make a seemingly impenetrable thicket. Chevaux-de-frise are the tactical ancestors of the barbed-wire entanglements of the 20th century.

CHEVALIER, MICHEL (1806–1879), French economist, an early convert to the theories of the comte de Saint-Simon (*q.v.*). He became a member of the Institut de France in 1850 and in 1851 published his *Examination of the Commercial System Known by the Name of Protective System.* He was influential in the discussion of the Cobden treaty between France and Great Britain in 1860. In that year he became a member of the French senate.

Among his other works are *Course [of Lectures] in Political Economy* (1842–50); *Essays in Industrial Politics* (1843); and *Concerning the Probable Decline [in Value] of Gold* (1859), translated into English by Cobden. (Fk. L. K.)

CHEVALIER, ULYSSE (1841–1923), French priest and scholar and the author of important bibliographies on medieval history, was born at Rambouillet on Feb. 24, 1841. He published a great number of documents relating to the history of Dauphiné and a *Bibliothèque liturgique* in six volumes (1893–97), the third and fourth volumes of which constitute the *Repertorium hymnologicum,* containing more than 20,000 articles. His principal work was the *Répertoire des sources historiques du moyen âge.* Of this, the first part, *Bio-bibliographie* (1877–78; 2nd ed., 1905), contained the names of all the historical personages alive between the years 1 and 1500 who are mentioned in printed books, together with the precise indication of all the places where they are mentioned. The second part, *Topo-bibliographie* (1894–1903), contained not only the names of places mentioned in books on the history of the middle ages, but, in a general way, everything not included in the *Bio-bibliographie.* The *Répertoire* remains one of the most important bibliographical monuments ever devoted to the study of medieval history. Chevalier was professor of ecclesiastical history at Lyons from 1887. He died at Romans in Dauphiné in 1923.

CHEVALIER (literally "horseman"; *see* Cavalier), a French title originally equivalent to the English knight. For its connotation in medieval times *see* Knighthood, Chivalry and Orders. Later the title chevalier came to be used in a variety of senses. It by no means always denoted membership of any order of chivalry, being very often used by men of noble birth or noble pretensions who could not claim any of the standard territorial titles (countships, marquisates, etc.). An ordinance of 1629 tried to forbid its being assumed except by virtue of royal letters patent or "eminent personal quality" (*éminence de qualité personnelle*). On the other hand a younger son of a great family *X,* who could neither take any title from any of its great estates nor get himself a suitably high position in the church, might be admitted to the Order of the Hospital of St. John of Jerusalem (knights of Malta) and so be styled the chevalier de *X.* Chevaliers of the French royal orders usually had some territorial title by which they remained designated (as an English duke is not designated as Sir . . . , though he be a knight of the Garter). There was some controversy as to whether the nobility attached to the title was hereditary.

Napoleon laid down certain conditions for the assumption of the title by members of the Legion of Honour. He also reserved the right of appointing chevaliers of the empire as he might see fit.

CHEVERUS, JEAN LOUIS LEFEBVRE DE (1768–1836), French prelate, was born on Jan. 28, 1768, in Mayenne. He was made assistant, then pastor, of Notre Dame of Mayenne, but because of the Revolution he fled in 1792 to England where he founded Tottenham chapel. Arriving in Boston, Mass., in 1796, he assisted at Holy Cross church and served the Indian missions in Maine. His courage and charity during the yellow fever epidemic of 1798, together with his eloquent preaching, attracted many Protestants. In 1808 the diocese of Boston was created with Cheverus its bishop; he was consecrated Nov. 1, 1810. At the insistence of Louis XVIII he returned to France in 1823 to become bishop of Montauban. In 1826 he was made archbishop of Bordeaux and peer of France, serving in the upper chamber of the legislature until 1830. Nominated by Louis Philippe to the college of cardinals, he was invested in Feb. 1836. Founder of a retirement system for the clergy of Bordeaux, and author of *Statuts du Diocèse de Bordeaux,* he died in that city on July 19, 1836.

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CHEVET, in architecture, the entire eastern termination of a church choir (*q.v.*), a term used especially for churches with apses (*q.v.*); also an ambulatory from which a series of radiating chapels open. It was a distinctly French development, appearing in a highly organized form in many 12th-century Romanesque churches; *e.g.,* Notre Dame du Port, Clermont-Ferrand and St. Paul, Issoire. It resulted from attempts to place as many subsidiary altars in chapels as possible in close association with the high altar and the procession path around it. The development of the chevet produced many spaces of unusual shape whose vaulting was one of the great incentives toward the evolution of the ribbed and pointed vault; the chevet, therefore, played an important part in the transition from Romanesque to Gothic architecture.

The radiating chapels were usually uneven in number, and the central one, frequently much larger than the others, was dedicated to the Virgin Mary and known as the Lady chapel (*q.v.*).

CHEVIOT CLOTH, a woolen fabric made originally from the wool of Cheviot sheep, and now also made from other types of wool or from blends of wool and man-made fibres. Cheviot wool possesses good spinning qualities, since the fibre is fine, soft and pliable. The true cheviot type of fabric has a crispness of texture similar to serge cloth except that it is slightly rougher and heavier.

Cheviot fabric may be produced either from woolen or worsted yarns according to the character and texture or feel desired in the finished fabric. Some qualities are produced from crossbred worsted yarns that are adapted for furnishing crispness of texture. Cheviot suitings for sportswear are made from the harder-spun worsted yarns, while some qualities are also made from botany worsted. So-called cheviot suitings of inferior quality contain an admixture of cotton, while other low-grade cheviots are weighted with flocks.

Cheviot shirting is a stout, twilled, cotton fabric woven with small geometrical patterns or with warp stripes and bleached weft. (H. N.)

CHEVIOT HILLS, a tract of highland followed for about 35 mi. by the boundary between England and Scotland. The most important route across is the main road over Carter Bar (1,370 ft.), a pass from the head of Redesdale in Northumberland to the valley of the Jed. The hills east of Carter Bar were carved from a great pile of volcanic rocks of Devonian age. In the heart of a mass of andesitic lavas, granite was later intruded, and forms the twin summits of The Cheviot (2,676 ft.) and Hedgehope hill (2,348 ft.). The hills are steep, but smoothly rounded, and are dissected by deep glens almost deserted save for a few shepherds' cottages, though evidences of prehistoric occupation are numerous. West of Carter Bar the Border hills nowhere reach 2,000 ft., and the rocks are of Lower Carboniferous age, mainly shales and sandstones; but, heavily coated with glacial drift, they form undulating, peaty moorlands. Apart from tongues of farmland, the area forms an extensive tract of grass and heather moorland, used as grazing for hardy sheep of the local Cheviot or Blackface breeds. Since World War II, however, the Border fells in the upper basins of the North Tyne and Rede have been the scene of major afforestation.

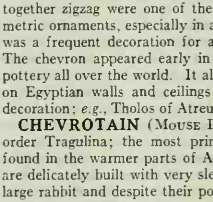
As well as being the scene of much Border warfare, the area was for centuries the fastness of cattle thieves who raided the neighbouring lowlands where fortified farmsteads, known as pele castles, are a characteristic feature. The land controlled by the forestry commission became a National Forest park in 1955, and an even larger adjacent area was designated as the Northumberland National park. (Ar. E. S.)

CHEVREUSE, MARIE DE ROHAN-MONTBAZON, Duchesse de (1600–1679), French princess whose attractive person and bold diplomacy made her a power in politics for nearly 30 years, was born in Dec. 1600, the daughter of Hercule de Rohan, duc de Montbazon. Married in 1617 to Charles d'Albert, later duc de Luynes (*q.v.*), she was appointed superintendent of the queen's household and soon captivated the queen, Anne (*q.v.*) of Austria. Widowed in Dec. 1621, she was in March 1622 dismissed from court by Louis XIII for having accidentally caused Anne's miscarriage (Anne fell while running with her), but secured her readmission by hastily marrying, in April, the influential Claude de Lorraine, duc de Chevreuse. In 1625, when the earl of Holland was in Paris for Henrietta Maria's marriage to Charles I of England, the duchesse became his mistress. Their efforts to promote a liaison between Anne and the duke of Buckingham led to the latter's scandalous behaviour when they were all escorting the bride on her way to England. In England the duchesse won Charles I's favour but discredited her husband's embassy by her conduct with Buckingham and Holland. Back in France, she organized the widespread opposition to the king's plan for the marriage of Gaston, later duc d'Orléans (*q.v.*). This grew into a dangerous conspiracy (1626). When its nominal leader, J. B. d'Ornano, was arrested, the duchesse seduced the young marquis de Chalais (Henri de Talleyrand) into carrying it on. He was beheaded. Exiled from court, she fled to Lorraine, where in 1627 she easily persuaded the duke, Charles IV, to join Buckingham's anti-French coalition.

Late in 1628 the cardinal de Richelieu, judging her too dangerous as an enemy, allowed her return to France. She then collaborated with him for a time, but in 1633 was exiled to Touraine for having betrayed to foreign powers state secrets extracted from the infatuated keeper of the seals, Charles de l'Aubespine, marquis de Châteauneuf. In 1637, after the Val-de-Grâce affair, she fled in disguise to Spain. Going thence to England, she spent two years in prevaricating correspondence about returning to France, then went to join the French malcontents in the Spanish Netherlands (1640). Louis XIII's will forbade her ever returning to France, but on his death (1643) she returned—to find Anne, now regent, under Cardinal Mazarin's influence. Having inspired the conspiracy of "les Importants" (*see* Beaufort, François de Vendôme, Duc de), she was again exiled from Paris. She fled again to the Netherlands via England in 1645. Returning to Paris in April 1649 (*see* Fronde), she negotiated first the agreement between the Frondeurs and Mazarin for the arrest of the Condé princes (1650), then the reconciliation of the Frondeurs and the Condés (1651). When Condé broke the bargain that his brother Conti should marry her daughter Charlotte (Mlle de Chevreuse), she made her final peace with Mazarin and, after Charlotte's sudden death (1652), retired to Dampierre to live quietly. A widow again in 1657, she may have secretly married her last lover, Geoffroy de Laigue. She died at Gagny on Aug. 12, 1679. (J. G. R.-S.)

CHEVRON, an ornament formed of two slanting lines meeting at an angle. In heraldry (*q.v.*) it is a bent bar. It is also one of the most common distinguishing marks for military and naval uniforms, where it is placed on the sleeves and serves either as a mark of honour or to indicate a special function (*see* Insignia, Military). In architecture, the term is sometimes applied to the angle formed by the meeting rafters of a roof, but it is more commonly used for the purely decorative form. Chevrons joined together zigzag were one of the commonest of Romanesque geometric ornaments, especially in areas under Norman influence. It was a frequent decoration for arch moldings and column shafts. The chevron appeared early in primitive work and is found on pottery all over the world. It also occurred frequently in textiles, on Egyptian walls and ceilings and in Aegean art as a column decoration; *e.g.*, Tholos of Atreus at Mycenae, *c.* 1200 B.C.

CHEVROTAIN (Mouse Deer), any member of the infraorder Tragulina; the most primitive of the living Ruminantia, found in the warmer parts of Asia and in parts of Africa. They are delicately built with very slender legs, are about the size of a large rabbit and despite their popular name have no close affinity with deer or mice. The fur is reddish-brown with spots and irregular stripes of paler colour or white; the underside is pale. They have no horns, but the males have small, curved tusks protruding from the mouth in the upper jaw. Several species (*Tragulus*) are known from the forests of India, Malaya and the East Indies, where they inhabit dense jungle. They are crepuscular and usually solitary; two young are generally born at the end of the rainy season. The slightly larger water chevrotain (*Hyemoschus*) of western Africa inhabits the thick cover on the banks of rivers. Chevrotains are timid and become very tame in captivity. Their method of tripping daintily on their hoof tips is characteristic. *See* also references under "Chevrotain" in the Index volume. (L. H. M.)



ERNEST P. WALKER

WATER CHEVROTAIN (HYEMOSCHUS AQUATICUS)

CHEWING GUM. Chewing gum is a confection product prepared from chicle and similar resilient substances, combined with sweetening and flavouring. For many centuries past the Mayans and other Central Americans chewed chicle, the coagulated milky juice (latex) of the sapodilla tree, just as people in many lands chewed various resins, leaves and grasses for relaxation and enjoyment. From the Indians of New England, the American colonists learned to chew spruce tree resins, and spruce gum was marketed in the United States in the early 1800s as the first commercial chewing gum. Later, chewing gum made of paraffin wax was introduced.

In the 1860s the use of chicle as a chewing-gum base was developed. Its resilient chewing quality and ability to carry flavours won preference for this type of gum and paved the way for the major rise in the popularity of chewing gum which began in the early 1900s with the advent of modern processing, packaging and promotional methods.

Modern chewing gum consists, by weight, of approximately 20% gum base, 19% corn sirup, 60% sugar and 1% flavouring. To ensure uniform chewing texture, gum base may be blended of as many as 25 latex products and like materials. The latex products are obtained from trees growing wild in tropical forests. The trees are tapped with grooved cuts from which the latex flows into containers. The latex is then collected, boiled down and molded into blocks. Chicle from Central America, leche caspi and sorva from the Amazon valley and jelutong from British Borneo and Indonesia are the principal types of latex products used.

Synthesized preparations having similar properties, such as vinyl resins and microcrystalline waxes, have been developed for use in combination with the tropical latex products. In the manufacturing process, the gum-base ingredients are washed, ground, sterilized and blended. In mixing kettles, the melted base is combined with corn sirup, sugar and flavouring. The doughlike mixture is then rolled into sheets, and divided into sticks or pellets. Essential oils from mint plants—peppermint and spearmint—provide the two leading flavours. In food content, one stick of gum contains nine calories.

The use of chewing gum rises in periods of social tension, and it increased rapidly during and after World Wars I and II. In the United States annual per capita consumption, for example, went from 39 sticks in 1914 to 89 in 1924; from 98 in 1939 to 165 in 1953. The English-speaking and Latin-American countries are the largest chewing-gum consumers. Second to the United States in per capita consumption is Canada. (P. H. E.)

CHEYENNE, an Algonkian-speaking Indian tribe inhabiting the western Great Plains of the United States in the 19th century. As late as the 17th century the homeland of the Cheyenne was located in central Minnesota. They were thus originally a hunting and wild rice gathering people. In the general westward displacement of eastern woodland tribes by European settlers the Cheyenne, in the 18th century, migrated into the plains. In close contact with the sedentary Mandan and Hidatsa villages of the upper Missouri river, the Cheyenne adopted horticulture and the earth lodge. At the close of the 18th century, smallpox and the aggression of the Dakota decimated the village tribes at the same time that the horse and gun were becoming generally available in the northeastern plains. The Cheyenne quickly abandoned the village way of life, moving west of the Missouri to establish their range in the vicinity of the Black hills. Here, between 1780 and 1830, they developed their unique version of the nomadic Plains Indian culture.

The Cheyenne had no clans. They were bilaterally organized in ten major bands. In the spring of each year, the bands gathered for the performance of one of three great tribal ceremonies, the Sun Dance (*q.v.*), the Sacred Arrows and the Buffalo Hat ceremony. A communal buffalo hunt followed. The tribal government, consisting of a sacred council of 44 chiefs plus the seven military societies, was then dominant. Tribal mythology derives Cheyenne customs and institutions from the teachings of two culture heroes, Erect Horns and Sweet Medicine, who were instructed by Maiyun (the Great Supernatural) within a cave in Bear butte, located near Sturgis, S.D.

From 1857 to 1879 the Cheyenne were embroiled in wars with the United States. In 1950 there were 1,900 northern Cheyenne on the Tongue River Indian reservation in southeastern Montana and 3,100 intermingled southern Cheyenne and Arapaho on allotted lands in the vicinity of Anadarko, Okla. *See* also ALGONKIAN TRIBES; PLAINS INDIANS.

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(E. A. HL.)

CHEYENNE, capital city of Wyoming, U.S., and the seat of Laramie county, is located near the southeast corner of the state on Crow creek just east of the point where the Great Plains meet the Laramie mountains, front range of the southern Wyoming Rockies. It is the state's oldest city. Squatters arriving in the summer of 1867 came just ahead of the Union Pacific railroad; by Nov. 1867 the population was 4,000. Officials of the railroad claimed the townsite under its land grant but had to get army assistance before some of the squatters would recognize the company's rights. During the few months in 1867–68 when the city was the end of the tracks vigilante action was necessary to maintain order. When the unruly element moved westward with the construction gangs only 1,000 people remained to build for the future. In 1869 Cheyenne was designated capital of the new Wyoming territory, a position it retained after statehood in 1890. The city is named after the Indian tribe.

The Union Pacific railroad has always been important in the city's economy. In the 1870s Cheyenne became a major shipping point for cattle from Texas. Surrounded by grazing lands, it has never lost its cow town atmosphere although sheep now share the range with cattle. Frontier days, a six-day celebration each July, recalls cattle kingdom days of yesteryear, with rodeo events and parades in period costumes.

Cheyenne has always had a military installation. At the outset it was Ft. D. A Russell. In 1930 the name was changed to Ft. Francis E. Warren in honour of the city's most famous citizen. In 1957 the fort became the headquarters for the nation's first Atlas intercontinental ballistic missile base and launching pads soon surrounded the city.

Cheyenne's economy is well diversified with employment provided by railroads, airlines, trucking companies, state government, the fort, an oil refinery, cattle and sheep ranches, dry-farming enterprises, a veterans' hospital, several small manufacturing industries and tourism. For comparative population figures *see* table in WYOMING: *Population*. (T. A. LN.)

CHÉZY, ANTOINE LÉONARD DE (1773–1832), French orientalist, the first occupant of the chair of Sanskrit in the Collège de France. Born at Neuilly on Jan. 15, 1773, he was attracted to the study of oriental languages by the post he held from 1799 in the manuscripts section of the Bibliothèque Nationale. He held his chair at the Collège de France from 1814 and translated various works from Persian and Sanskrit of which the most notable were *Les Amours de Medjnoun et Leila* (1807) and *La Reconnaissance de Sacountala* (1830). He died of cholera at Paris on Aug. 31, 1832.

CHHATARPUR, a town and district of Madhya Pradesh, India. The town (pop. [1961] 22,146) is 140 mi. S.E. of Jhansi by road. The nearest railway station is Harpalpur (32 mi. N.) on the Jhansi-Manakpur line. The town was named after Chhatarsal, an 18th-century Bundela chief who successfully resisted the authority of the Mogul emperor Aurangzeb (*q.v.*). The town has a college affiliated to Saugar university, a museum, and a modern officers' colony.

CHHATARPUR DISTRICT (area 3,381 sq.mi.; pop. [1961] 587,373) absorbed on Jan. 1, 1950, the former princely states of Chhatarpur, Bijawar and parts of Charkhari and Panna, and formed part of Vindhya Pradesh which was merged in Madhya Pradesh on Nov. 1, 1956. It is a fertile plain lying between the Dhasan and Ken rivers and is dotted with wooded hills rising to 1,500 ft. It contains many ancient monuments including the Khajuraho (*q.v.*) (29 mi. E.); and Rajgarh fort and palace (28 mi. S.E.).
(S. M. A.)

CHHINDWARA, a town and district in Madhya Pradesh, India. The town (pop. [1961] 37,244), 64 mi. N.N.W. of Nagpur, is the district headquarters and a market town with small local industries; situated on the Satpura plateau about 2,000 ft. above sea level, it is a pleasant place with a fairly temperate climate. It is connected by Southeastern railway metre-gauge lines with Nagpur and Jabalpur on the Central railway.

CHHINDWARA DISTRICT (area 4,565 sq.mi.) had a population in

1961 of 786,596; about 75% were Hindus and most of the rest Gonds and other aboriginal tribes. In the north of the district, bordering the Mahadeo range and Hoshangabad district, are hills rising to about 3,000 ft. and containing some sal forest. The rugged country immediately south of the hills were the jagirs or feudal estates of the Gond chiefs, who once preyed upon travelers and raided the open country on their borders. South of this is the more level Satpura plateau, extending from Betul in the west to Seoni in the east and drained by the Pench and Kanhan rivers. The southern and eastern parts of the plateau include the fertile wheat plain of Chaurai. On the south again the country drops into the Nagpur plain, to which it geographically belongs. This is a rich cotton and jowar (big millet) area and is the richest and most populous part of the district; the language of the area is Marathi. On the southeast the plateau, there called the Lahmarpani, projects into the plain, and this part is noted for its breed of cattle. The lowlands of the district are hot and the uplands have a temperate climate. There are fairly extensive coal fields to the north of Chhindwara, connected by narrow-gauge railway with that town and by a broad-gauge line with Betul. In the south, near the Nagpur district border, are valuable deposits of manganese.

(D. G. Na.)

CHIABRERA, GABRIELLO (1552–1638), Italian poet who introduced new lyric metres and a Hellenic style into Italian poetry. He was born at Savona on June 18, 1552, and, after studying philosophy at the Jesuits' college in Rome, entered the household of a cardinal. He mixed in the literary society of his day but presently was drawn into a quarrel which compelled him to leave Rome. He retired to Savona, where he read Pindar and Anacreon and Pierre de Ronsard. He determined to enrich Italian poetry with new forms, and his imitations from the classics include some successful innovations in Italian verse, which were adopted by the lyrists of the next century. Chiabrera's output is great and varied: epics, pastorals, odes, lyrics, satires, dramas and religious and didactic poems. His best poetry, however, is to be found in his gracefully musical *canzonette,* described as *anacreontiche.* His autobiographical sketch is also interesting. With his adoration of Greek (when a thing pleased him greatly he was wont to talk of it as "Greek poetry"), his delight in journeys and sight-seeing, his dislike for literary talk save with intimates and equals, his vanities and vengeances, his pride in the memory of favours bestowed by popes and princes and his quiet Christianity, as a personality he deserved more study than his literary importance would suggest. He died at Savona, Oct. 14, 1638.

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CHIA-I or Kagi, a city in one of Formosa's major south central agricultural basins, about 135 mi. S.S.W. of T'ai-pei and 35 mi. N.W. of T'ai-nan. Pop. (1956) 153,032. It is connected by railway with A-li Shan, a forested mountain several miles away. Industrial plants include sawmills, paper mills and plywood factories. Chia-i also is an important marketing centre for rice, mangoes, betel nuts and longans (dragon's eyes). Near Chia-i are extensive areas of sugar cane from which yeast, alcohol and solvents and butanol are manufactured. Chia-i is a typical medium-sized Formosan marketing-manufacturing centre. It is the seat of the Chia-i *hsien* government. (N. S. G.)

CHIANA (anc. Clanis), a river of central Italy which has its source near Arezzo, runs through a wide valley toward Chiusi (anc. Clusium), passes through Lake Chiusi and, after receiving the Paglia near Orvieto, flows into the Tiber 3 mi. S. of Orvieto. In ancient times all of the wide middle valley of the river drained to the Tiber, but a natural dam at Chiusi formed by alluvial material prevented proper drainage throughout the middle ages. As a result the wide Val di Chiana became marshy and malarial from Arezzo to Chiusi. In 1788 detailed engineering plans made by Vittorio Fossombroni were begun and the work was completed between 1826 and 1838 by Lucignano and A. Manetti. The watershed was moved southward and as a result the Val di Chiana drains partly to the Arno, partly to the Tiber, and has been almost entirely reclaimed for cultivation. (G. Kh.)

CHIANG KAI-SHEK (1887–), Chinese soldier and statesman, ruler of China from 1928 to 1949 and subsequently head of a Chinese government in exile on Formosa, was born on Oct. 31, 1887, into a moderately prosperous merchant and farmer family in the coastal province of Chekiang. He prepared for a military career, first (1906) at the Paoting Military academy in north China and subsequently (1907–11) in Japan. For two years (1909–11) he served in the Japanese army, whose spartan ideals he admired and adopted. More decisive an influence was that of youthful compatriots whom he met in Tokyo; plotting to rid the motherland of its alien Manchu dynasty, they converted Chiang to republicanism and made him a revolutionary.

In 1911, upon hearing of revolutionary outbreaks in China, Chiang returned home and helped in the sporadic fighting that led to the overthrow of the Manchus. But the revolutionists soon lost control of the new republic by handing its presidency to Yüan Shih-k'ai (*q.v.*). Yüan, aiming at personal rule, used his office to crush the party that had put him into it. The revolutionists, Chiang among them, struck back; but their "second revolution" soon collapsed, and Chiang had to flee the country (1913). He returned to Japan, where he remained with one interruption to the end of 1915. Meanwhile, Yüan discredited himself, especially by an attempt to restore the monarchy with himself as emperor. Chiang returned home to participate in the "third revolution," which by dashing Yüan's hopes of founding another dynasty saved the life of the republic.

After these sallies into public life, Chiang relapsed into obscurity. For two years (1916–17) he lived in Shanghai, where he apparently belonged to the Green gang, a secret society involved in financial manipulations. In 1918 he re-entered public life by going south to join Sun Yat-sen, the leader of the Nationalist party or Kuomintang (*see* Kuomintang). Now began the close association with Sun on which Chiang was to build his fame. Sun's chief concern at the time was to reunify China, which the downfall of Yüan had left divided among warring military satraps. Having wrested power from China's alien dynasty, the revolutionists had lost it to indigenous warlords; unless they could defeat these, they would thus have struggled for nothing.

Chiang joined the southern armies as a major general but could not gain control of them; for they were actually warlord troops that supported the Kuomintang only because Sun had struck bargains with their commanders. Each side intended to outwit the other, so that treachery followed treachery. Often outmaneuvered by their confederates, the revolutionists found their southern base insecure; twice they had to abandon it and return to the north. They needed an army of their own, and to build up an army they needed foreign help. Presently they turned to Russia, the only foreign power to have shown their cause any sympathy. Chiang visited Russia in 1923 to study Soviet institutions, especially the Red army. Back in China after four months, he became commandant of a military academy established on the Soviet model at Whampoa near Canton. Russian advisers poured into Canton, and the Chinese Communists were admitted into the Kuomintang. Chiang read Marx and Lenin and, like many Asian patriots of the time, seized on Lenin's doctrine of imperialism as the clue to his country's weakness and poverty. Henceforward Leninism coloured his outlook, but it did not make him tolerant of any efforts to sovietize his own country. The Chinese Communists made such efforts as they gained strength, especially after Sun's death in 1925. Chiang, with the Whampoa army behind him the strongest of Sun's heirs, met this threat with consummate shrewdness. By alternate shows of force and of leniency, he prevented a communist coup without losing Soviet support. Moscow supported him until 1927, when, in a bloody coup of his own, he finally broke with the Communists.

Meanwhile, Chiang had gone far toward reunifying the country. Commander in chief of the revolutionary army since 1925, he had launched a massive campaign against the warlords in the following year. It ended in 1928 when he entered Peking, the capital. A new central government with Chiang at its head was established at

Nanking, farther south. In the same year Chiang became Christian, apparently at the instance of the westernized Soong family, whose youngest daughter, Mei-ling, had recently become his wife. But compared with the Japanese and the Leninist influence on his thinking, that of Christianity remained minor. Chiang stood committed to a program of social reform, but most of it remained on paper, partly because his control of the country always remained precarious. In the first place, the warlords, whom he had neutralized rather than crushed, still disputed his authority. The Communists posed another continuing threat, having withdrawn to rural strongholds and formed their own army and government. In addition, Chiang faced certain war with Japan, which, after seizing Manchuria in 1931, showed designs upon China proper. Chiang decided not to resist the Japanese until after he had crushed the Communists—a decision that aroused many protests, especially since the Communists continued to elude him. To give the nation more moral cohesion, Chiang revived the state cult of Confucius and launched a campaign, the so-called New Life movement, to inculcate Confucian morals (1934). Simultaneously he pushed western notions of hygiene and urged conscious emulation of the Japanese as models of spartan discipline.

War with Japan broke out in 1937 and for over four years China fought alone. The effort nearly broke her endurance, and Chiang repeatedly received advice to negotiate a separate peace. But he stood firm, and China stayed in the war. Her reward was an honoured place among the victors as one of the Big Five. But internally Chiang's government showed signs of decay, which multiplied as it resumed the struggle against the Communists. Civil war recommenced in 1946; by 1949 Chiang had lost continental China. He moved his government to the island of Formosa, and, vowing to recover the mainland, continued to fight the Communists in the Formosa straits.

Among the reasons for Chiang's defeat, one frequently cited is the corruption that he countenanced in his government. But corruption is not a mortal disease, or few governments would live long. Nor can Chiang's downfall be ascribed to personal failings alone. Insofar as these contributed, however, none proved more fatal than his loss of flexibility in dealing with changing conditions. Growing more rigid, he became less responsive to popular sentiment and less tolerant of subordinates venturing novel ideas. He came to prize loyalty more than competence and to rely more on personal ties than on ties of organization. His growing dependence on a trusted clique also showed in his army, in which he favoured narrow traditionalists over many an abler officer. But to list Chiang's failings is not to deny his historical significance, which emerges from the contradictions that he combined in himself. Soldier and politician, revolutionary and traditionalist, Christian and Confucian, anti-Communist with a Leninist bias, Chiang embodies the crosscurrents and confusion of a transitional period in Chinese history.

See CHINA: *History: The Republic* and *China After World War II*. *See* also references under "Chiang Kai-shek" in the Index volume.

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(C. BT.)

CHIANGMAI (CHIENGMAI; KIANGMAI), a province (*changwat*) of northern Thailand with an area of 8,878 sq.mi. and population (1960) of 787,038. The capital and largest city in the *changwat* is also called Chiangmai, and is the terminus of the 467-mi. railway from Bangkok. For centuries this city was the capital of the Thai kingdom, Thai Yuan. The city of Chiangmai with a population (1960) of 63,464 is the fourth largest city in Thailand and serves as the regional geographic capital of the nine *changwats* comprising North Thailand. It is a religious, medical, economic, cultural, historical, educational and transportation centre for both North Thailand and some of the Shan provinces of Burma. Chiangmai is on the Ping river, the largest tributary of the Chao Phraya river, and is near the centre of a fertile intermontane basin about 80 mi. long and 20 mi. wide. The basin is covered with Chiangmai loams, the second most productive type of soil in Thailand. Where water is available for irrigation, two crops per year can be grown. Rice, the principal crop grown in the wet monsoon season (May through November) may be followed with a crop of soybeans, peanuts, corn or tobacco during the dry season (December through April). Mountain peaks that surround the basin range in height from 6,000 to 7,000 ft., but the city is at about 1,000 ft. above sea level. The mixed deciduous forests that cover the *changwat* outside the basin contain valuable stands of teak. Although teak exploitation has been curtailed and only half of the teak cut in Thailand is exported, Chiangmai is still the centre of the teak industry, as it has been for decades.

The American Presbyterian mission was opened in 1867 and its chief local institutions still are McCormick hospital and the Chiangmai Leper asylum. A Roman Catholic mission also established schools there. Chiangmai has a two-year teachers college, a junior college agricultural school and a technical institute.

Chiangmai, 453 mi. N.N.W. of Bangkok, is a tourist centre for both the Thai and for foreigners. Travelers may use an all-weather road, Thai Airways or the Northern Railway. (T. F. B.)

CHIANGRAI, the northernmost province of Thailand, bordered by Burma on the northwest and Laos on the northeast. Area, 7,260 sq.mi. (18,803 sq.km.); pop. (1960) 800,026. The capital, Chiangrai (pop. [1957 est.] 11,998), and Phayao (16,555) are the commercial centres of the north and south, respectively. Both towns, as well as Chiangsaen, were formerly walled seats of independent principalities. Natural topography orients the province northward toward the Maekhong river, but a highway built in the 1920s connects the chief towns with Lampang to the south. Major crops are tobacco and rice paddy, and there are over 25 commercial rice mills. (G. W. SK.)

CHIAPAS, a Pacific coast state of southern Mexico on the Guatemalan frontier, bounded by the states of Tabasco on the north and Veracruz and Oaxaca on the west. Pop. (1960) 1,215,475, largely Indians; area 28,732 sq.mi., mainly forested. The Sierra Madre crosses the southern part of the state parallel with the coast. The mountain region includes a fertile temperate plateau which contains the larger part of the state's population, but isolation and lack of transportation facilities have retarded its development.

The extension across the state to the Guatemalan frontier of the Pan-American railway (from Ixtepec, on the Tehuantepec national line) and the Inter-American highway improved the industrial and social conditions of the people. The main occupations are agriculture, which is very backward, stock raising, timber cutting, fruit farming and saltmaking. Coffee is cultivated on the Pacific slope of the Sierra Madre at elevation of 2,000 to 4,000 ft. Rubber plantations have also been laid out, principally by U.S. companies. The exports include mahogany, dyewoods, cattle, hides, coffee, rubber, fruit and salt. The mineral resources include gold, silver, copper and petroleum. The capital, Tuxtla (pop. [1960] 42,433), is on the plateau. San Cristobal (pop. [1950] 17,448), about 40 mi. east of Tuxtla, is an interesting old town and the seat of the bishopric of Chiapas, founded in 1525 and made famous through its associations with Bartolomé de Las Casas (*q.v.*).

Linked with Guatemala in colonial days, Chiapas became a Mexican state in 1824; its boundaries were fixed in 1882. The early Maya ruins of Palenque, now accessible to tourists, are in the northeast jungle. Maya Bonampak, with its famous murals, may be reached with difficulty from Tuxtla. (J. A. CW.)

CHIAROSCURO, the disposition of light and shade in a painting (Ital. *chiaro*, "light"; *oscuro*, "shade"); the term is applied to an early method of printing woodcuts in various tones from several blocks, and also to a picture in black and white or brown and white only. It has also come to mean the atmospheric effect produced by the handling of highlights and shadows.

CHIATURA, a town of the Georgian Soviet Socialist Republic in the U.S.S.R., stands on the Kvirila river in a deep trench in the southern foothills of the main Caucasus range 28 mi. E.N.E. of Kutaisi. Pop. (1956 est.) 19,200. It is the centre of one of the largest manganese mining areas of the world. First discovered in 1849, the ore has been exploited since 1879. The mines encircle the town and the ore is sent by cable railway and transporter to enriching plants in the town, whence the bulk is sent by railway to the ports of Poti and Batumi on the Black sea coast. Some of the ore is utilized in the nearby Zestafoni iron foundry. (R. A. F.)

CHIAVARI, a town of northwest Italy in the Liguria region, Genoa province, is situated on the coast of the Riviera di Levante at the mouth of the Entella, 44 km. (27 mi.) E. of Genoa by road. Pop. (1961) 25,976 (commune). It is on the main line from Genoa to La Spezia and Rome, which there follows the coast, threading a series of tunnels. Chiavari is in a fertile plain surrounded by hills with the sea to the south-southwest. The old part of the town is full of arcades. The 15th-century cathedral was rebuilt in 1823. Other buildings of interest, all 13th century, are the castle, the church of S. Giovanni Battista and the mansions of the Via Rivarola and Portici Neri. Tourism, chair making, lace and silk manufacture and the marketing of agricultural produce are carried on. The town grew up on the traces of a Roman camp on the Via Aurelia. In World War II it was captured by the Allies in April 1945. (Eu. P.)

CHIBA (Chiba-Ken), Japanese prefecture, located on the Pacific coast of the Kanto plain, central Honshu. It is formed by the Boso peninsula, which lies east of Tokyo bay and south of the Tone river. Area: 1,944 sq.mi. Pop. (1960) 2,306,010. Agricultural Chiba produces surpluses of rice, vegetables and eggs for Tokyo, and its offshore fisheries flourish. The Tokyo industrial belt has expanded eastward into Chiba; otherwise, there is little industry except the making of rice wine (sake) and the processing of raw materials. Large natural-gas deposits have been tapped. Important centres of population are Choshi, Tateyama, Ichikawa and Funabashi.

Chiba is the capital and largest (241,615 in 1960) city of Chiba-Ken, located on the northeastern coast of Tokyo bay. It is the prefectural administrative, commercial and cultural centre. A large steel mill was erected in 1952. (J. D. Ee.)

CHIBCHA, the South American Indians who at the time of the Spanish conquest occupied the high valleys surrounding the modern cities of Bogotá and Tunja in Colombia. With a population of over 500,000, the Chibcha are notable for having been more centralized politically than any other South American people outside the Inca empire. Numerous small districts, each with its own chief, had been consolidated through conquest and alliance into two major states and several lesser ones, each headed by a hereditary ruler. Although these states were not very stable, it seems clear that the arrival of the Spanish cut short the development of even larger political units.

The political complexity of Chibcha society was based on an economy featuring intensive agriculture, a variety of crafts and considerable trade. Weekly markets in the larger villages facilitated the exchange of farm produce, pottery and cotton cloth; and trade with neighbouring tribes provided the gold which was used extensively for ornaments and offerings. The use of gold was a prerogative of the members of the upper class, who were also carried in litters and shown great deference. Since descent was matrilineal, chiefs and religious leaders were succeeded by their sisters' sons, although land was inherited patrilineally. Heirs to important offices underwent long periods (6 to 12 years) of fasting and seclusion in preparation for their future duties.

The religion was dominated by a hereditary but unorganized priesthood which maintained numerous temples and shrines and held elaborate but infrequent public ceremonies. Offerings, especially of gold and cloth, were a prominent part of all religious observances, and on special occasions human sacrifices were made to the sun.

See also Colombia: *History*.

See A. L. Kroeber, "The Chibcha" in Handbook of South American Indians, ed. by Julian H. Steward, Bureau of American Ethnology, Bulletin 143, vol. 2, pp. 887–909 (1946); José Pérez de Barradas, *Los muiscas antes de la conquista*, 2 vol. (1950–51). (Se. L.)

CHIBCHAN, a linguistic stock consisting of languages spoken or once spoken in Central America and northwestern South America. The name is from "Chibcha" (*q.v.*), the people who formed the nucleus of the Chibchan empire and who are also called "Muisca," based on the word for "man" in their language.

In 1960 scholars had not yet reached agreement about the languages to be included in this stock. One classification recognizes at least eight divisions, each with one or more languages, and given in approximate north to south order, as follows: Paya; Watuso; Talamancan: Bribi, Cabecar, Boruca; Guaymian: Guaymi, Terraba; Dorasque; Cuna; Muiscan: Rama, Chimila, Cagaba, Bintucua, Muisca, Tunebo, Dobocubi; Timotean: Cuica, Mocochi. With respect to more remote relationships, it has been suggested that the least distant ties of Chibchan are with Tanoan, Uto-Aztecan, Cuitlatec, Misuluan and Tucanoan. Earlier classifications grouped Chibchan with Barbacoan languages, but these are perhaps best classified apart, even while admitting distant kinship.

The phonetics of Chibchan languages tend to be simple, but comparative evidence suggests greater complexity in earlier times. The structure is mildly inflectional, with person, tense-mode, voice and derivative notions expressed by affixes.

See also Indian, Latin-American; South American Languages.

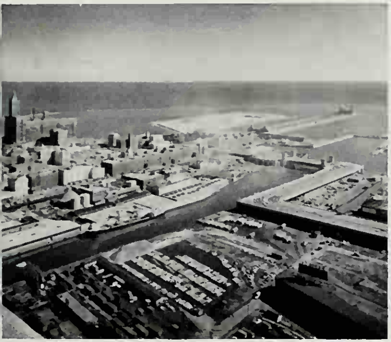
See M. Swadesh, *Mapas de Clasificación Lingüística de México y las Américas* (1959); Norman A. McQuown, "Indigenous Languages of Native America," *American Anthropologist*, Vol. 57, pp. 501–570 (1955). (M. Sw.)

CHICAGO, a city, a port of entry and seat of Cook county, Ill., the second city in the United States in population, commerce and manufacturing according to figures published in the early 1960s. Strategically located at the mouth of the Chicago river at the southwest corner of Lake Michigan, the natural transshipment centre for the grain, lumber and livestock of the growing middle west in the 19th century, Chicago in the 20th century became the transportation, commercial and industrial centre of the north central United States. By air it is about 713 mi. from New York city, 1,858 mi. from San Francisco and 833 mi. from New Orleans. The climate is very changeable and is much affected by the lake; changes of more than 30° F. in temperature in 24 hours are not rare, and changes of 20° are common.

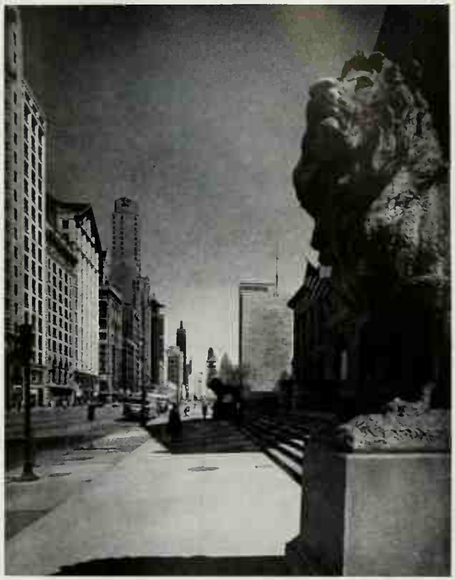
The land area of Chicago is 224.5 sq.mi., one-third less than that of New York city and not quite half that of Los Angeles. Chicago spreads loosely and irregularly backward from the lake over a shallow alluvial basin, which is bordered on the west by a low moraine watershed divide that separates the drainage of the lake from that of the Mississippi valley. The site has been built up out of the Lake Chicago of glacial times, which exceeded Lake Michigan in size. Lake Calumet, almost 5 sq.mi., and part of Wolf lake, with a water surface of about 6½ sq.mi., lie within the municipal limits. Chicago (41° 51′ N. lat., 87° 38′ W. long.) is 656 ft. above sea level. The original elevation of what is now the business heart of the city was only about seven feet above Lake Michigan, but between 1855 and 1860 the level was greatly raised—in some places more than ten feet—over a large area. The west side, especially the northwest near Humboldt park, is much higher (highest point, 75 ft. above Lake Michigan). The Chicago river, a narrow inlet from the lake, runs west from its shore for about a mile, dividing into a north and south branch, which run respectively to the northwest and southwest, thus cutting the city into the three divisions known as the north, the west and the south sides.

HISTORY

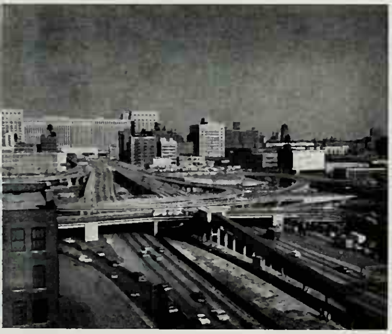
Early History.—Chicago (the name is derived from an Indian word of doubtful origin, meaning, according to some, "skunk" or "wild onion," but more likely "powerful") was first known as a place of portage in the 17th and 18th centuries. In 1673 Louis Jolliet and Jacques Marquette used it on their way to the Illinois country. René Robert Cavelier, sieur de la Salle, and other French explorers also came, as did traders and other adventurous spirits. During the first half of the 18th century Chicago was heard of occasionally as military base, Indian village, council point and trade centre. Following the defeat of the Indians by Anthony Wayne in the battle of Fallen Timbers in 1794, the United States gained control of six square miles of land at the mouth of



An industrial-commercial complex and railroad yards at the mouth of the Chicago river at Chicago harbour on Lake Michigan. The filtration plant built on lake fill is in the centre background



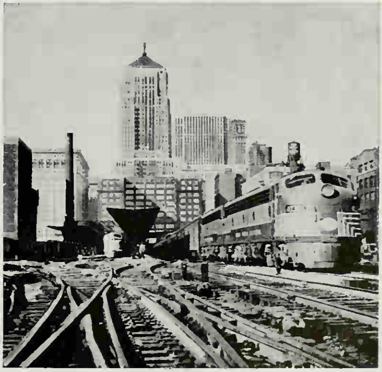
Sculptured bronze lions at the entrance to the Art Institute of Chicago dominate this view of Michigan avenue



The Kennedy-Eisenhower expressway interchange. The combined eastbound traffic passes through the federal post office building

CHICAGO SKYLINES

Night view along a stretch of the Chicago river



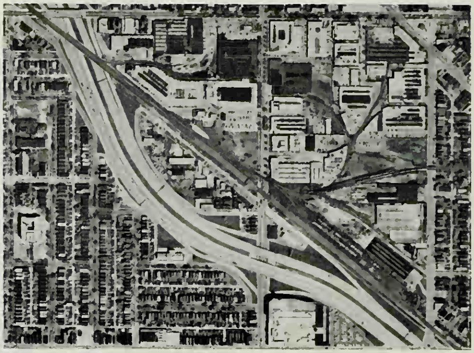
A rail terminal backdropped by Chicago skyline with the Board of Trade building predominating

PHOTOGRAPHS, (TOP LEFT, TOP RIGHT, BOTTOM LEFT) HEDRICH-BLESSING, (CENTRE LEFT) CHARLES E. WUERPEL, (BOTTOM RIGHT) EWING GALLOWAY

PLATE II

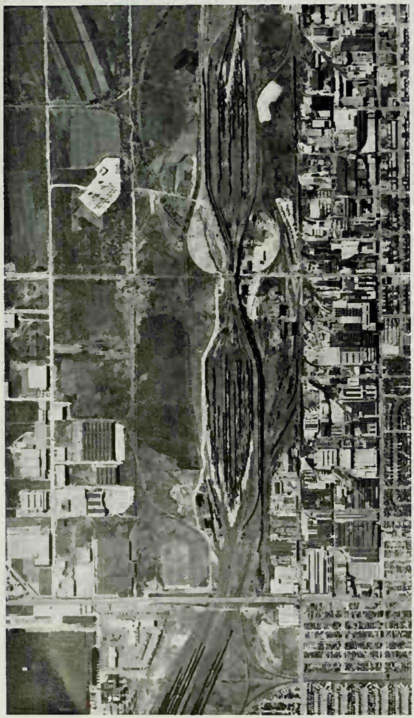
CHICAGO

The pressroom of a Chicago newspaper. Chicago is a leading printing and publishing centre

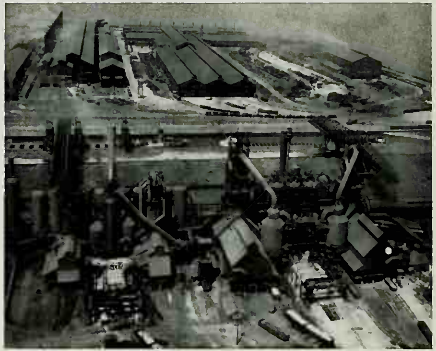


Aerial view of a small industrial complex in near northwest Chicago, surrounded by an older residential area and served by rail and road arteries

CHICAGO INDUSTRY



Overview of Clearing Industrial district and rail classification centre in the southwest section of the city



Steel mills at the southern city limits. Chicago rates number one among U.S. cities in the production of steel

A ship at a loading dock in Calumet harbour, a part of the port of Chicago for Great Lakes and ocean-going shipping

BY COURTESY OF (RIGHT CENTRE) UNITED STATES STEEL CORPORATION, (BOTTOM RIGHT) ILLINOIS CENTRAL R R.; PHOTOGRAPHS, (TOP LEFT) NAESS & MURPHY, ARCHITECTS, (TOP RIGHT, BOTTOM LEFT) CHICAGO AERIAL SURVEY

the Chicago river and in 1803 Ft. Dearborn was located there. In 1812 the garrison and settlers, who had abandoned the fort under Indian attack and were retreating toward safety, were massacred by the Indians about 1½ mi. S. of the fort. Rebuilt in 1816, the fort was occasionally occupied until it was finally evacuated in 1836.

Settlement.—On Aug. 4, 1830, James Thompson, a civil engineer, filed a survey and plat of the town, and Chicago received its first legal geographic location. Life remained uncertain because of the threat of Indian attacks until the defeat of Black Hawk (*q.v.*) in 1832, when the Indians relinquished title to the region from the southern half of Lake Michigan to the Mississippi. Soon came a rush of immigrants, and a settled community life began. In 1833 a town government was set up; a semipublic school was opened and three places of worship were built; the first newspaper, the *Chicago Democrat*, appeared on Nov. 26; and on Jan. 1, 1834, a mail route to Ottawa, 84 mi. S.W., was opened. In 1837 Chicago adopted a city form of government and soon became the trading point of the nearby countryside.

Arrival of the Railroads.—In 1848 the Illinois and Michigan canal connecting the Chicago river with the Illinois was completed, bringing the promise of a rich and vast tonnage in foodstuffs from the farming region to the southwest. In the same year the Chicago and Galena Union, the city's first railroad, completed its first experimental trip of five miles and foreshadowed the day, not far distant, when Chicago broke the control of other cities over the trade of the northwest and other sections. By 1870 rails reached north, south, east and west. In 1854 the Chicago, Rock Island and Pacific set up communications with Rock Island, Ill., and Chicago and Alton, Ill., were linked by the Chicago, Alton and St. Louis. The Illinois Central established direct traffic between Chicago and Cairo, Ill., in 1856. The Chicago, Burlington and Quincy strengthened its previous connections with Chicago (by short lines) with a direct run to Aurora, Ill., in 1865, and in the next decade this railroad covered the rich grain-producing areas directly to the south and west of Chicago, and with a connection at Burlington, Ia., opened up a route to Omaha, Nebr. In 1864 the Chicago and North Western Railway company absorbed the Chicago and Galena Union and became a significant agent in the transportation of grain and other produce from the land lying northwest and west of Chicago. With the completion of the Union Pacific railway in 1869, which for a time marked the last major extension of the transportation system leading west, Chicago was within about 106 hours of traveltime from San Francisco, Calif.

With the extension of railroads eastward through the Michigan Central and Michigan Southern (after 1852), the Pittsburgh, Fort Wayne and Chicago (1856), the Pennsylvania (1858) and eventually other connections, the lake lost its priority both in shipments and in passenger traffic east.

Civil War.—During the American Civil War the city, despite the earlier strength of the Democratic party, remained loyal to the North. The war brought a tremendous increase in the grain trade; production and sales of reapers and other farm implements rose as farm workers entered the armies; and Chicago became the leading pork producer in the nation, surpassing Cincinnati, O., and one of the leading markets for tents and uniforms, saddles and harnesses, salt, beef, bread and lumber. By 1870 the city had almost 300,000 inhabitants and was a commercial centre of immense importance.

The Great Fire.—On Oct. 8, 1871, a fire began, its origin undetermined, and continued until the night of Oct. 9. Two-thirds of the city's buildings were wood, and the summer and autumn had been excessively dry; to make conditions worse, a high and veering wind fanned the flames. The conflagration crossed the river, burned over an area of approximately 2,000 ac., destroyed about 18,000 buildings and property valued at $196,000,000 and left about 90,000 people homeless; at least 300 persons lost their lives. The flames traveled 2¼ mi. in an air line within 6½ hours. Thousands of persons, fleeing before the flames and firebrands, sought refuge on the shore and even in the waters of the lake. On the south side the fire was checked on Oct. 9 by the use of gunpowder; in the north (where the waterworks were early destroyed) it had extended almost to the prairie when rainfall finally brought it to an end after about 27 hours of destruction.

The common council acted with expedition to provide for the destitute and to safeguard the general interests of the community. By ordinance it fixed the price of bread at eight cents for a 12-oz. loaf; Mayor Roswell B. Mason pledged the credit of the city to pay for necessities; by other proclamations he regulated charges for hacks and similar carriers, opened public buildings as places of refuge and as distribution centres, closed saloons for one week at 9 P.M., invited volunteers to serve as emergency police, and entrusted the preservation of order largely to Lieut. Gen. Philip H. Sheridan, U.S. army, commanding the military division of the Missouri. Aid came from many places, organizations and individuals throughout the country. Though the fire was calamitous, it left unharmed the sources of Chicago's commercial prowess. The city had not lost its strategic location with reference to river, lake and canal and could, therefore, preserve a leadership in water-borne traffic. The railroads still provided contact with the main sources of the city's commerce and trade. Some grain elevators were unharmed; there was at hand a supply of lumber; and the Union stockyard and some manufacturing establishments were outside the line of the fire. In about a year the business district was largely rebuilt. The retail district moved south on Wabash and Michigan avenues and west to State street where in the 1860s Potter Palmer and Marshall Field had established their dry goods business. Manufacturing plants shifted from the north bank of the river to the neighbourhood of the south branch at 22nd street and Western avenue, and wholesale houses were located chiefly along West Monroe, West Madison and Wells streets. Banking interests took over Washington and LaSalle streets. From a large area use of wood was prohibited in the construction of new buildings, which were designed to be fire resistant. Business, in general, recovered rapidly. By 1873, when a serious panic struck the country, Chicago had already begun a climb toward prosperity and was affected by the depression less quickly than were many other places.

Labour Movement.—The growth of industry after the great fire was accompanied by intensified efforts to organize labour. Labour troubles increased, and Chicago was known as a centre of discontent and even of radical or anarchistic movements. In 1877 railway strikes in the east spread to the city and inaugurated a series of spectacular disturbances. Signs of discontent increased in 1884, 1885 and 1886, and several industries were the scenes of strikes. On May 3, 1886, a clash took place between strikers and scab labourers brought in to break a strike at the McCormick Harvesting Machine company works. The police were summoned and in the confusion six men were killed. A protest meeting was called by anarchists for the next evening at the Haymarket square on Randolph street between Desplaines and Halsted streets. Mayor Carter Harrison attended for a while and found the meeting peaceable except for the impassioned addresses of some anarchist leaders. He ordered the police reserves home and left the scene. Sometime later, however, a subordinate police officer, angered by the speeches, marched upon the meeting with a large force and ordered it to disperse. Thereupon a bomb was thrown, killing seven policemen and injuring many others. Under an excited public opinion the anarchist leaders were indicted, tried and found guilty, although the actual bomb thrower was never brought forward. The death penalty was imposed on seven and life imprisonment on an eighth, a verdict later upheld by the United States supreme court. Eventually four were hanged, one committed suicide, two had their death sentences commuted to life imprisonment, and an eighth was sentenced to prison for 15 years. In 1893 Gov. John Peter Altgeld (*q.v.*) pardoned the surviving three on the ground that the jury was packed and that the defendants were not proved guilty of the crimes charged in the indictment, and that there was no case at all against one of them. In liberal circles Governor Altgeld's action received commendation, but to others the pardons appeared a shocking miscarriage of justice. For the legitimate labour movement the Haymarket affair proved to be a setback, although these labour organizations were not led by persons committed to the philosophy of anarchism.

In 1894 a strike at the Pullman Car company works again attracted national attention. The cause of the workers was taken up by the powerful American Railway union, led by Eugene V. Debs. Transportation throughout the north came to a standstill. On the ground of protecting the transmission of mail, Pres. Grover Cleveland ordered 2,000 federal troops to Chicago despite the objection of Governor Altgeld that such aid was not requested and that the situation could be handled locally. The strike collapsed, and Debs and three other union officers were indicted for conspiracy (*see* DEBS, EUGENE VICTOR). Eventually Debs appealed to the U.S. supreme court the sentence he had received; the court, by upholding the decision of the lower court, announced significantly that the federal government had an implied right to protect interstate commerce even when there was no explicit law.

By 1890 about 65,000 workers in Chicago were reported to be organized, over a third of them in the American Federation of Labor. Chicago continued to be essentially a union town. The radical Industrial Workers of the World was founded there in 1905, but it represented a minority of the labour force. After the 1930s unskilled labourers, small shopowners and merchants, some white-collar workers and similar groups were organized by the American Federation of Labor and the Congress of Industrial Organizations (A.F.L. and C.I.O.).

Civic Life.—In World War I, despite its large German population and the openly expressed pro-German attitude of Mayor William Hale Thompson, Chicago supported the government with large Liberty Loan bond drives ($3,292,183,450). It contributed $12,000,000 to the activities of the Young Men's Christian association and $15,000,000 to the Red Cross. During World War II Chicago again gave generously to the war effort. Four service centres entertained 17,500,000 service personnel. In seven war bond drives Cook county residents bought bonds valued at $6,667,867,447, and they participated actively in the thrift drives for steel, fat and paper. The people of Chicago contributed 642,392 pints of blood.

Equally responsive to public needs have been humanitarian enterprises throughout the city's history. Often promoted by private benefactions, they represent both individual and collective sensitivity to the needs of the unfortunate. Chicagoans have contributed generously to hospitals, infirmaries and homes for dependent children and adults. The Community Fund (1934), United Charities (1909), Jewish Federation of Metropolitan Chicago (1958; precursor founded 1857) and Catholic and Protestant church welfare organizations represent unified action. Well-known settlement houses, particularly Hull house, established by Jane Addams and Ellen Gates Starr (1889), have been copied throughout the United States. Large congregations reflected steady growth in organized religion. In the second half of the 20th century, over 1,900,000 in Chicago were Roman Catholics and the Chicago archdiocese is the largest see in the United States. About 709,000 Protestants worshiped in 1,600 churches, and there were about 100 Jewish congregations.

The 400th anniversary of the discovery of America was commemorated by the World's Columbian exposition held at Chicago (1893) in Jackson park and the adjoining Midway. The grounds comprised 686 ac., of which 188 ac. were covered by buildings, planned by a commission of architects; John W. Root and Daniel H. Burnham were responsible for the general scheme. Forty years later (1933) Chicago threw open the gates of its second international exposition, A Century of Progress, celebrating the centennial of the first incorporation of the municipality.

Because of its central location, Chicago has been the United States' most famous convention city and the scene of the nominations of presidents Lincoln (1860), U. S. Grant (1868), James A. Garfield (1880), Grover Cleveland (1884 and 1892), Benjamin Harrison (1888), Theodore Roosevelt (1904), William Howard Taft (1908), Warren G. Harding (1920), F. D. Roosevelt (1932, 1940 and 1944); and Dwight D. Eisenhower (1952).

Politics and Civic Awakening.—From its early days Chicago, in common with other frontier towns, had a reputation for rawness, lawlessness and crime. Over the years gambling establishments, houses of prostitution, saloons and dram shops flourished. By 1849, according to one Chicago newspaper, there were more gambling establishments in the city than in Philadelphia; by 1858 there were said to be more than 100 houses of prostitution. Although much of the liquor trade was carried on illicitly, in 1859 the city collected $44,548 in licence fees and ten years later collected $110,136. Charges of open and flagrant violations of city ordinances became common, as did reports that justices and constables pocketed fines and that the police engaged in blackmail and were given to accepting gifts and bribes. Churches, temperance organizations and reform groups in general attempted to eliminate the causes of these conditions.

In the late 1890s the city experienced a great civic awakening. A civil service system was inaugurated in 1895. Numerous reform associations attempted to rouse public opinion, such as the Citizens' Association of Chicago which had been organized in 1874, the Civic federation (1894), the Municipal Voters' league (1896), the Legislative Voters' league (1901), the Referendum League of Illinois (1901), the Municipal Lectures association (1902), the Civil Service Reform Association of Chicago, the Civil Service Reform Association of Illinois (1902), the Merchants' club, the City club (1903), Law and Order league (1904) and Society of Social Hygiene (1906); and many women's clubs took an active part. These organizations stood for effective enforcement of the laws, sanitation, pure food, public health, the improvement of the schools and the widening of their social influence and (especially the women's clubs) aesthetic, social and moral progress. The Merchants' club reformed the city's bookkeeping and secured the establishment (1899) of the first state pawnbrokers' society. The Civic federation demonstrated (1896) that it could clean the central streets for little more than half the sum the city was paying (the city later saved the difference); it originated the movement for vacation schools and other educational advances, and started the Committee of One Hundred (1897), from which sprang various other reform clubs. The Municipal Voters' league investigated and published the records of candidates for the city council, and recommended their election or defeat. The reform movement, in its various phases, came to its full tide under the administration of Carter H. Harrison, Jr., who was elected to his fifth term as mayor in 1911.

Unfortunately the reform spirit failed to carry over into the years immediately following the adoption of the prohibition amendment (18th) to the federal constitution in Jan. 1919. A building boom and postwar prosperity attracted many lawbreakers to the city. The huge profits of the illicit liquor trade led to the organization of powerful criminal gangs, and competition between these organizations resulted at times in murder and banditry. It was during this period that the notorious gang leader Al ("Scarface") Capone came into power. The growth of the gang system subjected Chicago to wide criticism. William Hale Thompson, Republican, was mayor from 1915 to 1923. The term of William E. Dever, Democrat (1923–27), elected as a reform candidate, did not appreciably stem the tide of lawlessness. Thompson returned to the City hall in 1927 and served as mayor until 1931 when Anton J. Cermak, Democrat, took over and inaugurated a cleanup campaign.

Under the centralized regime adopted by Cermak, Chicago politics, long dominated by ward and district leaders, developed along the lines of Tammany in New York. The organization brooked no rebellion in its ranks. Although bloc voting had been promoted as early as the 1870s by the Irish boss Daniel O'Hara and by the German Anton C. Hesing, and by others later, it grew somewhat haphazardly. With Cermak came sophistication of management, and Chicago abandoned the frontier town characteristics it had long possessed. Cermak died on March 6, 1933, at Miami, Fla., the victim of an assassin's bullet intended for President-elect Franklin D. Roosevelt. His organization, however, remained firmly entrenched under Mayor Edward J. Kelly, Democrat (1933–47), who made the machine one of the most powerful vote-getting organizations in the country. The election of Martin H. Kennelly, Democrat (1947–55), a prominent businessman, inaugurated a mild reform. Under his successor, Mayor Richard J. Daley, also a Democrat, the machine continued its local domination and its prominent role in state and national politics.

20th-Century Progress.—During the 20th century Chicago pioneered in the production of drugs; recognition of the city's leadership in medicine is world-wide. After Enrico Fermi achieved the first self-sustaining nuclear chain reaction at The University of Chicago in 1942, work continued at the Argonne Cancer Research hospital and the Enrico Fermi Institute for Nuclear Studies. The Armour Research foundation of the Illinois Institute of Technology began operation of the first research reactor to be used only for private industrial research in 1956.

Construction of skyscrapers, a contribution of late 19th-century Chicago architects, brought to the city rare distinction in building design. The Wrigley building, *Tribune* tower and the Board of Trade building, among others, gave Chicago a uniquely beautiful skyline. In the second half of the 20th century the Prudential Insurance, *Chicago Sun-Times–Daily News,* Inland Steel, Borg-Warner and Marina City buildings added to the architectural distinction of the city.

POPULATION

City.—In 1833, the year in which Chicago was incorporated as a town, only about 350 people lived there; by 1837, when it was incorporated as a city, there were approximately 4,000. The number increased to 29,963 by 1850, less than one half of whom were born in the United States. The population was 1,099,850 by 1890; it was 2,185,283 in 1910; 2,701,705 in 1920; 3,376,438 in 1930; 3,396,808 in 1940; 3,620,962 in 1950; and 3,550,404 in 1960. The increase from 1920 to 1930, partly as a result of annexations, was 674,733, largest gross gain in the history of the city.

Almost from the beginning Chicago was a cosmopolitan city; its social fabric included people from all parts of the world. The large number of European immigrants Chicago attracted in the 19th and early 20th centuries was added to the earlier population of American settlers, many of whom came from the eastern part of the United States, particularly from New England and New York. At first these persons of eastern origin made up the leaders of the city's political and economic life, but as the immigrants became assimilated they too began to play their part in civic life. Shortly after the Civil War this assimilation had been accomplished for many of the early immigrants, but Chicago continued to have many roots in the soil of other countries. As late as 1960 approximately one out of five white Chicagoans was foreign born. In 1850 the largest part of Chicago's foreign-born population was Irish; the second largest group was of German origin. Although Poles comprised less than 1% of the population in 1850, a century later they made up the largest number of foreign born (94,009); Germans (56,635) ranked second, followed by Italians (54,954), Russians (52,879), Swedes (31,104) and Irish (29,804 from the Republic of Ireland, 751 from Northern Ireland).

The tendency of newcomers to congregate in neighbourhoods where their conationals predominated gave rise to distinct islands of settlement where foreign languages were often heard. Local ethnic associations reflected their members' attachment and ties to the old country. At the same time these organizations often helped immigrants to adjust to their new homes and provided work through their employment agencies, as well as insurance and other benefits. Besides such ethnic organizations, other welfare agencies developed to perform similar services not only for the foreign born but for all minority groups.

After World Wars I and II the Negro population increased considerably: from 109,458 in 1920 to 277,731 in 1940; to 812,637 in 1960. The increase in the proportion of Negroes in the city proper has been due largely to the continued migration of Negroes into the city while the white population was moving to the suburbs. In 1960 Japanese comprised the largest oriental group in the city (11,375), the second largest being Chinese (5,082). American Indians numbered 3,394.

Metropolitan Area.—In the 1960 census the vast urban complex centring on Chicago was designated by the census bureau as the Chicago standard consolidated area. This consolidated area consisted of the Chicago standard metropolitan statistical area, comprising Cook, Du Page, Kane, Lake, McHenry and Will counties in Illinois, and the Gary-Hammond-East Chicago standard metropolitan statistical area, comprising Lake and Porter counties in Indiana (*see* GARY). The census bureau definition did not include adjacent communities in Wisconsin, with most of which Chicago has long enjoyed economic ties. In 1960 the population of the Chicago standard consolidated area was 6,794,461; that of the standard metropolitan statistical area was 6,220,913. Although the city occupied about 5½% of the metropolitan area it contained 57.1% of the population in 1960. Between 1950 and 1960 the population of the city dropped 1.9% but in the metropolitan area increased 20.1% and in the consolidated area 21.6%. The rate of regional growth outside the city was stimulated not only by the extension of motor traffic and hard-surfaced highways but also by the desire of many to live in less crowded areas. Part of the population growth in the second half of the 20th century is attributable to an increase in births over deaths; in the 1950s only about 30% was due to the excess of in-migrants over out-migrants. Population experts foresaw a continuing rise in population because persons of ages 15 to 44 (the reproductive years) had reached a low point by the mid-1950s, and this segment of the population would increase in numbers as "war babies" came of age. Projected industrial expansion was also regarded as a probable incentive for population increases.

Within the standard metropolitan statistical area of Chicago are many incorporated cities and towns. Thirty-four of these towns have populations exceeding 20,000. (For comparative population figures *see* table in ILLINOIS: *Population.*)

GOVERNMENT

The City.—The basic framework of Chicago's government had been established even before the city's adoption in 1875 of the Illinois general city charter law of 1872. Although minor amendments have somewhat altered the original charter the government operated even after mid-20th century under prescriptions designed for a rural rather than an urban age.

A mayor, elected for a term of four years, is the executive of the city government. His salary was raised in 1959 from $25,000 to $30,000. At one time only the presiding officer of the common council, the mayor has come to occupy a position of considerable influence. He has power of appointment to many positions, including heads of administrative departments who make up a so-called cabinet. As the demands of governing a growing city have increased, commissions to care for various urban problems have been created under these appointive powers. The mayor selects the personnel of special advisory agencies such as the commission on human relations; he chooses the members of commissions in charge of city functions, such as the school board, the public library board, the commission in charge of elections and that in charge of the Municipal Tuberculosis sanitarium. His appointive powers, however, do not extend to most city employees, who are under a civil service law.

A unicameral city council is composed of one alderman elected quadrennially from each of the city's 50 wards. It controls the budget, police, excise, city contracts and franchises (the latter, however, subject to popular referendum). The council confirms appointments by the mayor and may pass legislation by a two-thirds vote over his veto.

In the 20th century services performed by the city multiplied even within departments the charter had set up. In the police department, for example, special units were created in the 1950s to deal with pressing problems: a task force that moved from neighbourhood to neighbourhood as conditions required; a youth bureau, supplanting a unit in the crime prevention division and co-operating with the mayor's advisory committee on juvenile welfare, to combat juvenile delinquency.

Cook County.—Like most U.S. cities Chicago has a dual city and county government. Cook county, of which Chicago is the seat, retains practically all of the extensive government functions of rural counties of the type that arose in the southern colonies, in which the county was the real unit of local government. This complication of dual government in Cook county extends to Chicago's suburbs which have separate municipal organizations. The county was laid out after 1848 in townships, and these too had some governmental functions; it was not until 1900 that the town organizations within the territory, gradually annexed to the original village of Chicago, were deprived of their political structure and divested of governmental functions within the city. As late as 1903 ten townships exercised taxing powers within the municipal area. In addition to the original duplications of government, new quasi-governmental bodies were set up for special purposes and in some cases were granted police and taxing powers. The sanitary district, practically an independent government in itself, with powers of tax levy and debt making, has jurisdiction within the territory of Chicago and Cook county. The forest preserves, too, represent another quasi-governmental body with some sovereign powers. In all, there are more than 400 distinct political units in Cook county, empowered to levy 600 different sorts of taxes.

The grant of independent taxing power to so many governmental bodies is a result of state constitutional limitations upon the public debt. Chicago, as a municipal corporation, cannot incur debt exceeding 5% of the value of city property. Therefore many independent agencies have been created to meet current needs.

The Chicago Sanitary district, established by the state legislature in 1889, is such an agency, designed to provide for the disposal of sewage. A drainage canal, constructed between 1892 and 1900, joined the south branch of the Chicago river with the Des Plaines, and so with the Illinois and Mississippi. The canal, or sewer, is flushed with water from Lake Michigan (the amount of water so diverted being a source of prolonged dispute between Chicago and the states bordering the Great Lakes and Canada).

Water for the use of Chicagoans is pumped from Lake Michigan through several tunnels connecting cribs located two to five miles from shore. The first tunnel was completed in 1867. Chicago must supply more than 50 suburbs (in the Sanitary district) as well as the city proper.

In 1906 the archaic system of administering petty justice through justices of the peace was abolished and a co-ordinated municipal court with numerous judges and a chief justice was established. The juridical system is complicated by the fact that the circuit court is a constitutionally established court of the state. The superior, municipal and other special courts are created by statute. The first juvenile court in the United States was established by Cook county in 1899, becoming known in 1949 as the Family court; it is a branch of the circuit court.

City Planning.—Advisory committees have come to play an increasingly important part in the city's management. One of the most important is the Chicago Plan commission, an outgrowth of the brilliant plans of Daniel H. Burnham (1846–1912), architect and city planner, and of the Commercial club. Since 1909 under the commission's influence, improvements of the lake front and park systems have been undertaken, Wacker drive along the river was built and slums and other depressed areas have been improved. On Jan. 1, 1957, the commission was made a department of the city with enlarged powers. The Northeastern Metropolitan Local Services commission (Randolph commission) was established in 1955 to furnish services needed for co-operative activity in the metropolitan area. Public housing projects and slum clearance had advanced considerably by the 1930s. The Chicago Land commission, serving without salary, developed from the Illinois Blighted Areas act of 1947 and had important powers of demolition, relocation of families and condemnation and acquisition of property. In various projects financing is a combination of municipal, state and federal grants. The Hyde Park project near The University of Chicago demonstrated the effectiveness of co-operative endeavours by municipal, state and federal governments.

Finance and Taxation.—The budget for the city of Chicago called for the expenditure of more than $500,000,000 annually in the second half of the 20th century for operating expenses, the public library, the Municipal Tuberculosis sanitarium and civil defense. In addition other local governmental agencies affecting Chicago in whole or in part appropriated money. The board of education alone appropriated about $250,000,000 annually.

The largest source of the city's tax dollar was the general property taxes, which provide more than 40% of the city's revenues. Other sources included aid from other governments, sales and receipts, licences and permits and charges and miscellaneous sources.

ECONOMY

Chicago's location at the head of the most southwestern of the Great Lakes gave the city, from its earliest days, considerable importance in trade and industry. The largest railway centre in the United States, Chicago became the commercial outlet and centre of trade of the northern Mississippi valley. The most important economic undertaking during the city's early years was the grain trade. In 1851 Chicago became the largest corn market in the United States, and in 1854 the largest wheat trade centre. The power of grains over the city's destiny persisted, and was responsible, at first, for making Chicago the exchange point of the middle west. Lumber, too, was of early importance to Chicago's economy; in 1856 the city became the country's foremost lumber market, and by the 1870s and 1880s it was described as the greatest distributing centre in the world.

Even before the Civil War, Chicago showed promise of a later position of primacy in livestock trade and meat packing. By 1862 the city had surpassed Cincinnati as a pork-packing centre. In these undertakings Chicago's early economy found a secure foundation. The city's paramount position as a great market during the 19th century was associated with the extractive industry of the U.S. economy of that period, and its trade consisted principally in the acquisition and distribution of the raw crops and resources of fields and forests; its industries were mainly processing raw products, such as meat packing, woodworking, flour milling, tanning, etc. With the rest of the United States the city underwent an industrial and commercial transformation following the Civil War. By 1890 Chicago ranked second in the country in manufacturing, surpassed only by New York. During the 20th century the city's economic endeavours were to be characterized more and more by great variety and enormous size.

Manufacturing and Industry.—No other manufacturing centre in the country except New York is as important as Chicago in so many industries. Among its chief manufactures are food products, primary metals, nonelectrical machinery and electrical machinery.

In terms of value the manufacture of primary metals, including steel-mill operations, foundry and forge shop operations and the smelting and refining of nonferrous metals, had, by the second half of the 20th century, assumed first place. Until 1953 the Pittsburgh area led in production, but in that year Chicago outdistanced its long-time rival. The largest proportion of steel comes from mills in the Calumet region south of the city and from mills just over the Illinois line in Indiana. This district was important as early as the 1880s when promoters recognized the desirability of a site where artificial harbours could easily be constructed and where there was vacant, level and low-cost land near a large volume of clean water required by the industry. Other advantages were the district's location on the shore of Lake Michigan, its railway facilities, accessibility to the source of supplies and a rich consuming market nearby. With the opening of the rich iron deposits in the upper peninsula of Michigan in the 1850s, nearness by water to the Lake Superior ranges proved a prime factor in the evolution of Chicago as an iron and steel centre. By the late 1890s two-thirds of all the ores used in the United States came from the south shore of Lake Superior.

The gigantic United States Steel Corp. mills in Gary (*q.v.*), Ind., the company's south works and the Inland Steel Co. plant —all in the Chicago metropolitan area—are the three largest steel mills in the United States. Others of great productive capacity in the area include the mills of the Republic Steel Corp., the Wisconsin Steel Works of the International Harvester Co., and the Youngstown Sheet & Tube Co. These companies enjoyed their greatest expansion after mid-20th century, their mills in the Chicago metropolitan area supplying more than 14,000 manufacturing plants.

Rails and railroad equipment factories have long been heavy consumers of steel; the first steel rail in the United States was rolled in Chicago in 1865. Pullman-Standard car manufacturing company, a direct descendant of George M. Pullman's Palace Car company established in 1867, the Electro-Motive Division of General Motors Corp. and the General American Transportation Corp. (GATX) manufacture freight and passenger cars, locomotives and specialized rolling stock, and scores of additional concerns fabricate numberless other metal products.

The making of agricultural implements and other farm equipment has a long and enviable history in Chicago. Cyrus H. McCormick (*q.v.*) set up his factory in Chicago in 1848 at the threshold of the rising wheat empire of the great middle valley. By the 1850s sales had multiplied, and the shortage of man power during the Civil War led to more widespread use. Soon Chicago-made reapers were found throughout the country, and their exhibition in London in 1851 and in Paris in 1855 demonstrated their superiority over others. By 1880 McCormick had conquered the world market. Ten years later agricultural implements manufactured by Chicago firms stood fifth among the city's leading products in terms of value added by manufacture. The International Harvester Co., a consolidation in 1902–03 of the McCormick Harvesting Machine company and other companies, became one of the giant industrial organizations of Chicago and the largest manufacturer of agricultural machinery in the world.

The manufacture of electrical machinery is one of the city's seven leading industries, followed by the manufacture of fabricated metal products. After the 1940s the metalworking field in general had a tremendous expansion. After the Civil War printing and publishing assumed an important position, rising from third in the city's economy in 1880 to first by 1910; by the second half of the 20th century the annual value added by manufacture exceeded $1,000,000,000. A few chemical plants manufacturing paint, varnish and glycerine had been established by the 1850s. A century later about 700 such plants manufactured a wide variety of products. The manufacture of petroleum and coal products was a major industry after mid-20th century.

Meat Packing and Food Products.—No economic enterprise has played a more significant role in Chicago history than has meat packing and its affiliated trade in livestock. The plants of Armour & Co. and Swift & Co. were founded by Philip D. Armour and Gustavus F. Swift after their arrival in the city in 1875. In a few years Chicago was the meat capital of the world. Within two years after he started in Chicago, Swift began shipping dressed beef to Boston, and in 1882 Armour sent refrigerated beef east. Chicago meat packers shipped to European as well as American markets. By the late 1870s Libby, McNeill & Libby, among others, shipped canned meat overseas, and in 1885 Armour and company alone filled an order from the British government for 2,500,000 lb. of compressed beef for the Nile expedition of the Egypt and Sudan campaign. By the beginning of the 20th century wholesale slaughtering and meat packing ranked first among Chicago's industries in terms of value added by manufacture.

As animal-raising areas were developed farther west in the late 19th century, packing establishments were set up nearer to the source of supplies. Many of the new plants were owned and managed by Chicago packers who thereby ensured the city's continued dominance in the industry. After mid-20th century the Union stockyard (opened in 1865) became more and more a place of sales and trade. Although Armour continued to pack hogs, Swift ceased slaughtering, dressing and packing them in 1952, processing only pork slaughtered elsewhere; even this activity in pork was abandoned in April 1957. On Jan. 25, 1958, Swift discontinued also the processing of lamb and veal, and in April stopped making so-called domestic meats (sausages, bologna and frankfurters). Libby, McNeill & Libby, engaged since 1868 principally in canning, continued to purchase already slaughtered animals.

Associated with the packing industry from an early day were the processing and marketing of by-products, including hides and skins, edible and inedible fats and the livers, hearts and other products not sold with the carcass. In the second half of the 20th century the value of by-products tended downward relative to the value of the live animal because of the development of competing products from nonanimal sources.

Although meat products topped the list, a variety of other food products was turned out in large quantities. Chicago became the largest producer of candy and related products in the country. Other important food products included bakery goods, dairy products, canned and frozen foods and grain mill products.

Even as early as the late 1860s, Chicago showed signs of losing its pre-eminence as a grain market to cities nearer the shifting grain-producing areas. By 1870 both Milwaukee and St. Louis had moved ahead, and soon Minneapolis, too, had surpassed Chicago. Furthermore, the struggle of the north and south railway lines in the Mississippi valley to divert grain and other freight to ports on the Gulf of Mexico brought about loss to Chicago. A considerable increase in the cereal trade of Philadelphia, Baltimore and Newport News and Norfolk, Va., was partly caused by the traffic eastward over lines south of Chicago. Altogether, the competition of the Gulf roads and lines running southwest from Duluth had done much to exclude Chicago by 1899 from the grain trade west of the Missouri river. Nonetheless its facilities for receiving and distributing remained unequaled, and it continued to monopolize the traffic between the northern Atlantic seaboard and the central west. Since the mid-1850s large elevators have provided storage for the huge volume of grain passing through the city.

The Board of Trade, the greatest speculative grain and provisions market in the world, was organized in 1848, and no other agency has continuously played a more important role in the city's economic development. Its future prices are the basis of cash prices wherever farmers sell.

Wholesale and Retail Trade.—Chicago's wholesale trade accounted for more than 8% of the wholesale trade of the nation in the late 1950s. The major products handled by more than 12,000 wholesalers in the city are groceries, confections, meats, machinery, industrial equipment and supplies, produce, electrical goods and equipment, drugs and chemicals, dry goods and apparel, lumber and construction materials and paper and paper products. Throughout the 20th century wholesalers organized trade shows, or fairs, in Chicago. By the second half of the century a yearly average of more than 500 such shows attracted about 500,000 buyers to the city each year.

The Loop is the largest single centre of Chicago's retail trade, the seven blocks along State street drawing an average of almost 500,000 people each day. Following World War II, competitors—off-street shopping centres, usually built in new neighbourhoods or in suburbs and made up of a variety of stores—arose to challenge both State street and the neighbourhood stores. Many of the State street stores met this competition by opening branch stores in the new centres. In addition, a modernization program was instituted on State street, and new parking facilities for Loop shoppers were built.

Chicago's foreign trade is mostly by rail through other ports, although after the opening of the St. Lawrence seaway in 1959 ocean-going vessels from the Atlantic reached the city.

Employment and Income.—Chicago, in general, enjoyed a higher level of employment in the second half of the 20th century than did the country as a whole. A higher proportion of those in the active age group was part of the labour force, and women were actively engaged as wage earners to a greater degree in Chicago than in the country at large. Per capita income also was above the national average. The cost of living in Chicago reflects local as well as national economic factors and usually has been among the higher index figures in the nation.

Public Utilities.—Much of Chicago's factory industry is due to an abundance of electric power, supplied by a system of interconnected generating stations. The electrical output, 5,574,961,000 kw.hr. in 1929, increased to more than 20,000,000,000 kw.hr. yearly in the second half of the 20th century. The first electric power generated by atomic energy entered the system in the spring of 1960.

Chicago's gas supply is interconnected by pipelines with the natural gas fields of Texas and with producing plants and consumers within a wide radius of the city. Use is also made of surplus by-product gases generated in the steel and iron industry.

Banking.—Although Chicago is one of the most important banking centres of the nation, it has not attained national leadership or the international standing New York enjoys. The large banks are located in the Loop. Since branch banking was prohibited by state law in 1923, neighbourhood banks serve the small businessmen of the community and individual depositors and borrowers. Savings and loan organizations experienced tremendous growth after World War II and by 1960 outnumbered banks by two to one; currency exchanges are even more numerous. In 1914 one of the 12 regional banks of the Federal Reserve system was established in Chicago. With its member banks (in Illinois, Iowa, Michigan and Wisconsin) it became the Seventh (Chicago) Reserve district.

The Midwest Stock exchange plays an important role in financing industrial and general business activities. The exchange was established in 1949 by a merger of the old Chicago Stock exchange (organized in 1882) and the exchanges of Cleveland, O.; St. Louis, Mo.; and Minneapolis-St. Paul, Minn.

TRANSPORTATION

Chicago is the world's largest railroad and air traffic centre. The highway network makes possible vast movements of people and of raw and manufactured products by truck, bus and automobile. Waterways throughout the city's history have served as a means of transport.

Railroads.—The combined mileage of the city's 19 trunk lines is about half that of all the railroad systems in the United States. Trunk lines reach east to Montreal, Que., Boston, Mass., New York, Philadelphia, Pa., and Baltimore, Md. (the nearest point on the Atlantic coast, 854 mi.); south to Charleston, S.C., Savannah, Ga., Mobile, Ala., New Orleans, La., Port Arthur and Galveston, Tex.; west to Los Angeles and San Francisco, Calif., and Seattle and Vancouver, Wash. Chicago is also the greatest Canadian railway centre from the standpoint of traffic. The Canadian National and Canadian Pacific enter the city through subsidiaries.

The so-called terminal district from which the trunk lines operate reaches in the form of a crescent from Muskegon (Mich.) on the north to Joliet on the southwest and Gary on the southeast. Through this district stretch 7,800 mi. of track, seven belt lines, switching facilities and three electric line railroads. More than 200 freight terminals, industrial yards having a capacity of approximately 200,000 freight cars, some 250 freight houses and almost 400 team yards and specially constructed coal yards are within the terminal district. In the second half of the 20th century over 35,000 freight cars were handled each week-day, 5,000 through, 10,000 intraterminal and 20,000 inbound and outbound. About 43,000 firms in the district owned their own sidings. The Elgin, Joliet & Eastern railway, also called the Chicago Belt, runs from the steel mills at Gary at the south to Waukegan on the north. Because it crosses every railroad coming into Chicago and maintains facilities for interchange the Chicago Belt line carries more tonnage per mile than any other Class I railroad.

Railroad passenger service likewise is extensive. Each day about 550 trains pass through Chicago and 1,225 carry the city's commuters. On a normal business day about 280,000 commuters and 47,000 passengers use the trains.

The passenger terminal situation for the greatest railroad centre of the country has not measured up to the performance of the railroads, and there is no central station. The passenger station of the Chicago and North Western railway was opened for service in 1911. The Union station, directly to the south of this terminal and used by the Pennsylvania, the Burlington, the Gulf Mobile and Ohio and the Milwaukee railways, was finished in 1925.

The far more numerous railways entering the city on the south side spent years working on plans for the consolidation and rearrangement of their terminal facilities, but decline of railway passenger traffic and weakened railway finances during the depression of the 1930s diminished interest in the projects. The increased patronage enjoyed by air lines and the greater use of automobiles and trucks even in prosperous days further decreased the revenue not only of railroad passenger service but of freight traffic, and the railways continued to use four separate passenger terminals.

Of many physical improvements undertaken by various railroads, the use of diesel engines had particular significance. In 1934 the Burlington road inaugurated such a run between Chicago and Denver. In 1936 the Santa Fe railway introduced passenger streamliners for a trip of 39¾ hours between Chicago and Los Angeles. The North Western's "400" had already covered the distance between Chicago and Minneapolis-St. Paul in a mile-a-minute, the first to make this speed for this distance. Sixteen-hour passenger service between Chicago and New York started in 1938.

Air Traffic.—The first municipal airport in Chicago was established in 1927. By 1960 over 20 airports served the area and the three city-owned airports handled millions of passengers annually. Midway airport, so-called for the United States victory at Midway Island in 1942 and because it was situated midway between the majority of national airways, became the busiest airport in the world. Chicago-O'Hare International airport, named for a World War II hero, Lieut. Comdr. Edward O'Hare, was opened in 1956. With the growth of commercial jet aviation and the opening of new terminal facilities in the early 1960s, O'Hare superseded Midway, where traffic had declined sharply by 1962. Meigs field, an airport near the downtown area, on Northerly Island, was designed primarily to accommodate private planes and helicopters.

Airfreight and airmail lines expanded in numbers and services, particularly during the 1950s. Through its air division the American Railway express increased the speed of its service. Before the mid-1950s helicopters carried air mail to numerous towns near Chicago, and after 1956 the use of helicopters expanded considerably; they provided service to the three municipal airports and increasingly served private interests.

Trucking.—The growth of transportation by truck is one of the best illustrations of the changing pattern of the United States economy in which Chicago participates. The transition from horse-drawn wagons, found even as late as the 1920s, to motorized, heavy vehicles capable of carrying an average of 20 tons of freight, occurred in less than three decades. The process was gradual until the 1940s, when the needs created by World War II stimulated the trucking business. By this development in the transport of freight the railroads suffered greatly, as they had by the transport of passengers by motorbus.

Chicago became the chief centre of trucking in the United States, with more than 2,000 cartage companies in the city and its suburbs. The majority were organized after World War II, although a few prominent cartage companies were teamsters before then. By the mid-1950s about 10,000 trucks entered and departed from Chicago in an average day, bearing all kinds of cargo, from canned foods to steel. About 85% of the livestock entering the Union stockyard was transported by truck. Refrigerated trucks transported fresh and frozen foods, and armoured trucks, the property of Brink's Inc., founded in Chicago in 1859, carried money to approximately 2,000 cities and towns in the United States and Canada.

Water Traffic.—Ship traffic on Lake Michigan, important since the city's earliest days, became principally a matter of transporting bulk cargoes of iron ore, coal, coke and limestone directly from mine rail terminals to the great iron, steel and cement plants with their own docks on the south shore of the lake. Throughout the 20th century traffic shifted to the ports on the southern extremities of Chicago—Calumet harbour, Indiana harbour, etc.—and steamers that formerly docked in the river called, after 1915, at Navy pier, which projects 3,000 ft. into Lake Michigan north of the Chicago river. Some lake cargo destined for Chicago is landed at Milwaukee, Wis., and proceeds by rail.

Upon completion of the Illinois waterway in 1933 (connecting Chicago through the Illinois and Mississippi rivers with New Orleans by a barge route of nine-foot draft) the Chicago river became an important link for through-water traffic. With the completion of the St. Lawrence seaway in 1959, Chicago was connected with the Atlantic ocean, making the city a world port.

Improvement of the Chicago outer harbour by the federal government began in 1833. Great breakwaters protect the river mouth from the silting shore currents of the lake, and an outer roadstead affords secure shelter from storms. The river itself has about 15 mi. of navigable channel, in part lined with docks. The channel has been deepened several times and, from 1896, widened and straightened after overhanging building constructions along the river banks were removed. In 1890 the federal government assumed control of the river as a navigable stream. In the days when it served Chicago as an important highway of commerce, the shores of the river were lined with grain elevators, lumberyards, coalyards and warehouses.

With the opening of Wacker drive at the northern boundary of the Loop business section in 1927, abutting buildings disappeared from the south bank of the river to Lake street. This construction, which connects with the Michigan avenue bridge and the two-level boulevards approaching it, was the beginning of a plan to make the south and east banks of the river into broad traffic arteries. Farther south, the south branch of the river, which curves west for about a mile, was moved westward a quarter of a mile to permit the building of wide streets from the south into the Loop.

The port of Chicago includes Chicago harbour and Calumet harbour on the lake front, Lake Calumet, the Chicago and Calumet rivers, the Chicago Sanitary and Ship canal and the Calumet-Sag channel.

Local Transportation.—The first city ordinance providing for streetcar service was passed in 1855, but the initial trip was not made until 1859. By 1890 electrification began to supersede the cable system, and two years later the electric trolley car was introduced. The last years of the 1880s saw the beginning of an elevated railway system. Under a state referendum act the city voted for municipal ownership and operation in 1902; and the next year the state legislature (in the Mueller law) granted the city the requisite powers. In 1906 acquisition of all roads by the city seemed assured, but the necessary bond issue was declared unconstitutional (1907). The electorate reversed its stand in 1907, voting for private ownership but greater municipal control. In 1927 the franchise arrangement terminated and the lines operated under temporary agreements.

With increasing congestion of the streets by motor traffic and the growth of the city, surface electric lines failed to meet the demands made upon them. Elevated railway lines also were inadequate to serve potential passengers. In 1938 the construction of a subway to connect with the elevated was started, but the first unit did not begin running until 1943. A second unit was opened in 1951. This transportation, city owned, is operated by the Chicago Transit authority (C.T.A.), a semipublic body, publicly owned but privately financed. The C.T.A. lines comprise one of the largest local transportation systems in the world, operating gasoline, diesel and electric buses and elevated and subway trains in Chicago and other Cook county municipalities.

EDUCATION AND CULTURE

Education.—The general control of the public schools is the responsibility of the board of education, a policy-making agency, appointed by the mayor. The board serves without pay. At the head of the administrative staff is a general superintendent. The cost of operating the public schools is met largely from local taxes, some state aid, and income from school lands. Some aid comes from federal grants such as the Smith-Hughes act for vocational training. Special schools provide instruction for the physically handicapped, for the socially maladjusted, for those wishing vocational training and for the exceptionally gifted. Educational facilities are made available for children in hospitals; teachers visit homes where children are bedridden; and some instruction is carried on by television. The city system also includes the Chicago Teachers college, with its three branches, and six junior colleges.

Besides elementary and high schools supported by public funds there are many private and parochial schools, of which Roman Catholic (approximately 400 elementary schools and 90 high schools) and Lutheran (approximately 120 elementary schools and 3 high schools) are the most numerous.

The University of Chicago is described in a separate article (*see* CHICAGO, THE UNIVERSITY OF). Northwestern university, established in 1851 under the auspices of the Methodist Episcopal Church, maintains a campus on the shore of Lake Michigan in Evanston, north of Chicago, and professional and evening schools in Chicago. De Paul university (chartered in 1907), Loyola university (1909) and Mundelein college for women (1929) are the principal Catholic institutions of higher education in the city. Roosevelt university was founded in 1945 and in less than a decade had an enrollment of more than 4,000 students. In 1940 the Lewis institute and the Armour Institute of Technology were consolidated as the Illinois Institute of Technology (I.I.T.). The Institute of Design, founded as the New Bauhaus by Laszlo Moholy-Nagy in 1937, became a part of the design division of I.I.T. in 1956. The University of Illinois (*see* ILLINOIS: *Education*) has professional schools in Chicago and an undergraduate branch. George Williams college (founded 1890) and North Park college (1891) also offer college courses. Theological schools include the Presbyterian Theological seminary, the Chicago seminary (Congregational, opened in 1858, and including German, Danish-Norwegian and Swedish institutes); the Seabury-Western Theological seminary and Garrett Biblical Institute, both in Evanston; a German Lutheran Theological seminary and an Evangelical Lutheran Theological seminary.

Chicago's medical centres offer outstanding educational as well as research and treatment facilities. On the south side are Michael Reese and Mercy hospitals, The University of Chicago medical group and the Argonne Cancer Research hospital. On the near north side are the Northwestern university medical school and, nearby, Passavant and Wesley Memorial hospitals and a Veterans administration research hospital. The West Side Medical centre was first proposed in 1917; in 1941 the state legislature set up the Medical Centre district. Associated in this major concentration of medical resources are Cook County hospital, the largest in the world and internationally known for medical training; the University of Illinois-Chicago Research and Educational hospitals; Presbyterian-St. Luke's hospital; and other institutions.

Libraries and Museums.—When the great fire occurred in 1871 Chicago had no free tax-supported library, although several private libraries were semipublic in practice. The nucleus of the Chicago public library, established the year after the fire, was a collection of books from England, Ireland, Germany, France and other countries to which many contemporary literary and other celebrities made contributions; the library was opened in 1874. There are more than 2,000,000 volumes in the main library. There are about 40 independent branch libraries throughout the city. The John Crerar library, endowed in 1889 by John Crerar, manufacturer of railway supplies, has more than 700,000 volumes on physical, natural and medical sciences and other applications. The Newberry library, endowed in 1885 by a bequest of Walter L. Newberry and opened in 1887, contains more than 650,000 volumes, chiefly in literature, history, music and genealogy. The Burnham Library of Architecture and the Ryerson library devoted to the fine arts are located in the Art Institute of Chicago. The Municipal library in the city hall has gathered data on city government; the Chicago Law institute is a law library located in the County building. The Chicago Historical Society library, established in 1856, houses a rich collection of Chicago history. In 1949 the Midwest Inter-Library centre was organized to provide participating midwestern universities with research materials. Other libraries include those of the universities and various trade and professional organizations with headquarters in Chicago, as well as libraries connected with several museums.

Among important museums are the Museum of Science and Industry, opened in 1933; the John G. Shedd aquarium, opened in 1929; the Chicago Natural History museum, founded in 1893 as the Columbian museum; and the Adler Planetarium and Astronomical museum, with a collection of antique astronomical instruments.

Newspapers.—About 600 periodicals and newspapers are published in Chicago. The *Chicago Tribune*, established in 1847, is the city's oldest English-language newspaper. The *Sun*, founded in 1941, merged with the *Times* in 1947 as the *Sun-Times*. The afternoon papers are the *Daily News* and *Chicago's American* (formerly the *Herald-American*). In 1956 the Tribune company bought the *Herald-American*, formerly a Hearst newspaper, and in Jan. 1959 Field Enterprises, Inc., publisher of the *Sun-Times*, purchased the *Daily News*, which began continuous publication the first of the year 1876. The *Defender*, founded in 1905, is one of the country's largest Negro newspapers. A large number of foreign-language dailies serve many readers.

Art and Music.—The first important organization to study art history and methods in Chicago was the Chicago Academy of Design (1867). In 1882 the Chicago Academy of Fine Arts (established in 1879) became the Art Institute of Chicago. Under the administration of its first president, Charles L. Hutchinson (1882–1924), the Art institute built its museum and school on the lake front and assembled under its roof outstanding collections, including those of private citizens. Widely acclaimed are the institute's collections of 19th-century French paintings, Chinese bronzes and Japanese prints. The institute's art school offers training in painting, drawing, sculpture, commercial illustrating, decorative design and architecture. The Arts club of Chicago, opened Nov. 11, 1918, was for a time a rival, bringing to Chicago the art of 20th-century European moderns. But the Art institute gradually accepted the innovators and absorbed the functions of the Arts club.

As early as 1833 monthly concerts were given in Chicago, and in 1835 a Chicago Harmonic society was organized. In 1857 George P. Upton started the Mendelssohn society, which later became the Apollo club, still in existence.

On Oct. 16, 1891, after several visits to the city with touring orchestras, Theodore Thomas (*q.v.*) raised his baton over a newly created Chicago Symphony orchestra and inaugurated a golden age of symphonic music in the city. Upon Thomas' death in 1905, Frederick Stock (*q.v.*) succeeded to the position of conductor, holding it, except briefly during World War I, until his death in 1942. Stock was succeeded by Désiré Defauw (1943–47), Artur Rodzinski (1947–48), Rafael Kubelik (1950–53) and Fritz Reiner (1953–63). Jean Martinon became conductor in 1963.

Chicago enjoyed its first season of opera as early as 1858–59. In 1910 Chicago and New York businessmen organized the Chicago Grand Opera company and eventually brought in Mary Garden (*q.v.*) as not only its prima donna but its artistic manager as well. Upon withdrawal of the New York supporters, the company was reorganized as the Chicago Opera association. In 1921 a reorganization again occurred and the name was changed to the Civic Opera company. The Lyric Opera company, organized in 1954, presented regular opera seasons thereafter.

There are many minor orchestras and opera companies and scores of singing societies. Open-air concerts are offered by the Chicago Park district in Grant park throughout the summer in a program that is a successor of similar events scheduled in the 1930s under the auspices of the Works Progress administration. Opera, symphony organizations and popular music are presented in concerts during the summer at Ravinia park, 25 mi. N. of Chicago. Schools of music include the American Conservatory of Music, the Cosmopolitan School of Music, the Chicago Conservatory college and the Chicago musical college of Roosevelt university. The concert hall of the Auditorium building (Roosevelt), designed by Adler and Sullivan and famous for its acoustics, was closed from 1940 but was being refurbished in the mid-1960s.

PARKS

The city's park system covers an area of approximately 7,550 ac. Popular agitation for a park system began in 1835, two years after Chicago was incorporated as a town, when an unsuccessful effort was made to gain possession of the Ft. Dearborn reservation for a public square. In the 1840s only small plots adorned with shrubs and grass fringed the scrubby and unkempt streets. Concern over the abrasion of the shores along Lake Michigan came to a climax in 1851 when the state legislature forbade the sale of block 39 of the original town, reserved it for a public square and invested the city's council with the right to grade and improve it. Various attempts to establish parks in the different divisions of the city failed. In 1861, 80 ac. in the north division of the city were laid out and called La Frambois park, later becoming a part of Lincoln park. Lake park (later named Grant park) along the lake shore was acquired in 1864, and five years later the state legislature enacted legislation which led to the establishment of a true system of parks. In 1870 about 1,887 ac. were devoted to parks. Chicago then acquired the name of the Garden city, still emblazoned on the municipal coat of arms.

Lincoln park (1,119 ac.), near the lake shore on the north side, was much enlarged by an addition reclaimed from the lake. It has fine monuments, a conservatory, a zoological garden and the collections of the Academy of Sciences. Jackson and Washington parks are the most important parks on the south side. Jackson park (543 ac.), the main site of the World's Columbian exposition of 1893, lying along the shores of Lake Michigan, is joined to Washington park (371 ac.) by a mile-long boulevard known since the Columbian exposition as the Midway Plaisance. Along the Midway are the buildings of The University of Chicago. Grant park occupies 303 ac. of land along the lake near the downtown district; in it are the Art institute, the Shedd aquarium and the Chicago Natural History museum. Soldier field, with a capacity of more than 100,000, and McCormick Place, an exposition centre, are located south of Grant park in Burnham park (598 ac.). The Adler planetarium is on Northerly Island (91 ac.) in the lake off Grant park. On the west side of the city are three large parks—Douglas (182 ac.), Garfield (187 ac.) and Humboldt (206 ac.), which has a remarkable rose garden—and on the extreme south side several others, including Calumet, by the lakeside, and Marquette.

In 1933 the state legislature passed an act consolidating the 22 park systems. Under the act, approved by popular referendum, the Chicago Park district became operative in April 1934. A board of five commissioners is appointed by the mayor and confirmed by the city council but not subject to council control. A functional merger of the city of Chicago and the Chicago Park district occurred in 1957; control of all parks and playgrounds was placed under the park district commissioners, the city assuming the obligation of maintenance and policing of all boulevards.

In addition to the city park system, the Cook county forest preserves, a broad belt of wooded lands (38,000 ac.) acquired over many years, extend north, south and west of the city.

See also references under "Chicago" in the Index volume.

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(B. L. P.)

CHICAGO, THE UNIVERSITY OF, an institution of higher learning in Chicago, Ill., was founded in 1890 and opened on Oct. 1, 1892. It is privately supported and coeducational. Though originally established as a Baptist university, requirements for Baptist membership on the board of trustees were progressively relaxed by the Northern Baptist convention, and the university became nondenominational.

The university is approximately 8 mi. S. of the downtown section of Chicago, with frontage for three-fourths of a mile on both sides of the Midway Plaisance, which links Jackson and Washington parks. The campus of more than 100 ac. has over 100 buildings, most of which are collegiate Gothic in architectural style and grouped in quadrangles. Newer buildings, however, departed from the Gothic style, though general uniformity was maintained with limestone exteriors. Growth of the university in facilities, program and influence was rapid, largely because of the combination of John D. Rockefeller, its founder, who provided liberal and consistent financial support, and William Rainey Harper, who served as the first president until Jan. 10, 1906.

Harper had original educational ideas and enthusiasm, and he gathered a distinguished faculty, including nine presidents of colleges and universities. From the start, therefore, the university was eminent in research and advanced study.

Although the university gained an international reputation as a centre of research, it also was continuously concerned with the development of undergraduate education. Harper established junior and senior college divisions, of two years each, which prevailed until 1931, when the Chicago plan was instituted. This program was extended in 1941 to provide a four-year liberal education curriculum, beginning at the end of the sophomore year of high school. Under that plan, yearlong integrated courses covering the broad fields of knowledge were developed. Students met the requirements for the bachelor's degree by passing, either through comprehensive examinations or placement tests taken at the beginning of their residence, 14 required courses. At the beginning of the academic year 1954 the plan was modified to relocate undergraduate education primarily at the end of high school, and to provide approximately half of the requirements in specialized fields. Early admission was continued, as was the four-year program entirely in liberal arts for students so electing, but the large majority of entering students were high-school graduates. Many of the innovations of the Chicago plan, including the integrated courses, early admission of qualified students and renewed attention to liberal education, had a wide influence on collegiate programs of the country.

An administrative reorganization also was made in 1930, establishing largely the present university organization: the College; four divisions—the physical, biological and social sciences and the humanities; the professional schools—business, divinity, education, law, library science, medicine and social service administration; the library; the press; extension (University college for adult education; and home study, for correspondence work). This grouping includes the Oriental institute, engaged in research on earlier civilizations; Yerkes observatory, Williams Bay, Wis. (whose astronomers and those of the University of Texas have joint faculty appointments and staff Texas' McDonald observatory, Mt. Locke, Tex.); the laboratory schools (nursery, elementary and high school); an orthogenic school; the University clinics; and two basic research organizations, established in 1945, the Institute for Study of Metals and the Enrico Fermi Institute for Nuclear Studies (named in honour of Fermi in 1955). Much of the research and advanced study is conducted through interdivisional and interdepartmental committees. The University of Chicago Press, established in 1892, publishes many learned journals and an average of 80 books a year.

In addition to the building during Harper's administration, there was extensive construction during the period 1924–32, which trebled floor space. Principal units built after World War II were new hospitals, the administration building, the accelerator building (housing a 450,000,000-ev synchrocyclotron) and laboratories for the new institutes in nuclear energy and metals. Another period of extensive construction began in the mid-1950s.

Harper, a professor of biblical literature at Yale university before he became the university's first president, was succeeded in 1907 by Harry Pratt Judson. Judson had served as dean of the faculty under Harper and was the first head of the political science department. He consolidated and co-ordinated the university, following its rapid development and expansion under Harper. Judson retired in 1923 and was succeeded by Ernest DeWitt Burton, a New Testament scholar who was also a member of the original faculty. In his two-year administration, terminated by his death, Burton displayed remarkable qualities of enthusiasm and leadership, initiating a program of expansion and implementing it with the university's first public campaign for funds, an effort that produced $9,500,000 in gifts. Max Mason, a mathematical physicist, succeeded Burton in 1925, and on July 1, 1929, Robert M. Hutchins (*q.v.*), dean of the law school of Yale university, became the fifth president at the age of 30. Under Hutchins the Chicago plan for undergraduate education, mentioned previously, was introduced and the faculties were reorganized. Hutchins' title was changed by trustee action to that of chancellor in 1945. He resigned on Dec. 19, 1950 (effective June 30, 1951).

Lawrence A. Kimpton, professor of philosophy and vice-president in charge of development of the university, was elected chancellor April 12, 1951. He announced his resignation March 30, 1960, after reorienting the college, raising about $100,000,000 in new funds, initiating a construction program which added 15 major new buildings, and leading successful efforts to protect the environment of the university from deterioration with programs of clearance and rehabilitation. After Kimpton's resignation became effective Sept. 8, 1960, R. Wendell Harrison, vice-president of the university, dean of faculties and professor of microbiology, served as chancellor. In Jan. 1961 George W. Beadle (*q.v.*), 1958 Nobel prize winner in medicine and physiology and former professor and chairman of the division of biology at the California Institute of Technology, became chancellor. Later that same year a reorganization of the university administration eliminated the office of chancellor and Beadle was named president of the university.

For the university's association with *Encyclopædia Britannica*, *see* ENCYCLOPAEDIA; *see* also references under "Chicago, The University of," in the Index volume. (W. V. M.)

CHICAGO HEIGHTS, an industrial city of Cook county, Ill., U.S., 27 mi. S. of the Chicago loop. The elevation averages 95 ft. above the surrounding area, hence the name. The site was the intersection of the Hubbard trail, from Vincennes to Fort Dearborn, and the Sauk trail, used by Indians going from their hunting grounds to the fur post and garrison at Detroit; the Sauk trail later became an important route to the west. The settlement was known as Thorn Grove in the 1830s; in 1849 it was renamed Bloom by German settlers in honour of Robert Bluehm, a German patriot executed at Vienna in 1848. In 1890 the Chicago Heights Land association induced manufacturers to establish plants there, and in 1901 the city of Chicago Heights was incorporated. It was the earliest and for a time the most important of the steel-making communities in the Chicago district. Other industrial plants manufacture chemicals, glass specialties, roofing, textiles, school supplies, fertilizers and paints. For comparative population figures *see* table in ILLINOIS: *Population*. (D. A. PR.)

CHICAGO SANITARY AND SHIP CANAL, in the United States, an engineering development of special importance to the city of Chicago and surrounding districts, was first opened in 1900. Before the construction of the canal Chicago discharged sewerage through the Chicago river into Lake Michigan, which was also the source of the water supply. A canal channel was dug by which the Chicago was connected with the Des Plaines river (which flows southwest to the Illinois river and thence to the Mississippi river) and at the same time the flow in the Chicago river was reversed from east to west. The canal is 34 mi. long, 160 ft. wide and 24 ft. in depth. Another phase of the project, completed in 1933, was the creation of an all-water route with a minimum depth of 9 ft. between the Great Lakes and the Gulf of Mexico.

CHICHA, a freshly fermented, unfiltered liquor brewed from maize (Indian corn) by many Indian groups of Latin America. It also has been known as *cangüi* among the Avas and Chiriguanos of Bolivia, *asua* among the Quechua-speaking groups of Ecuador and *tesvino* or *texgüino* among Nahuatl-speaking tribes of Mexico.

Chicha has a cloudy appearance and an aroma and taste resembling beer, but lacks the bitter undertone and character of the missing hops. One of a number of fermented drinks known to Latin-American Indians, it is not made commercially, but is a popular home brew made and consumed in modern times much as in pre-Columbian days, particularly along the altiplano or high levels of the Andean range from Colombia to southern Chile, as well as in Mexico and Central America. Used by the Indians as both a social and ceremonial beverage, it is ritually dedicated to the earth to promote an abundant maize crop and is drunk at celebrations of births, marriages and other important occasions.

Two basic methods of production are known. In the first, the corn is allowed to sprout, becoming a corn malt containing the enzyme diastase. After it is ground into meal, water is added and the mixture cooked; then the pot is covered and set aside for a few days to permit fermentation. When bubbling subsides, fermentation is completed and the liquor is potable. In the more remote areas, unmalted corn is chewed and spit into a pot, the salivary enzyme ptyalin performing the starch-to-sugar conversion function of the diastase of malt. The remainder of the process is the same. *Chicha* keeps for some time in the cold climate of the high Andes, but at warmer temperatures spoils in a few days.

See W. La Barre, "Native American Beers," *Amer. Anthrop.*, 40:224–234 (1938); J. M. Cooper, "Stimulants and Narcotics," in Julian H. Steward (ed.), *Handbook of South American Indians*, 5:525–558 (1949), with bibliography. (H. J. Gn.)

CHICHELE (Chicheley), **HENRY** (1364–1443), archbishop of Canterbury, cofounder with Henry VI of All Souls college, Oxford, was born at Higham Ferrers, Northamptonshire, and educated at Winchester and Oxford. He served as advocate in the court of arches and was ordained in 1396. Chichele was the English envoy to Innocent VII in 1405 and to Gregory X in 1407 concerning the great papal schism. He negotiated peace with France in 1406. In 1409 he represented the English bishops at the council of Pisa, which elected a third papal claimant. In 1410, in an important test case before king's bench, papal decrees were declared not to supersede English law and Chichele had to resign his numerous minor benefices. In the second phase of the Hundred Years' War, he fought against the Armagnacs at Paris and helped to negotiate the peace of 1413. In 1414 he was consecrated archbishop of Canterbury. The charges in Hall's *Chronicle* and in Shakespeare's *Henry V* that Chichele agitated for war with France in 1414 to avert attention from the disendowment of the church are ill-founded. He suppressed the Lollards but upheld the independence of the national church against papal claims. In 1419 he assisted in the capture of Rouen and negotiated the marriage of Henry V to Katherine of France. A patron of education, he established a burse for poor students and two colleges at Oxford (in addition to All Souls, another, the ancestor of St. John's college) and a college at Higham Ferrers. Chichele died on April 12, 1443, and was buried at Canterbury.

See Duck, *Life of H. Chichele* (1699); Hook, *Archbishops of Canterbury* (1860). (T. L. C.)

CHICHÉN-ITZÁ, the ruins of an ancient Mayan city of that name, in the south-central part of the state of Yucatán, Mex., near the boundary of Quintana Roo, about 20° 30′ N. lat. and 88° 30′ W. long. The dry, waterless region around Chichén-Itzá is of limestone formation, with only an underground water supply, available in but a few places called *cenotes* by the Mayans, where the limestone cap has fallen into the caves through which the water flows. Two large *cenotes* determined the location of the city and gave it its distinctive name, *Chi,* which in Mayan means "mouths," *chen,* "wells," and *Itzá,* the name of the particular Mayan tribe or group that first settled there, the whole meaning the "Mouths of the Wells of the Itzá."

Founded not later than A.D. 530, the settlement for about the first century constituted but a frontier post of a Mayan civilization, the Old Empire, which at that time was flourishing in the much greater centres to the southward—Copán, Tikal, Quiriguá, Palenque (*q.v.*) and a dozen other equally important cities. When about a century later these great flourishing southern cities were finally abandoned, Chichén-Itzá was also temporarily abandoned, A.D. 668, and the Itzá trekked westward across Yucatán to a new capital, Chakanputun, south of the modern Campeche. Chakanputun was burned in A.D. 944 and the "Holy Men of the Itzá" led their people back to Chichén-Itzá, where in A.D. 964 they re-established their household gods and rebuilt their shrines and altars. It was the period of the founding of the New Empire, with Uxmal (*q.v.*), Mayapán and a group of satellite cities sharing with Chichén-Itzá a superb renaissance of Mayan culture and power. In A.D. 1004 the three greater cities formed an alliance, the League of Mayapán, and the calm and order and prosperity that followed gave rise to a golden age of Mayan religion, science and art, with majestic temples and superb sculptures scattered about the land. At Chichén most of the middle section of the city lying south and west of the Thousand Columns was built at this time, graced by the Akab'tzib (House of the Dark Writing), the Chichanchob (Red House), the House of the Deer, and parts of the Monjas (Monastery).

JIM MITCHELL FROM BLACK STAR

CHICHANCHOB (RED HOUSE), CHICHÉN-ITZÁ, MEX.; ABOUT A.D. 1004

In 1201 the League of Mayapán was disrupted by an attack of the Mayapán people upon Chichén-Itzá because of conspiracies against the league by Chac Xib Chac (The Very Red Man), the Itzan ruler. With the aid of Toltec and Aztec allies from Central Mexico the Mayapán people conquered the Itzans. Henceforth the city was held in thrall by the Toltec-Aztec allies of the Mayapán group. These Toltec-Aztec conquerors brought with them the worship of the fair, golden-haired god, Quetzalcóatl, the "Feathered Serpent," who became "Kukulcán," the Itzan equivalent. During this period Chichén-Itzá rose to heights of prosperity, prominence and architectural development surpassing anything in its earlier history, and highly adorned temples, sanctuaries and shrines rose: the principal temple, the so-called Castillo, covering an acre of ground and rising 100 ft. above the plain; the Thousand Columns enclosing a central plaza of more than five acres with pyramid temples, colonnaded halls, sunken courts, terraces and theatres; the Tlachtli-ground or Ball Court; the Temple of the Jaguars; the Temple of the Tables; the Astronomical observatory; the High Priest's grave; and a host of others.

The two *cenotes* upon which the city depended for its very life constituted the religious as well as the economic centre of the city and its culture. Young Itzan maidens were sacrificed to the gods of the wells, as were all kinds of valuables, in gruesome spectacles that drew thousands to share in the ceremonies and the rites and gave to the city its holy character. The natural setting of the wells, the grandeur of the temples built beside them, the austerity and dignity of the rites, all contributed to the lure and made Chichén-Itzá the Mecca of the Mayan world for almost two and one-half centuries until about the middle of the 15th century when it was rather suddenly and finally abandoned, only a few stragglers making their homes there and doing homage to the old gods. *See* also Maya Indians.

See S. G. Morley, "Chichén-Itzá, an Ancient American Mecca," *Natl. Geog. Mag.*, vol. xlvii, no. 1, pp. 63–95 (Jan. 1925). (W. E. E.)

CHICHERIN, GEORGI VASILIEVICH (1872–1936), Soviet statesman who conducted the foreign policy of the Russian Soviet Federated Socialist Republic from 1918 and of the U.S.S.R. from 1922 to 1928, the son of an official in the Russian ministry for foreign affairs, was born in Tambov *oblast*. He was educated at a Russian higher school and at St. Petersburg university and entered the diplomatic service in the archives department of the foreign ministry. Having been drawn into the revolutionary movement, he resigned from the diplomatic service in 1904, renouncing his estates, and went to Berlin, where he followed closely the German Social Democratic movement. He was at first attached to the Russian Socialist Revolutionary party, but later joined the Social Democratic party and until 1918 remained a member of its Menshevik wing. He was prevented by illness from taking part in the revolution of 1905. He spent 12 years in revolutionary activities in London, Paris and Berlin, being elected secretary of the central bureau of the Russian Social Democratic party organizations abroad in 1907. In the same year he was arrested in Berlin for the possession of a false passport and banished from Prussia.

During World War I he assisted the pacifist Labour elements in Great Britain and organized relief for Russian political refugees —philanthropic work which had a revolutionary aspect in maintaining contact with Russian revolutionaries. After the Bolshevik revolution in Nov. 1917, when Russia, having opened peace negotiations with the Central Powers, was no longer considered an ally, Chicherin was imprisoned in Brixton jail on the ground of "enemy associations." On Jan. 3, 1918, he was exchanged for Sir George Buchanan by the Soviet government, returned to Russia and joined the Bolsheviks. Trotski having resigned the post of people's commissar for foreign affairs in March 1918, Chicherin was appointed to it in May. In 1922 he headed the Soviet delegation to the conference of Genoa (*q.v.*) of which the unexpected result was the treaty of Rapallo (*q.v.*) between Soviet Russia and Germany. He thereafter conducted Soviet foreign policy till late in 1928, when illness began to prevent him from carrying on his duties. Chicherin finally retired in July 1930 and died in Moscow on July 7, 1936.

CHICHESTER, a city and municipal borough in the Chichester parliamentary division of Sussex, Eng., and county town of the administrative county of West Sussex, is 62 mi. S.W. of London by road. Pop. (1961) 20,118. It lies in the coastal plain at the foot of a spur of the South Downs, a mile from the head of Chichester harbour, an inlet of the English channel and a noted yachting centre. Chichester is probably on the site of Noviomagus or Regnum, the capital of the realm of Cogidumnus, native ruling prince of the Regnenses, who enjoyed legatine authority from imperial Rome.

On Roman roads to London and Winchester, Chichester (Cisseceastre of the Saxons in 895, Cicestre in Domesday Book) remained of considerable importance under the South Saxon kings and it had a mint in about 928. A charter of Henry I mentions the borough, but the earliest extant charter is that of Stephen, about 1135, confirming the rights of the borough and guild merchant as held in the time of William I. This grant shows the Chichester guild merchant to be possibly the oldest in England. This was confirmed by Henry II in 1155. By Edward II's charter, the customs of wool, hides and skins were reserved to the king. Edward III directed that the Sussex county court should be held at Chichester. James II in 1685 granted the charter now in force. Chichester returned two members to parliament from 1295 to 1867, and one from then until 1886. Throughout the middle ages the town was commercially important, and a wool staple was probably established as early as 1314. Chichester had five fairs in 1889; all but Sloe fair (granted by Henry I, about 1107–08) were abolished. Thomas Fuller mentions the Wednesday market as being famous for corn (grain), while William Camden speaks of the Saturday market as the greatest for fish in the county.

The cathedral church of the Holy Trinity was founded toward the close of the 11th century, after the see was transferred to Chichester from Selsey in 1075. It was dedicated in 1108; Bishop Ralph Luffa (1091–1123) was the first great builder, followed by Seffrid II (1180–1204), but disastrous fires led to further building throughout the 13th century. Norman work appears in the nave (arcade and triforium), choir (arcade) and elsewhere; but there is much beautiful Early English work, as in the ambulatory. The nave is remarkable in having continuous chapels parallel with the north and south aisles, thus giving the effect of double aisles. The church is unique among English cathedrals for its detached campanile, a massive Perpendicular structure with an octagonal top story. The original 14th-century central tower and spire fell in 1861, but were skilfully rebuilt in their former style; the spire is 277 ft. high. The Lady chapel, the cloisters of irregular plan, the library and the 12th-century stone carvings are among the many features of interest. The cathedral is 393 ft. long within, 131 ft. across the transepts and 90 ft. across the nave with its aisles and chapels. The bishop's palace nearby retains its Early English chapel. The diocese includes all Sussex except for a few parishes, with small portions of Kent and Surrey.

At the junction of the four main streets of the city, which preserves its Roman plan, stands an octagonal market cross built and given by Bishop Edward Story in 1501, one of the finest of its kind in the country. St. Mary's hospital was founded in the 12th century, but the existing buildings are of late 13th- and early 14th-century date; its use as an almshouse is maintained. Other ancient buildings are St. Olave's church; the 13th-century guildhall, formerly the choir of the Gray Friars' church; the Canon gate leading into the cathedral close; and the Vicars' hall. The city retains a great part of its ancient walls, which have a circuit of about 1½ mi. and were built about A.D. 200. There is a theological college and a women teachers' training college. The county hall was built in 1936. The city has a large cattle market and a considerable agricultural trade, but no outstanding industry. It is celebrated for its wealth of Georgian architecture. A canal connects with Chichester harbour. Goodwood Park, 3 mi. N.E. is the scene of the fashionable race meet held each July.

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CHICHESTER OF BELFAST, ARTHUR CHICHESTER, BARON (1563–1625), English lord deputy of Ireland who decisively influenced English policy there, in particular in planning the colonization of Ulster, was born in May 1563 at Raleigh, Devonshire. Like many younger sons of Devonshire gentry he sought his fortune overseas, serving in the armed forces at Cádiz (1596), where he was knighted, and in the Netherlands. He went to Ireland in 1599, and took a leading role in the successful campaigns in Ulster against Hugh O'Neill. When the war ended (1603) he was granted large estates in Belfast and Carrickfergus.

His appointment as lord deputy in 1604 was unexpected, and his two chief incursions into general politics suggest that he brought to the problems of government more the direct approach of the soldier than the political awareness of the statesman. In 1605 his attempt to reverse the earlier policy of religious toleration by banishing priests and imprisoning recusants brought him into difficulties with the Roman Catholic gentry, and the English privy council was forced to intervene in 1606. Chichester again followed an uncompromising policy when he tried to crush all opposition in the forthcoming parliament of 1613 by creating 40 government boroughs whose members would outnumber those of the 39 Catholic boroughs.

But Chichester is chiefly remembered for his role in the plantation of Ulster (*see* IRELAND: *History*). His religious policy and the declaration of 1605 against the quasi-feudal authority of the Gaelic lords over their tenants were partly responsible for the flight of the Ulster earls of Tyrone and Tyrconnell (1607). This, together with Sir Cahir O'Dogherty's rebellion of 1608, led to Chichester's plans for confiscating the land of the six Ulster counties. His scheme was more moderate than the government's final plan, but like other aspects of his policy it yielded to immediate temptation without due consideration of the ultimate consequences. Chichester himself acquired a vast estate in Inishowen, and, in his own words, he preferred "to labour with his hands in the plantation of Ulster than to dance or play in that of Virginia." He was raised to the peerage in 1613, and retired in 1615 with the honorary post of lord high treasurer. He was sent on an embassy to the Palatinate by James I in 1622, and died in London on Feb. 19, 1625.

See T. W. Moody, *The Londonderry Plantation, 1609–41* (1939); R. D. Edwards (ed.), "Letter-Book of Sir Arthur Chichester," *Analecta Hibernica*, no. viii (1938). (H. F. KE.)

CHICKADEE, common American name (derived from the call note) for a plump, black-throated, black-capped bird (*Parus atricapillus*) of the northern states and Canada; in England it is called the willow tit. The brown-capped chickadee (*P. hudsonicus*) is resident in Canada and northern New England. The smaller Carolina chickadee (*P. carolinensis*) breeds in the southeastern states. The mountain chickadee (*P. gambeli*) is resident in the Rocky mountains and westward; it has a white stripe

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BLACK-CAPPED CHICKADEE, THE ENGLISH WILLOW TIT (PARUS ATRICAPILLUS)

over the eye. The Alaska chickadee (*P. cinctus alascensis*) is also found in eastern Siberia. The chestnut-backed chickadee (*P. rufescens*) lives on mountains from Alaska to Montana and California. Others are found in Mexico. All are closely allied with the old world titmice. *See* Titmouse. (G. F. Ss.)

CHICKAMAUGA, BATTLE OF, Sept. 19–20, 1863, during the American Civil War, was a vital part of the maneuvering and fighting to control the important railroad centre at nearby Chattanooga. As Gen. William S. Rosecrans (*q.v.*), commanding the Army of the Cumberland moved against Chattanooga, Gen. *Braxton Bragg* (*q.v.*), to avoid being surrounded in the city, withdrew his Army of Tennessee to La Fayette about 20 mi. S.E. in Georgia. There he could await reinforcements and possibly, if Rosecrans chose to follow him, defeat the Union army in detail as it was widely dispersed among the several routes through the intervening hills and low mountains. Rosecrans, however, succeeded in moving his army without serious interference and established headquarters at Chickamauga about 12 mi. S.E. of Chattanooga. Meanwhile *Bragg* was collecting reinforcements and was preparing to give battle. The Confederate high command recognized the importance of stopping this Federal advance and sent Gen. *James Longstreet* (*q.v.*) from *Lee's* Army of Northern Virginia to *Bragg's* assistance. On Sept. 9 the first of *Longstreet's* men left by a roundabout route through the Carolinas to Atlanta, and thence up the Western Atlantic railroad to the scene of the impending battle. The first of them arrived barely in time to play what may well have been the decisive role in the battle.

The conflict raged for two days along Chickamauga creek over a very small area, not quite five miles from east to west and even less from north to south. Most of the area was in virgin forest badly tangled with undergrowth that made it difficult to distinguish between friend and foe. Both commanders soon lost anything like general direction of the fighting. On the second day, *Longstreet*, who had arrived the night before, was placed in command of the Confederate right wing. He found a hole in the extended Federal line, poured his men through quickly and moved to crush the flanks on either side. Rosecrans, assuming that his left wing had also fallen, retreated pell-mell to Rossville and on to Chattanooga. But Gen. George H. Thomas (*q.v.*), the "Rock of Chickamauga," soon to supersede Rosecrans in command, skillfully organized the defenses and withstood the attack until the reserve corps came to his assistance and made possible an orderly withdrawal to Chattanooga. Some 120,000 men about equally divided between the Blue and the Gray participated. Casualties totaled 34,000, about 18,000 of them Confederate, making Chickamauga one of the bloodiest battles of the war. *Bragg* did not choose to follow up this decisive victory, and two months later in the fighting around Chattanooga (*see* Chattanooga, Battle of) it was completely nullified. An Act of Congress in 1890 created the Chickamauga and Chattanooga National Military park, comprising 10 sq.mi. of the Chickamauga battlefield and some detached areas important in the succeeding Chattanooga campaign. *See* also American Civil War.

For an extended nontechnical account *see* Gilbert E. Govan and J. W. Livingood, *The Chattanooga Country, 1540–1951* (1952).
(C. W. Te.)

CHICKASAW, an American Indian tribe of Muskogean linguistic stock residing originally in northern Mississippi and Alabama, and later forming one of the "Five Civilized Tribes" (*q.v.*) after removal to Oklahoma. The Chickasaw were an offshoot of the Choctaw (*q.v.*) and closely related in language and culture. First seen by De Soto in 1540–41, they became involved in the power struggles between the British and French in the 18th century and suffered considerable losses. At the time of removal to Oklahoma between 1822 and 1838 they numbered about 5,000; at mid-20th century the population was about 9,000, including many persons of mixed blood. The Chickasaw were an agricultural and hunting people living in scattered "towns" built around a ceremonial square. They were organized in a dual division, with matrilineal exogamous clans and a Crow-type kinship system (*see* Kinship Terminology), the dual divisions being associated with war and peace, respectively, and forming opposing sides in games and ceremonies. The supreme deity was associated with the sky, sun and fire; and a harvest ceremony, similar to the Creek busk, was performed annually. *See* also Muskogean Indians.

See J. R. Swanton, "Indians of the Southeastern United States," Bureau of American Ethnology, *Bull. 137* (1946). (F. R. E.)

CHICKEN, a name generally applied to the most widely domesticated barnyard fowl and its many varieties, originally descended from the wild red jungle fowl, *Gallus gallus*, of southeastern Asia (*see* Fowl). The females—mature hens and younger pullets—are raised for their edible eggs and meat; the males—variously called cocks, stags, roosters or chanticleers—are also raised for meat. *See* Poultry and Poultry Farming.

CHICKEN POX or varicella, a contagious disease characterized by an eruption of vesicles in the skin. The disease usually occurs in epidemics, and the patients are generally between two and six years old. The incubation period is at least two weeks; there are practically no premonitory symptoms, though slight fever for about 24 hours may precede the eruption. A number of raised red papules appear on the back or chest; in from 12 to 24 hours these develop into tense vesicles filled with a clear fluid, which in another 36 hours or so becomes opalescent. During the fourth day these vesicles shrivel up and the scabs fall off, leaving, as a rule, no scar. Fresh spots appear during the first three days, so that at the end of that time they can be seen in all stages of growth and decay. The eruption is most marked on areas covered by clothing, but it also occurs on the face and limbs and on the mucous membrane of the mouth and palate. The temperature rarely rises above 102° F. The disease runs a favourable course in most cases and aftereffects are rare. The patient should be isolated. The diet should be light, and the patient should be prevented from scratching the spots, which would lead to ulceration and scarring. After the first few days there is no necessity to confine the patient to bed. In the large majority of cases it is easy to distinguish the disease from smallpox but sometimes it is difficult. The chief points in the differential diagnosis are as follows: (1) In chicken pox the rash is chiefly on the trunk, and less on the limbs and face; (2) some of the vesicles are oval, whereas in smallpox they are always hemispherical. They have not at the outset the hard shotty feeling of the more virulent disease; (3) the vesicles attain their full growth within 12 to 24 hours; (4) the rash appears "in crops"; (5) there is no premonitory period. The disease is caused by a virus.

A curious and imperfectly understood relationship exists between chicken pox and herpes zoster (shingles). Contact with chicken pox gives rise in some individuals to herpes zoster, while the reverse may also occur though to a lesser extent. There also appears to be a certain degree of cross-immunity between the two diseases.

CHICK-PEA is a plant belonging to the family Leguminosae. It is cultivated as a porridge food in southern Europe, in Egypt and western Asia. *See* Gram.

CHICKWEED, any low annual or perennial herb of the genus *Stellaria* (family Caryophyllaceae, *q.v.*), called also starwort, tongue grass and winter weed. All are Eurasian but naturalized throughout North America and other regions. They have weak, reclining, much-branched stems, oval or ovate leaves and small white flowers. In mild climates they are found blooming throughout the year; in colder regions, as in the northeastern U.S., they withstand severe frosts and may be discovered blossoming under light snow in midwinter. Various species of *Arenaria, Paronychia* and *Cerastium* are known as chickweeds but the latter is better known as the mouse-ear chickweed. Some of them are cosmopolitan. Most plants called chickweed, though abundant as weeds, are not readily eradicated by cultivation, especially the perennials, which are sometimes persistent in lawns. Annual species are controlled by cultivation; for winter annuals and perennials spraying with 2,4-D is fatal if done in bright sun. (N. Tr.)

CHICLAYO, a city of northern Peru, capital of Lambayeque department; pop. (1958 est.) 54,390. It is located on the Inter-American highway about 400 mi. N.W. of Lima, in the midst of an irrigated area producing sugar cane, cotton and rice. The city is the leading commercial centre of the department, with industries dependent on its regional produce, among which are cattle from the highlands. Chiclayo has an airport and is connected by rail with two ports, Puerto Eten and Pimentel. (P. E. J.)

CHICLE (Chicle Gum), the coagulated milky juice (latex) of the sapodilla (*q.v.*) or naseberry (*Achras zapota*), a tropical American tree of the family Sapotaceae, the fruit of which is used in tropical and subtropical regions. Chicle was first introduced to the U.S. as a substitute for rubber, but by about 1890, it was imported in increasing quantities as the basic ingredient of commercial chewing gum.

The latex is collected by making deep intersecting zigzag cuts in the bark to a height of 30 ft. or more up the trunk, the same tapping method used in gathering balata and gutta-percha. The viscous "milk" oozes from the cuts and runs down slowly to a receptacle at the base of the tree. The flow lasts for several hours and may amount to several quarts. The native collector (*chiclero*) collects this latex from his "walk" of trees once a day, gathering about a ton per season from 200 to 300 or more trees, which are rested from 6 to 10 years between tappings (about 15% of the trees die by this method of bleeding). The raw latex is boiled in kettles until about 67% of the water is lost; the semisolid mass is then molded into *marquetas* or blocks of about 25 lb. weight, which are packed in groups of four for transportation.

For manufacture into chewing gum, the grayish-brown chicle is remelted and cleared of foreign matter; other gums, sugar and flavouring extracts are added; and the finished product is molded and wrapped into packages.

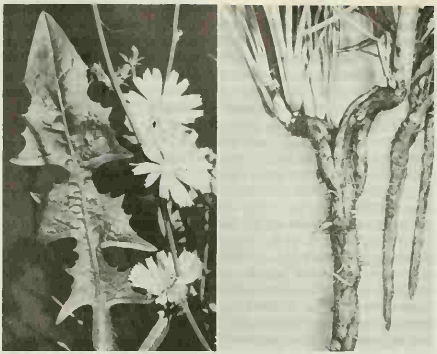
Most chicle comes from wild trees in Yucatan and Guatemala; attempts to grow it profitably on plantations have failed. Insufficiency of chicle after 1924 led to the importation of jelutong and sorva from the East Indies and South America, gums from *Dyera costulata* and *Couma macrocarpa* (family Apocynaceae; *q.v.*) which are mixed with chicle to make chewing gum. Since 1948, chicle has been largely supplanted by synthetic products as the basis for chewing gum.

See also Chewing Gum. (J. S. Kg.)

CHICOPEE, a city of Hampden county, Mass., U.S., located just north of Springfield on rolling hills. Bounded on the east by the Connecticut river and bisected by the Chicopee river, the city is divided into a number of identifiable communities which take on different character from the ethnic groups, especially Polish, French and Irish, which predominate in each. Pop. (1960) 61,553; Springfield-Chicopee-Holyoke standard metropolitan statistical area (*see* Springfield) 478,592.

Originally part of Springfield, portions of the city were settled in 1652. Industrialization began early in the 19th century when the Chicopee river was first dammed. Separated from Springfield in 1848, it became a city in 1890. The name is an Indian word meaning "cedar tree." Chicopee has had a steady growth in population; for comparative population figures *see* table in Massachusetts: *Population*. It has a wide variety of industry, with the manufacturing of machinery and rubber and sporting goods predominating. (Ge. G.)

CHICORY, *Cichorium intybus* (family Compositae), is a plant native to Europe and introduced to the United States late in the 19th century. It has a long fleshy taproot, a rigid branching hairy stem rising to a height of 3 to 5 ft., the leaves around the base being lobed and toothed, not unlike those of the dandelion. The flower heads are of a bright blue colour, few in number, and measure nearly an inch and a half across. Common chicory is cultivated extensively on the continent of Europe—the Netherlands, Belgium, France, Germany. In North America chicory is an introduced weed which has become widely distributed. It is abundant in pastures and along roadsides in the eastern United States and Canada, and is usually considered a pest. As a cultivated crop common chicory is grown to some extent for its root.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CHICORY (CICHORIUM INTYBUS): (LEFT) FLOWERS WITH A BASAL LEAF; (RIGHT) ROOTS

Its roots, roasted and ground, are used as a substitute for, an adulterant of, or an addition to coffee; both roots and leaves are employed as salads; and the plant is grown as a fodder or herbage crop for cattle. In Great Britain it is chiefly in connection with coffee that chicory is employed. A large proportion of the chicory root used for this purpose is obtained from neighbouring continental countries but a considerable quantity is cultivated in England, chiefly in Yorkshire. It gives the coffee additional colour, bitterness and body.

The loose, blanched leaves are much esteemed by the French as a winter salad, *barbe de capucin*. In Belgium and elsewhere tighter heads or crowns called *Witloef* (or witloof) are preferred. There, also, the fresh roots are boiled and eaten with butter, and throughout Europe the roots are stored to supply leaves for use as salads during winter.

The roots are grown in the open during the summer and are taken up in the fall to be forced during the winter. One method of forcing produces *barbe de capucin* and another produces witloof. If the seed is sown early in the spring in temperate regions having a growing season of five and a half to six months, the plants may go to seed instead of forming large storage roots suitable for forcing. In such regions seed should be sown in June. The roots may be forced under greenhouse benches, in cellars or out of doors. *See* also Endive.

CHICOUTIMI, an industrial town of the Lake St. John and Saguenay region, Quebec, Can., is situated on low terraces overlooking the canyon of the Saguenay river (*q.v.*), 70 mi. W.N.W. of its junction with the St. Lawrence. Chicoutimi is an Indian word meaning "limit of deep water." Lying on the main highway from Quebec, Chicoutimi is a commercial, manufacturing and administrative centre closely associated with the extensive Saguenay hydroelectric development, which provides power for aluminum production at nearby Arvida. Established in 1676 as a Jesuit mission and trading post, it grew rapidly after 1850 with the development of lumbering. Pulp, paper, furniture and textile plants were established later. Pop. (1961) 30,549. (J. D. I.)

CHIDAMBARAM, a town in South Arcot district, Madras state, India, is 122 mi. (by rail 153 mi.) S.S.W. of Madras city on the Southern railway. Pop. (1961) 40,740. It is noted for its great Hindu Siva temple, dedicated to Nataraja, or Siva in his aspect of "cosmic dancer." The temple is entered by lofty towergates and its *mandapam* or hall is supported by more than 1,000 pillars. Chidambaram is also the seat of Annamalai university, founded in 1929. The name of the town comes from Tamil *chit* plus *ambalam*, "the atmosphere of wisdom." (G. Kn.)

CHIEF, the common designation of the political leader of a primitive social group, such as a band, tribe or confederacy of tribes. In a more technical sense a chief is any person who participates, by publicly accepted right, in an organization of specialists in primitive political decision-making. Among the simpler primitive peoples chiefs have very little coercive authority and depend on community consensus for the implementation of recommendations; furthermore, often among these simpler peoples a number of recognized chiefs form a tribal chiefs' council. Among the more advanced preliterate peoples there may be a single paramount tribal chief with coercive authority. Such a paramount chief is sometimes called a divine king because of the sacredness of his person, paraphernalia and utterances and because the accompanying elaborate social apparatus of noble courtiers, army, lesser village chiefs, peasantry and slaves somewhat resembles the feudal society of medieval Europe and Asia.

Popular literature has introduced a number of mistaken notions about the identity and role of the chief in primitive society. In loose usage, the word has been used to denote any famous war leader or orator who frequently appears in negotiations with whites. Such a man may well be a leader in his community but not be recognized as a chief. An example is the Sauk Indian Black Hawk, who led a band of Sauk and Fox in the so-called Black Hawk War (1832). Black Hawk was not a member of the Sauk chiefs' council and was never recognized as a chief by the Sauk tribe, despite his prominence as a warrior and as a spokesman for those who opposed abandonment of the native settlements in Illinois. Similarly, Europeans have often sought to confer upon prominent and co-operative natives the title of chief, although the political role expected of these persons had no place in the aboriginal political system.

Primitive societies may be broadly classified into three groups to which correspond three different types of political organization: hunters; mixed hunters and gardeners; and primarily agricultural or herding societies with relatively dense populations. In simple hunting societies, such as those of the Eskimo and the Ona of Tierra del Fuego, there are often no real chiefs; the adult community achieves decision by consensus influenced by such leaders as successful hunters and shamans. Among the mixed hunters and gardeners, represented by such North American Indian tribal groups as the Iroquois and Sauk, there is characteristically a chiefs' council of half a dozen to several dozen men representing kin and community or tribal units, with nonchiefly specialists responsible for such technical tasks as war leadership, record-keeping and the proper oratorical presentation of council policy. Sometimes two classes of chiefs are recognized, war chiefs and civil chiefs, the civil chiefs (sometimes called sachems) usually holding higher status except during war emergencies. In densely populated agricultural or herding societies, such as those of the Aztec and Inca, the west African kingdoms and Polynesian island societies, the divine king type of chieftainship, with its associated elaborate political and religious bureaucracy, is characteristic.

The qualifications of a chief generally include both a particular kinship status and recognized competence in policy formulation, the precise nature and combination of these criteria depending on local circumstances. In the mixed hunting and gardening groups, the chief may represent his own kin group in council deliberations; in the more complex societies, competence for tribal-wide decisions may be conceived to be hereditary in a particular kin line. But competence, demonstrated both before and during chieftainship, is generally requisite. The particular functions of chieftainship are highly varied, depending both on the political structure of the group and on its economic, religious and military problems. Chiefs may recommend or decide policy on hunting, planting, war, migration and intergroup relations; they may serve as ritual leaders; and, particularly in the agricultural populations, they may function as economic intermediaries, receiving economic produce and distributing it according to tribal custom.

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CHIEF JUSTICE. The chief justice of the United States is the highest judicial officer of the country. He is appointed by the president with the advice and consent of the senate and has life tenure. His primary functions are to preside over the supreme court of the United States (*q.v.*) in its public sessions when the court is hearing arguments and during its private conferences when it is discussing and deciding cases. In the court he serves as chairman and has authority to assign the writing of opinions where he is a member of the majority; otherwise his powers are the same as those of any other supreme court justice. When the office is occupied by a person of extraordinary intellectual capacity and dynamic personality, as was the case with Charles Evans Hughes (*q.v.*), the administrative powers may be utilized to exert a great influence on the court's work. When the occupant of the centre chair is a lesser figure, as has often been the case, he is likely to be overshadowed by other members of the court.

The chief justice of the United States is also the presiding officer of the Judicial Conference of the United States, which is made up of the chief judges of the United States courts of appeals, the chief judge of the court of claims, and 11 senior district court judges. The conference has four major duties. First, it investigates problems relating to the administration of justice in the federal courts and recommends legislation pertaining thereto. Second, it provides for an interchange of information among the lower court judges concerning common problems. Third, it studies the effectuation of the rules of procedure governing practice in the lower federal courts and initiates suggested changes in those rules for promulgation by the supreme court. Fourth, the conference supervises and directs, through the administrative office of the U.S. courts, matters pertaining to budget, travel, the interchange of judges among courts and other matters of judicial administration. The chief justice is responsible for utilizing the judicial power of the federal courts to best advantage by assigning judges from one federal court to another as occasion demands.

The chief justice customarily administers the oath of office to the president and vice-president at the time of their inauguration.

The title of chief justice is usually accorded the presiding judicial officer within any multi-judge court as well as to the highest judicial officer within a state of the United States. But the title varies from jurisdiction to jurisdiction: in New York and Maryland, for example, the judge presiding over the high court is designated as chief judge; in West Virginia, as president; and in South Dakota, as presiding judge. Equally variant are the methods of selection, the terms of office and the administrative functions to be performed.

Since 1860, the title of lord chief justice of England (*q.v.*) has been given to the officer presiding over the queen's bench division of the high court of justice. The title had been assumed by Sir Edward Coke and his successors before 1860, but until the abolition of the chief justiceship of the court of common pleas it was not strictly appropriate. *See* also Court; Judiciary and Court Officers. (P. B. K.)

CHIEMSEE (Bayrisches Meer), the largest lake in Bavaria, Ger., lies 1,699 ft. above the sea between the Inn (to which it drains through the Alz) and Salzach rivers. With a length of 5 and a breadth of 9 mi., it has an area of 31 sq.mi. and contains three islands, Herreninsel, Fraueninsel and Krautinsel. The wooded Herreninsel was the seat of a bishop from 1215 to 1805 and until 1803 contained a Benedictine monastery; it is the site of an interesting castle which is an imitation of the palace at Versailles. The shores of the lake are flat on the north and south sides, but its other banks are flanked by undulating hills. The waters are clear and well stocked with trout and carp; however, the fishing is strictly preserved. The lake has steamer service. (R. E. Di.)

CH'IEN-LUNG (given name Hung-li; temple name Kao-tsung) (1711–1799), fourth emperor of the Manchu (Ch'ing) dynasty in China, was born on Sept. 25, 1711. He became emperor in 1736, inheriting a soundly governed empire extending beyond China to Manchuria, Mongolia, Kokonor and Tibet. He himself directed from 1755 to 1759 the expeditions for the conquest of Sinkiang and in 1790–92 the successful expedition across the Himalayas against Nepal. The latter campaign marked the zenith of Manchu military power.

Internally the first four decades of Ch'ien-lung's reign gave evidence of vigour, integrity and wisdom in the use of power—an autocratic power under less restraint than ever before in Chinese history. The prestige of China under his rule was reflected in the increase in population, improvement in arts and crafts, expanding favourable foreign trade at Canton, admiration expressed by the Europeans serving at his court in Peking, and the vogue of Chinese styles in Europe, from landscaping to the wearing of pigtails. Public works were built on a large scale, and enormous literary projects were undertaken, culminating in the production of the seven manuscript sets of the Imperial library, the *Ssu-k'u ch'üan-shu*, each set comprising more than 3,450 titles in nearly 36,000 volumes. Yet the revenue was abundant and the treasury full. The long period of success and prosperity contributed to the vanity of the emperor, which increased with age. After 1780 he placed his trust in the unscrupulous minister Ho-shen, who knew how to satisfy that vanity. Corruption in government became rampant, and morale deteriorated. Thereafter the power of the dynasty was on the decline.

Ch'ien-lung himself enjoyed good health until his death. A strict disciplinarian, he conducted an exemplary life as a Manchu horseman and archer, was well versed in Chinese scholarship and could speak Manchu and Mongolian fluently and even some Turkish. He was always conscious of his duties and attended to state affairs with regularity. In his leisure he painted, practised calligraphy, wrote essays or composed poems, of which he left more than 40,000. George Staunton, who was on the Macartney mission in 1793 and saw the emperor, then 82 years old, said that he "walked firm and erect." In 1796 he abdicated in favour of his 15th son, but in name only, for he continued to rule, with the help of Ho-shen, until his death on Feb. 7, 1799, concluding a reign of more than 63 years, one of the longest in recorded history.

See A. W. Hummel (ed.), *Eminent Chinese of the Ch'ing Period*, 2 vol. (1943–44). (C. Fa.)

CHIETI, a town in the Abruzzi e Molise region of Italy, the chief town of Chieti province and a metropolitan episcopal see, lies 225 km. (140 mi.) E.N.E. of Rome. Pop. (1957 est.) 43,841 (commune). It is 1,085 ft. above sea level. From its position the town dominates the Pescara valley. It consists of an upper residential area on the side of a hill and a rapidly developing industrial and commercial area (Chieti-Scalo) in the valley where there are branches of several national industries including cellulose, sugar, wire and tobacco.

The most notable Roman and medieval monuments are the ruins of the Roman theatre (1st century A.D.), the baths, the temple of the Dioscuri and the octagonal church of Sta. Maria del Tricalle, built in 1317 on the pagan temple of Diana Trivia. The cathedral is a very old building with 15th-century frescoes and a great Gothic tower at its side (1335–1498). Chieti has a considerable academic reputation and contains a large provincial library, the National Museum of Archaeology, the Institute of Art, a theological university and a provincial picture gallery.

Chieti is the ancient Teate, capital of the Marrucini. It later became a Roman municipium, and was sacked and destroyed by the barbarians. Rebuilt by Theodoric the Ostrogoth, it was successively a Lombard stronghold, a Norman county and the possession of the Hohenstaufens, the Angevins, the house of Aragon and the Caracciolo. It gives its name to the religious order of the Theatines, founded in 1524. (G. La.)

CHIFFON is a French word used in English with a considerable change in meaning. In French it means "a rag." In English it is used to mean a delicate, lightweight, sheer fabric of a plain weave, usually of silk or one of the man-made fibres, although it is not limited by fibre content. It is a relatively strong, balanced fabric although delicate in appearance. The term chiffon is also used as a modifier to mean a lightweight or softly draping condition, *e.g.*, chiffon velvet, chiffon taffeta, chiffon stockings, chiffon net and so forth. In Rumania chiffon means a bleached cotton shirting; in Germany and Austria it means a stout, fine, plain-woven linen fabric of smooth finish that is used for making shirts and underwear. (G. R. Co.)

CHIFLEY, JOSEPH BENEDICT (1885–1951), Australian statesman and an outstanding leader of the Australian Labor movement, was born at Bathurst, New South Wales, on Sept. 22, 1885. He became a locomotive driver and, interested in politics like many Irish-Australians, was an active member of his trade union. He was elected to the federal parliament in 1928 and became minister of defense in the 1929 Labor government. In 1931 he was defeated partly because of J. T. Lang, premier of New South Wales and leader of a rebel Labor group. Chifley spent the 1930s mainly in a fierce and successful struggle with Lang, although he also sat on a royal commission on banking and monetary reform in 1935–36. In 1939, on the outbreak of war, he became adviser on labour in R. G. Menzies' government, returning to parliament in 1940 with high prestige. He was treasurer in John Curtin's Labor government (1941–45) and then succeeded to the premiership (1945–49). Throughout these years he played a tremendous part in maximizing Australia's war effort and shaping the policies that dramatically hastened the country's economic and social development: extensive government interference in the economy, full employment, the development of power, large-scale immigration, extension of social services and the encouragement of education. Chifley, serene and idealistic, came to have heroic stature in the eyes of Labor sympathizers. Chifley's leadership was decisively rejected in the 1949 election, largely because of his abortive legislation to nationalize all trading banks. This radical proposal illustrated his socialist belief and also how his stubbornness and contempt for advantage seeking verged on disregard for democratic processes and reactions. The problem of Communism also accelerated his downfall, caught as he was between his deep feeling for political liberty and the extremist behaviour of the Australian Communists. Chifley remained leader of the opposition until his death in Canberra on June 13, 1951.

See L. F. Crisp, *Ben Chifley* (1961). (O. M. R.)

CHIGA (Kiga), a Bantu-speaking agricultural people of southwestern Uganda, numbering about 272,000 in the 1960s. Their country is one of steep hills and ridges, and this may have helped to protect them from the overlordship of non-Negro Hima and Tutsi conquerors as well as neighbouring Toro, Nkole, Ruanda and other Interlacustrine Bantu tribes around them. Although subjected to much raiding by these neighbours and also by pygmies from the adjacent Congo, the Chiga managed to retain their independence. They have been administered by the British since 1913.

They lack specialized chiefs, their small settlements, based upon patrilineal descent groups, being almost autonomous. Many of their traditional religious practices were held to be subversive and to have led to antigovernment uprisings, and have been rigorously suppressed by the government and missions. *See* also Uganda; Africa: *Ethnography;* and Bantu (Interlacustrine).

See M. M. Edel, *The Chiga of Western Uganda* (1957); D. E. Apter, *The Political Kingdom in Uganda* (1961). (J. F. M. M.)

CHIGGER, the larvae of certain mites of the family Trombiculidae. The larvae are parasitic on vertebrates including man. Many of them are uniformly coloured or spotted with red.

Chiggers, variously known as scrub mites, harvest mites, bête rouge or chigger mites, are not insects but arachnids, relatives of the spider (*see* Arachnida). However, "chigger" is also used (erroneously) for another skin-burrowing pest, an insect better known as the chigoe, jigger or jigger flea (*q.v.*). The attacks of the chigger larvae on man often result in a dermatitis accompanied by intense itching. At times scratching of infested areas results in sores and secondary infections. Most victims have a marked reaction to the "bites" and may develop large blisters.

The common chigger or "red bug" that attacks man in North America is *Trombicula* (*Eutrombicula*) *alfreddugesi*. This species occurs from New York to Minnesota and south to the Gulf and into Mexico. In summer it is especially abundant in the southern states, where it is a notorious pest. The larvae are tiny and easily penetrate clothing. Once on the skin surface they attach by their barbed appendages, the palpi, and pincerlike hooked chelicerae. The chelicerae are usually inserted near a hair follicle where clothing is tightest. The larva injects a fluid that digests the tissue with which it comes in contact; surrounding tissue becomes hardened and forms a tube. As it ingests the liquified tissue the mite continues to feed, thus lengthening the tube. The digestive juices of the mite cause the severe itching. Having fed well, the larvae drop to the ground and molt first into a nymph and then into the adult. These stages are not parasitic on vertebrates but feed on plant materials and perhaps other arthropods.

The eggs are laid by the adult singly on the ground or on the leaves or stems of low-growing plants.

Other species of chiggers including *Trombicula splendens* and *T. batatus* are found in the United States. In Europe *Trombicula autumnalis* attacks not only man but cattle, dogs, horses and cats.

In the orient certain species of *Trombicula* are the vectors of a disease known as tsutsugamushi (Japanese for "dangerous bug") fever or scrub typhus. The causative organism of this disease is a microscopic rickettsia carried by the chigger. Mice, rats and other rodents provide the reservoir of this disease. Larval mites become infected while feeding on infected rodents. The rickettsiae are then passed through the nymphal stages to the adults and then into the eggs. Larvae hatched from these infected eggs then pass the disease on to man. (*See* TYPHUS FEVER: *Scrub Typhus.*) Because of the importance of chiggers as disease carriers, much research has been done on developing effective mite repellents or acaricides, some of which, in solutions, are used to impregnate clothing. *See* also MITE. (C. J. Go.; M. L. G.)

CHIGI-ALBANI, the Roman branch of the Chigi, a noble Italian family of Sienese origin with branches still surviving also in Siena. They began as bankers in the 13th century. The first member of the family to win more than local eminence was Agostino "il Magnifico" (*c.* 1465–1520), a merchant prince who, as a banker in Rome, developed one of the richest business houses in Europe, lending money to popes, administering church revenue and spending lavishly on display and the patronage of artists and writers. It was he who built the palace and gardens later known as the Farnesina, decorated by Raphael. The Roman branch, however, descends not from him but from another Agostino, the nephew of Fabio Chigi, who was elected pope as Alexander VII in 1655 and who created his nephew successively prince of Farnese (1658), prince of Campagnano (1661) and duke of Ariccia (1662); the Holy Roman emperor Leopold I also made Agostino a prince of the empire (1659). After Alexander's death the Roman Chigi continued to prosper in the service of the papacy. In 1852, on the extinction of the Albani family, with whom they had intermarried in 1735, they added that name to their own.

As cardinal and then as pope, Fabio Chigi was mainly responsible for gathering the Biblioteca Chigiana, a rich collection of manuscripts and books, now incorporated in the Vatican library.

See G. Cugnoni, *Agostino Chigi il Magnifico* (1883); L. Pastor, *History of the Popes*, vol. viii (1908) and vol. xxxi (1940). (P. J. J.)

CHIGWELL, an urban district (1933) in the Chigwell parliamentary division of Essex, Eng. Pop. (1961) 61,021. Area 14 sq.mi. (36 sq.km.). Mentioned in Domesday Book, Chigwell lies on the River Roding and includes Buckhurst Hill, Loughton, and parts of Epping and Hainault forests. Charles Dickens describes the local scenery in his *Barnaby Rudge* and the King's Head Inn is his "Maypole." The old grammar school was founded by Samuel Harsnett, archbishop of York (d. 1631), whose fine memorial brass is in St. Mary's Church, a perpendicular structure with a Norman south door. Under the London Government Act 1963 a small area in the south was joined to the new London borough of Redbridge on April 1, 1965.

CHIH-I (frequently but erroneously given as CHIH-K'AI) (538–597), Chinese Buddhist monk, whose monastic fellowship on Mt. T'ien-t'ai (Chekiang Province) developed after his death into the T'ien-t'ai school of Buddhism in China and, beginning in the 9th century, the Tendai school (*see* SAICHO), which still claims more than 2,000,000 adherents in Japan. He was born in what is now Hunan Province and took monastic orders in 555. His discipleship to his only known master, Hui-ssu (515–576), was from 560 to 567 on Mt. Ta-su (Honan Province). From his first visit to Nanking (567) until his death, Chih-i's associations with the imperial government were intimate, first with the Ch'en dynasty in south China and then with the Sui dynasty, which eventually reunified the country.

Chih-i's philosophy, derived through Chinese translations from the Madhyamika school of Indian Mahayana Buddhism and based on his own interpretation of the Saddharma Pundarika ("Lotus of the True Doctrine"), was one that saw existence *as it impinges on the mind* in terms of a dialectical relationship, in which (1) the thesis was the Madhyamika tenet of absolute impredicability, (2) the antithesis was the phenomenal world, and (3) the synthesis was the assertion of the mutual identity of (1) and (2). This synthesis in turn became the new thesis, the antithesis and synthesis were as before, and so on *ad infinitum*. The order of these three terms is, however, not chronological, and Chih-i specifically insisted upon their mutual identity. The phenomenal world was subsumed under ten headings: nature, characteristics, substance, powers, functions, causes, conditions, effects, retributions, and the mutual identity of the nine. The ten states of existence preached by Buddhism he multiplied by ten, on the grounds that each of the ten potentially contains all the others. The product he then multiplied by the ten headings enumerated above, and that product in turn by three, viz., (1) the five groups (skandhas) under which Buddhism subsumes all existence, (2) the living beings, and (3) the places occupied by the latter. The product was 3,000. He held that where there is "a mustard-seed's quantity of consciousness" there are present the Three Thousand, denying that either is prior to the other, but merely asserting that, where there is the one, there inevitably the other must also be. Chih-i also effected a threefold reconstruction of the Buddha's preaching career as he imagined it to have been, into chronological, methodological, and content divisions, the respective method and content being adapted to the listeners. The goal of the Buddha's preaching career, in Chih-i's view, had been to lead all to Buddhahood, and Chih-i himself worked out an elaborate course of contemplation designed to lead the practitioner to that goal. For him, intellection and contemplation were always indispensable each to the other. (L. Hz.)

CHIHUAHUA, the largest state of Mexico, bounded north and northeast by the United States (New Mexico and Texas), east by Coahuila, south by Durango, and west by Sinaloa and Sonora. The population in 1960 was 1,226,793, and the area, 95,400 sq.mi. Indian influence is slight. The once fierce Apache tribes are almost extinct. The surface of the state is in great part an elevated plain, sloping gently toward the Rio Bravo del Norte (Rio Grande). The western side, however, is much broken by the Sierra Madre Occidental and its spurs, which form elevated valleys of great fertility. The more elevated plateaus and valleys have heavy rainfall, but over most of the state it is less than 20 in.; an impermeable clay substratum prevents its absorption by the soil, and the bare surface carries it off in torrents. The state's Copper canyons dwarf the Grand canyon but are still inaccessible. The Bolsón de Mapimí, an enclosed depression in the southeastern part of the state, was once considered to be an unreclaimable desert, but experiments with irrigation have shown its soil to be highly fertile. The only river of consequence is the Conchos, which flows north and northeast into the Rio Bravo del Norte.

Agriculture has made progress in Chihuahua, but the scarcity of water has been a serious obstacle to its development outside the districts where irrigation is practicable. Stock-raising is an important industry in the mountainous districts of the west, where there is excellent pasturage for the greater part of the year. Cotton farming and meat packing were important developments of the area in the 1950s. Principal industry of the state is the mining of iron, antimony, gold, silver, copper, mercury, lead, zinc and coal. The more than 100 silver mines of Chihuahua are among the richest in Mexico. The state is well served by air lines, highways and railways, with branches to the mining districts. The Mexican hairless or Chihuahua dog is also from this region.

In colonial times Chihuahua with Durango formed part of the province of Nueva Viscaya. An effort was made to overthrow Spanish authority in 1810, but its leader Miguel Hidalgo y Costilla and two of his lieutenants were captured and executed, after which the province remained passive. Chihuahua was not separated from Durango until after independence in 1823. The people of the state have been active partisans in most of the revolutionary outbreaks in Mexico, and in the war of 1862–66 Chihuahua was loyal to Benito Juárez. Porfirio Díaz at the end of the 19th century doled out several million acres in the state to seven families. The Terrazas ranch alone contained 15,000,000 ac.

Principal towns are the capital Chihuahua, Hidalgo del Parral, 120 mi. S.S.E. of the state capital, in a mining district, pop. (1960) 41,474; and Ciudad Juárez (*q.v.*) across the Río Bravo del Norte from El Paso, Tex. (1960) 262,119. (J. A. Cw.)

CHIHUAHUA, capital of Chihuahua state, Mex., about 1,000 mi. N.W. of Mexico City and 225 mi. S. by E. of El Paso, Tex. Pop. (1950) 86,961; (1960) 144,653. The city stands in a beautiful valley opening northward and hemmed in on all other sides by spurs of the Sierra Madre Occidental. It is 4,635 ft. above sea level, and its climate is mild and healthful.

The city is laid out regularly, with broad streets, and a handsome plaza with a monument to Miguel Hidalgo y Costilla and his companions of the revolution of 1810, who were executed there. The most noteworthy of its public buildings is the fine old parish church of San Francisco, one of the best specimens of 18th-century architecture in Mexico. Other prominent buildings are the government palace, the Porfirio Díaz hospital, the old Jesuit college (now occupied by a modern institution of the same character), the mint and an aqueduct built in the 18th century.

Chihuahua was officially founded in 1709, but was originally settled in the 16th century. Because of the rich mines in its vicinity it became one of the most prosperous towns in northern Mexico, although the state was constantly raided by Indians. In the war between Mexico and the United States, Chihuahua was captured on March 1, 1847, by Col. A. W. Doniphan, and again on March 7, by Gen. S. Price. Modern Chihuahua is a thriving, energetic city, with strong American influences. It has modern textile mills, meat canning plants and good hotels. (J. A. Cw.)

CHIKAMATSU MONZAEMON (pseudonym of Sugimori Nobumori) (1653–1725), widely regarded as the greatest Japanese dramatist, credited by some scholars with as many as 160 plays, most of which were written for the puppet theatre. Before Chikamatsu, plays for the puppet theatre and kabuki had been turned out by hack writers whose chief concern was to provide ample opportunities for the actors (or puppet operators) to display their virtuosity, but Chikamatsu attempted from early in his career to write dramas of artistic merit. His dissatisfaction with the liberties taken with his texts by actors may have been responsible for his decision to write mainly for puppets.

Chikamatsu's works fall into two main categories: historical romances and domestic tragedies. Modern critics generally prefer the latter plays because they are more realistic and closer to western conceptions of drama. The historical plays suffer in comparison because of their heavy reliance on the exaggerated actions and declamations that Chikamatsu felt were necessary if wooden puppets were to seem alive. Some of Chikamatsu's views on the art of the puppet theatre have been preserved in *Naniwa Miyage,* a work written by a friend in 1738. Chikamatsu declared, "Art is something which lies in the slender margin between the real and the unreal," and he endeavoured accordingly in his own works to steer between the fantastic nonsense that had been the rule in the puppet theatre and the facile realism that was coming into vogue. Chikamatsu's domestic tragedies seem closer to reality, if only because they deal not with generals and princesses but with merchants, housewives, thieves and prostitutes and all the great variety of people who made up the Osaka of his day. Most of the domestic tragedies were based on actual incidents (though modified in the direction of a more artistic "unreal"), such as the frequent double suicides of lovers. *Sonezaki Shinju* ("The Love Suicides at Sonezaki," 1703), for example, was written by Chikamatsu within a fortnight of the actual suicides he dramatized. The haste of composition is not at all apparent in this first of his double suicide plays, the archetype of his other domestic tragedies.

Chikamatsu's most popular work was *Kokusenya Kassen* ("The Battles of Coxinga," 1715), a historical melodrama based loosely on events in the life of the Chinese-Japanese adventurer who attempted to restore the Ming dynasty in China. Another famous work is *Shinju Ten no Amijima* ("The Love Suicide at Amijima," 1720), still frequently performed. Despite Chikamatsu's eminence, however, the fact that he wrote for the puppet theatre with its special requirements has meant that with the decline in the fortunes of that theatre most of his plays have become unfamiliar to the public, except in the abridgements and considerably revised versions used in the *kabuki* and elsewhere.

Works available in English include *The Love Suicides at Sonezaki,* in Donald Keene, *Anthology of Japanese Literature* (1955), and *The Battles of Coxinga* (1951), both translated by Keene; and *The Love Suicide at Amijima,* tr. by Donald Shively (1953). (Dd. K.)

CHIKMAGALUR, a town and district of Mysore state, India. The town, about 90 mi. N.W. of Mysore city, had a population of 30,253 in 1961. It is a coffee trading centre.

Chikmagalur (formerly Kadur) District has an area of 2,787 sq.mi. Pop. (1961) 597,305. The larger part consists of the Malnad or hill country, which contains some of the wildest mountain scenery in southern India. The western border is formed by the Ghats, of which the highest peaks are the Kudremukh (6,207 ft.) and the Meruti Gudda (5,444 ft.). The centre is occupied by the horseshoe range of the Baba Budans, containing the highest mountain in Mysore, Mulainagiri (6,317 ft.), and enclosing the Maidan or plain country, a fertile, well-watered region, with the famous "black cotton" soil. The principal rivers are the Tunga and Bhadra, which rise near each other in the Ghats and unite to form the Tungabhadra, a tributary of the Kistna. The eastern region is watered by the Vedavati (Hagari). From all the rivers water is drawn off into irrigation channels by means of anicuts or weirs. The chief natural wealth of Chikmagalur is in its forests, which contain large supplies of the finest timber, especially teak, and provide shelter for the coffee plantations. Iron is found and smelted, and there is corundum in some places. Coffee is grown on the hill slopes of the west, and rice in the valleys and in the Maidan, where cotton, tobacco and millet are also grown. The district is served by the Southern railway, on which, 23 mi. N.E. of Chikmagalur, is Kadur, from which the district formerly took its name.

CHILAS, a subagency, part of the Gilgit agency of West Pakistan, is administered as an unsettled area by an assistant political agent. Pop. (1951) 16,060; area 1,635 sq.mi. Chilas village is an important settlement (4,010 ft.) far up the Indus, about 100 mi. N.N.E. of Abbottabad. It holds an important position on the Muzaffarabad-Gilgit route, via Kaghan valley (Hazara district) and Babusar pass. It is connected with Gilgit (about 80 mi.) via Bunji by a road suitable only for jeeps.

The village has a small fort, hospital and bazaar, providing the essential needs of the population. There is a middle school, and a small airstrip for light aircraft.

The Chilas valley is rich and green, in part covered with forests. Maize (corn) is the chief crop, though some black wheat, potatoes and caraway (*Carum carvi*) are also grown. Sheep are the main domestic animals. (K. S. Ad.)

CHILBLAIN: *see* Skin, Diseases of.

CHILD, CHARLES MANNING (1869–1954), U.S. zoologist and experimentalist who attacked the central problem of biology, that of organization, by experiments on regeneration and the alteration of development. He was born at Ypsilanti, Mich., on Feb. 2, 1869. He was educated in Connecticut and at the University of Leipzig, and spent his academic life in the zoology department of The University of Chicago (1895–1934). Child died on Dec. 19, 1954.

From his experiments, Child developed the theory of the axial gradient, a gradation in the rate of physiological processes along the axis of organisms. He believed this gradient, produced by the action of external factors on protoplasm, to be the mechanism of correlation by which the multitudinous cells of which an animal is composed are maintained as a unified whole. The chief factor in correlation is antero-posterior dominance, *i.e.*, each level dominates the region behind and is dominated by that in front (*see* REGENERATION: *Polarity; Gradient Theory;* DEVELOPMENT, ANIMAL). Of several books published on his ideas and researches the most important are: *Individuality in Organisms* (1915) and *Patterns and Problems of Development* (1941). A biography and complete bibliography appear in *Biographical Memoirs* of the National Academy of Sciences, vol. 30, 1957. (L. H. H.)

CHILD, FRANCIS JAMES (1825–1896), U.S. scholar and educator, was born in Boston, Mass., Feb. 1, 1825. He graduated at Harvard in 1846, taking the highest rank in his class, and remained as a tutor in various subjects. After two years of study in Europe he succeeded Edward T. Channing in 1851 as Boylston professor of rhetoric, oratory and elocution and in 1876 became professor of English at the same institution. Child studied the English drama and Germanic philology, the latter at Berlin and Göttingen during a leave of absence, 1849–53; and he took general editorial supervision of a large collection of the British poets. He edited Edmund Spenser (5 vol., 1855) and published an important treatise in the *Memoirs of the American Academy of Arts and Sciences* for 1863, entitled "Observations on the Language of Chaucer." His largest undertaking, however, grew out of an original collection of *English and Scottish Ballads* (8 vol., 1857–58). He accumulated, in the university library, one of the largest folklore collections in existence, studied manuscript rather than printed sources and carried his investigations into the ballads of all other tongues, meanwhile giving a sedulous but conservative hearing to popular versions still surviving. His final collection was published as *The English and Scottish Popular Ballads*, first in ten parts (1882–98) and then in five quarto volumes, which remain the authoritative treasury of their subject. Child died in Boston Sept. 11, 1896, having completed his task save for a general introduction and bibliography.

CHILD, SIR JOHN (d. 1690), English deputy governor of Bombay from 1679 to 1681 and president of Surat from 1682 to 1690, was the first person to be placed in control of all the East India company's factories in India. While still a youth he was apparently sent to India to live with relatives who were associated with the company. In 1672 he married Susannah, daughter of Capt. John Shaxton, commander of the Bombay garrison. He was implicated in the mutiny of Shaxton's troops two years later but was restored to favour through the influence of his namesake, Sir Josiah Child, the powerful governor of the company in London. Like his patron he was utterly unscrupulous and had a passion for intrigue. His tyrannical behaviour as president led to Capt. Richard Keigwin's rebellion at Bombay in 1683. Acting under instructions from London, Child became involved in war with the Mogul emperor Aurangzeb, but the seizure of Surat by Mogul troops forced him to sue for peace. One of the conditions was that Child should be removed from India, but while the matter was still pending he died in Bombay on Feb. 4, 1690.

See R. and O. Strachey, *Keigwin's Rebellion* (1916). (C. C. D.)

CHILD, SIR JOSIAH (1630–1699), English merchant, economist and governor of the East India company, was born in London in 1630, the son of a London merchant. He amassed a comfortable fortune as victualler to the navy under the Commonwealth, and became a considerable stockholder in the East India company. His advocacy, both by speech and by pen, under the pseudonym of Philopatris, of the East India company's claims to political power, as well as to the right of restricting competition with its trade, brought him to the notice of the shareholders, and he became a director in 1677, and, subsequently, deputy governor and governor. He was for a time virtually the sole ruler of the company and directed its policy as if it were his own private business. He died on June 22, 1699.

Child made some important contributions to the literature of economics, especially *Brief Observations Concerning Trade and the Interest of Money* (1668) and *A New Discourse of Trade* (1668 and 1690). He viewed Dutch prosperity as deriving in part from a low-interest policy, in part from a relatively liberal trade policy, and Child advocated similar policies for the British. He had the mercantilist partiality for a numerous population and propounded a new scheme for the relief and employment of the poor; he advocated the reservation by the mother country of the sole right of trade with its colonies. (D. F. DD.)

CHILD, LYDIA MARIA (née FRANCIS) (1802–1880), U.S. author and reformer, was born at Medford, Mass., Feb. 11, 1802, and died at Wayland, Mass., Oct. 20, 1880. One of the most prominent women of her day, Mrs. Child's present claims to remembrance are the contemporaneous popularity of her stories *Hobomok* (1824), *The Rebels* (1825) and *Philothea* (1836); her editorship of the *Juvenile Miscellany*, the first children's monthly periodical in the United States; and her efforts in behalf of the slaves, freedmen and Indians, including her stirring *Appeal for That Class of Americans Called Africans* (1833) and her editing of the *Anti-Slavery Standard* (1840–44) in association with her husband.

In spite of the 35 editions of her *Frugal Housewife* (1829) and the German, the eight American and the 12 English editions of her *Mother's Book* (1831), these and her many other stories and books on feminism, religion, biography and history have been superseded by later works.

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CHILDBIRTH, the act of bringing forth a child. Because this process requires considerable physical effort on the part of the mother it has been termed and is usually known as "labour." The term "parturition" (a bringing forth) is also applied to the process of childbirth.

At the termination of pregnancy (*q.v.*) in the human female, the irregular intermittent contractions of the uterus (womb) that began in the early months of pregnancy become more regular and increase in frequency and intensity. This assumption of a rhythmic character by the uterine contractions marks the beginning of the process by which the maternal organism separates and expels the mature products of conception.

For descriptive purposes labour is divided into three stages: (1) the first stage (dilatation), which has to do with the opening up of the neck of the womb; it begins with the onset of labour and ends when the cervix or neck of the womb is dilated sufficiently to permit the passage of the child's head (*i.e.*, nine to ten centimetres, or about four inches, in diameter); (2) the second stage (expulsion), which is concerned with the passage of the child through the maternal birth canal; it begins when the cervix is sufficiently dilated to permit the passage of the child's head and terminates with the expulsion of the child; (3) the third or placental stage, that part of labour which is related to the separation and extrusion of the placenta (afterbirth); it begins with the birth of the child and ends when the placenta is expelled and bleeding from the vessels in the uterus is arrested.

STAGES OF LABOUR

First Stage (Dilatation).—Early in labour the uterine contractions come on at intervals of 20 to 30 minutes and last about 40 seconds. They are then accompanied by slight pain, which usually is felt in the small of the back. The term "labour pains" often is used as a synonym for uterine contractions. As labour progresses these uterine contractions become more intense and progressively increase in frequency until at the end of the first stage, when dilatation is complete, they recur about every three minutes and are quite severe. With each contraction a twofold effect is produced to facilitate the opening up of the cervix. Since the uterus or womb is a muscular sac containing a bag of waters that more or less surrounds the child, contraction of the musculature of its walls should diminish its cavity and compress its contents. Because its contents are quite incompressible, however, they are forced in the direction of least resistance, which is in the direction of the internal *os* or upper opening of the neck of the womb, where they act like a wedge and are driven farther and farther into this opening. In addition to forcing the uterine contents in the direction of the cervix, shortening of the muscle fibres which are attached to the neck of the womb tends to pull these tissues upward and away from the opening and thus add to its enlargement. By this combined action, each contraction of the uterus not only forces the bag of waters and fetus downward against the dilating neck of the womb but also pulls the resisting walls of the latter upward over the advancing bag of waters and presenting part of the child.

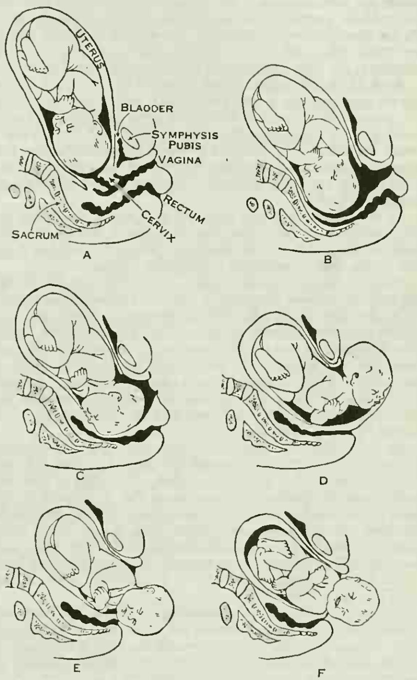
In spite of this seemingly efficacious mechanism, the duration of the first stage of labour is rather prolonged, especially in women who are in labour for the first time. In them, the average time required for the completion of the stage of dilatation is between 13 and 14 hours, while in women who have previously given birth to children the average is 8 to 9 hours. Not only does a previous labour tend to shorten this stage but the tendency often increases with succeeding pregnancies, with the result that a woman who has given birth to three or four children may have a first stage of one hour or less in her next labour. Since the cervix of a young woman dilates more readily than does that of a woman who has her first child late in the fourth decade of life, the duration of the first stage of labour often is somewhat prolonged in women who become pregnant for the first time after they have passed the age of 35. A similar delay is to be anticipated if the cervix is extensively scarred as a result of previous labours or an amputation, deep cauterization or other operation on the cervix. Even a woman who has borne several children and whose cervix accordingly should dilate readily may have a prolonged first stage if the uterine contractions are weak and infrequent or if the child lies in a faulty position and as a result cannot be forced into the mother's pelvis. In this connection it may be noted that early rupture of the bag of waters often increases the strength and frequency of the labour pains and thereby shortens the stage of dilatation. On the other hand, premature loss of the waters occasionally leads to molding of the uterus about the child and thereby delays dilatation by preventing its normal descent into the pelvis. Just as an abnormal position of the child and molding of the uterus may prevent the normal descent of the child, an abnormally large child or an abnormally small pelvis may interfere with the descent of the child and prolong the first stage of labour.

Second Stage (Expulsion).—About the time that the cervix becomes fully dilated, the bag of waters breaks and the force of the involuntary uterine contractions is augmented by voluntary bearing-down efforts of the mother. With each labour pain she takes a deep breath and then contracts her abdominal muscles. The increased intra-abdominal pressure thus produced may equal or exceed the force of the uterine contractions. When properly used, accordingly, these bearing-down efforts may double the effectiveness of the labour pains. As the child descends into and passes through the birth passages the sensation of pain often is increased. This is especially true of the terminal phase of the stage of expulsion when the child's head distends and dilates the maternal soft parts as it is being born.

Anterior Position of the Occiput.—The manner in which the child passes through the birth canal in the second stage of labour depends upon the position in which it is lying and the type of the mother's pelvis. In this discussion, the mechanism presently to be described is that which is frequently followed when the mother's pelvis is of the usual or gynecoid type and the child is lying with the occiput (the back of its head) lowermost and directed toward the fore part of the mother's left side (figure, A). The back of the child's head accordingly is the leading pole and is in the left anterior quadrant of the mother's pelvis, while the long diameter of the head circumference which is to pass through the pelvis lies obliquely. This is one of the commonest mechanisms and is chiefly concerned with the various movements of the head. These usually are grouped under the following heads: (1) flexion, (2) internal rotation, (3) extension, (4) restitution and (5) external rotation.

1. The force derived from the uterine contractions and the bearing-down efforts exerts pressure on the child's buttocks and is transmitted along the vertebral column to drive the head into and through the pelvis. Because of the eccentric attachment of the spine to the base of the skull, the back of the head is made to advance more rapidly than the brow, with the result that the head becomes flexed until the chin comes to lie against the breast bone (figure, B). As a consequence of this flexion mechanism, the ovoid head circumference which entered the birth canal is replaced by a smaller, almost circular circumference, the long diameter of which is about two centimetres or almost one inch shorter than that of the replaced circumference. The advantage of flexion, therefore, is equivalent to a reduction of almost one inch in the long diameter of the head as it passes through the pelvis.

2. As the head descends more deeply into the birth canal it meets the resistance of the bony pelvis and of the slinglike pelvic floor or diaphragm, which slopes downward, forward and inward. When the back of the head, the leading pole of the child, is forced against this sloping wall on the left side, it naturally is shunted forward and to the right as it advances, just as a ferryboat is shunted into its wharf by meeting the sloping resistance of its ways (figure, C). This internal rotation of the head brings its longest diameter into relation with the longest diameter of the pelvis and thus greatly assists in the adaptation of the advancing head to the configuration of the cavity through which it is to pass.



BY COURTESY OF ALFRED C. BECK

MECHANISM OF LABOUR

A. Onset of labour. B. Flexion. C. Internal rotation of the head. D. Extension. E. Restitution. F. External rotation

3. Further descent of the head directly downward in the direction in which it has been traveling is opposed by the lower portion of the mother's bony pelvis behind and the resisting soft parts which are interposed between it and the vaginal orifice (figure, C). Less resistance, on the other hand, is offered by the soft and dilatable walls of the lower birth canal, which is directed forward and upward. The occiput (back of the child's head) accordingly ad-

vances along the lower birth canal, distending its walls and dilating its cavity as it progresses. Soon the back of the child's neck becomes impinged against the bones of the pelvis in front and the chin is forced farther and farther away from the breast bone. Thus, as extension takes the place of flexion, the occiput, brow, orbits, nose, mouth and chin pass successively through the vulvovaginal orifice (external opening of the lower birth canal) and are born (figure, D).

4. The neck, which was twisted during internal rotation of the head, untwists as soon as the latter is freed from the grasp of the vulvovaginal ring. Almost immediately after its birth, therefore, the occiput is turned toward the left and backward to assume the same relative position which it occupied at the onset of labour (figure, E).

5. As it advances, the child's lower shoulder meets the sloping resistance of the pelvic floor on the right side and is shunted forward and to the left toward the middle of the pelvis in front. This brings the long diameter of the shoulder circumference into relation with the anteroposterior or long diameter of the pelvic cavity. As the shoulders rotate internally, the occiput is turned farther backward and to the left so that the child's face comes to look directly at the inner aspect of the mother's right thigh (figure, F).

Birth of the Shoulders.—Soon after the shoulders rotate, the one in front appears in the vulvovaginal orifice and remains in this position while the other shoulder is swept forward by a lateral bending of the trunk, through the same upward and forward curve which was followed by the head as it was being born. After this shoulder is delivered the shoulder in front and the remainder of the child's body are expelled almost immediately and without any special mechanism.

An average of about one hour and 45 minutes is required for the completion of the second stage of labour in women who give birth for the first time. In subsequent labours the average duration of the stage of expulsion is somewhat shorter.

Posterior Position of the Occiput.—The child may lie so that the back of its head (occiput) is directed backward and toward either the right or left side. The leading pole is then in the right or left posterior quadrant of the mother's pelvis, and the condition is referred to as a posterior position of the occiput. In such cases, the back of the child's head usually rotates to the front of the pelvis and labour proceeds as in anterior positions. Because of the longer rotation required and the difficulty sometimes encountered in securing flexion, labour may be somewhat more prolonged than in anterior positions.

Face Presentation.—When the child's head becomes extended so that it enters and passes through the pelvis face first, the condition is known as a face presentation. The chin is then the leading pole and follows the same course that is followed by the back of the head in occipital presentations. If the chin lies to the front as it enters the pelvis, labour often is easy and of short duration. Should it be directed backward, on the other hand, considerable difficulty may be encountered, and the head may have to be flexed or rotated artificially or a complete turning of the child may be necessary.

Breech Presentation.—The condition in which the lower extremities or buttocks pass through the pelvis first is encountered about once in every 30 labours. Because the head in such cases is the last part of the child to be delivered and because this part of the delivery is the most difficult, the umbilical cord (navel string) may be compressed while the aftercoming head is being born, with the result that the child may be asphyxiated. Asphyxia or injuries to the child which result from the attendant's effort to hasten the delivery and prevent its asphyxiation are responsible for the loss of three times as many breech babies as head-on babies. The infant mortality varies from 2% to 10% according to the size of the child and the skill of the attendant. Because very small premature infants are particularly susceptible to the dangers of breech delivery, the mortality among them is very high when they are born breech first.

Transverse Presentation or Cross Birth.—This is relatively rare, being encountered only once in several hundred labours. In this situation the long axis of the child tends to lie across or transverse to the long axis of the mother. Unless the child is very small or has been dead for some time and has become greatly softened, delivery through the natural passages is impossible in such cases. For this reason the child must be turned by the attendant or delivered by Caesarean section if it is alive.

That the latter complications are infrequent and can be cared for easily is shown by the excellent statistics of many maternity services. In them the maternal death rate is less than 1 per 1,000 and would be still lower if the deaths caused by general systemic diseases rather than pregnancy and labour were excluded. The infant mortality usually is also low, ranging between 2% and 3%. It likewise would be much lower if the premature and poorly developed infants were excluded. In other words, the risk to a healthy mother who carries her child to maturity is less than 1 per 1,000, and the risk to her mature child is about 1%.

Third Stage (Placental).—With the expulsion of the child, the cavity of the uterus is greatly diminished. As a consequence the site of placental attachment becomes markedly reduced in size, with the result that the placenta (afterbirth) is separated in many places. Within a few minutes subsequent uterine contractions complete the separation and force the afterbirth into the vagina, from which it is expelled by a bearing-down effort. The third stage of labour accordingly is of short duration, seldom lasting longer than 15 minutes. Occasionally, however, the separation may be delayed and accompanied by profuse bleeding, in which circumstance its artificial removal is necessary. Because of the ever-present danger of hemorrhage as long as the afterbirth is retained, the attendant always remains with the mother until the third stage is completed and the possibility of *post partum* hemorrhage is eliminated by firm contraction and retraction of the uterus.

RELIEF OF PAIN IN LABOUR

Not much was done to relieve the suffering of childbirth before chloroform was first used for this purpose in the mid-19th century. Because of its toxicity, even this drug was employed sparingly and ultimately came to be used only during the second or expulsive stage of labour. Early in the 20th century, morphine and scopolamine were given according to the "twilight sleep" technique to lessen the pain that accompanies the stage of cervical dilatation. While this technique was found to be less safe than had been hoped, it gave a new and strong impetus to the search for a satisfactory method of pain relief, with the result that the old methods were improved and many new ones were suggested. Among these were the use of chloroform, ether, nitrous oxide, ethylene, cyclopropane, trichloroethylene, morphine and scopolamine, the barbiturates and scopolamine, demerol and scopolamine, paraldehyde and local, paravertebral, presacral, caudal and spinal anesthesia. While this long list of agents indicates the praiseworthy efforts that were made to find a satisfactory method of pain relief suitable for use during childbirth, it also indicates that no such method was found. It remained impossible to secure 100% relief from pain in all women without adding to the maternal and fetal risk. On the other hand, the judicious employment of one or more of these drugs eliminates much of the pain of childbirth with safety. (*See* also ANESTHESIA AND ANESTHETICS.)

Morphine and Scopolamine (Twilight Sleep).—By the use of hypodermic injections of morphine and scopolamine a condition of seminarcosis, "twilight sleep," is induced. When it is successful, the mother awakens after her child is born and has no recollection of having felt any pain during her labour. Such a result is attributable either to the actual relief of pain or to her inability to remember such pain as did occur because of the scopolamine-induced amnesia. If given too soon, these drugs may stop the labour completely. If given too late, their effect on the child's respiratory centre may cause its death from asphyxia. This lack of safety has led to more or less abandonment of the twilight sleep routine. Morphine and scopolamine, on the other hand, can be given within the limit of safety and still relieve much of the pain of childbirth. They accordingly are used extensively for this purpose.

Barbiturates.—These drugs, usually combined with scopolamine, are frequently employed for the relief of pain during labour. As in the case of twilight sleep, their successful use is followed by a loss of memory, and the mother either has no pain or forgets it completely. To obtain a satisfactory result, unpleasant side effects sometimes are encountered. The commonest of these is excitement of varying degrees. Restraint accordingly may be necessary, and the constant presence of a nurse or other attendant is required. Restlessness or the patient's inability to use her bearing-down efforts properly often makes it necessary to deliver the child with instruments under nitrous oxide–ether anesthesia. Although some infants delivered in this way do not breathe so readily as do those born to mothers who have had no medication for the relief of pain, the effect of the barbiturates on the child is much less marked than that produced by the twilight sleep routine.

Demerol.—Demerol, combined with scopolamine, has been employed to produce analgesia and amnesia during labour. Accumulating evidence after mid-20th century seemed to indicate that this combination would ultimately prove to be the safest and best method of pain relief during the first stage. Because of the antispasmodic action of demerol, the dilatation of the cervix apparently is hastened by its use. If the combination of demerol and scopolamine is supplemented by local anesthesia during the stage of expulsion, the greater part of the pain of childbirth may be eliminated without risk to mother or child.

Nitrous Oxide.—Nitrous oxide, or "laughing gas," is one of the most popular of the analgesic agents. It is given during the latter part of the first and throughout the second stage of labour and is administered only for the duration of the uterine contractions. While the child is being delivered the addition of ether usually is necessary. Unless adequate amounts of oxygen are added to the nitrous oxide mixture which the mother breathes, the child may suffer from anoxia or die from asphyxia.

Chloroform, Ether, Ethylene and Cyclopropane.—These are often given while the child is being delivered. Because of its toxicity, chloroform lost much of its popularity, with the result that its use became restricted largely to those cases in which the duration of the anesthesia is to be short. Ether is much safer than chloroform but is not so pleasant to take and is irritating to the respiratory passages. Ethylene and cyclopropane are excellent gaseous anesthetic agents and are well suited to the needs of obstetric practice. Because of their highly explosive nature a special and elaborate apparatus for their administration is required and adequate measures to prevent the occurrence of static sparks must be employed. Trichloroethylene, a volatile anesthetic agent, has been found to be suitable for self-administration during the latter part of labour. The patient inhales this gas through a special inhaler which she places over her nose and mouth at the onset of each uterine contraction. Loss of consciousness occurs before the contraction ends; the inhaler thus drops away from her nose and the administration of the gas is discontinued. Trichloroethylene anesthesia is used extensively in Great Britain.

Continuous Caudal Anesthesia.—This may be produced by surrounding the terminal portion of the spinal cord with an anesthetic agent. For this purpose a special flexible needle is passed into the canal at the base of the spine which contains this portion of the spinal cord and is left in place. Through it from time to time a solution of the anesthetic agent, metycaine, is injected. Perfect anesthesia for a prolonged period without loss of consciousness accordingly is made possible by this method. Unfortunately the technique is difficult to master and requires the constant attendance of one who is capable of recognizing and treating the accidents that may arise from its administration. These accidents, unlike those that may accompany the use of other methods of anesthesia, may cause death because of their sudden occurrence and because of the difficulties surrounding their treatment. This narrow margin of safety together with the fact that only 60% of the women who have children are suitable subjects for continuous caudal anesthesia militates against the universal application of this method.

Spinal Anesthesia.—Spinal anesthesia has been used late in labour. It is obtained by passing a needle between two of the lower vertebrae into the spinal canal and injecting a solution of procaine (novocaine). Following the injection, relief of pain is prompt and lasts for one to two hours. Unfortunately this form of anesthesia often destroys the reflex responsible for the bearing-down efforts and thus greatly increases the need for instrumental delivery of the child. Like caudal anesthesia it has no effect on the child, and most infants born under its influence breathe and cry immediately after birth. Accidents occasionally occur and may cause the sudden death of the mother. For this reason, spinal as well as caudal anesthesia should be administered only by trained anesthetists who are careful to follow the meticulous technique required by both methods and who are capable of immediately recognizing and treating untoward reactions.

Local Anesthesia.—Local anesthesia of the lower birth tract may be secured by infiltrating these structures with an anesthetic agent or by surrounding the trunk of the nerves that supply this region with the same. A solution of procaine (novocaine) is most frequently used for this purpose. It is easily injected by means of a hypodermic syringe. Because the technique of its administration may be easily learned and because it can be given without risk to the mother or child, local anesthesia is one of the best means of relieving the pain that accompanies the actual delivery of the child. Demerol and scopolamine in the first stage, supplemented by local anesthesia in the latter part of the stage of expulsion, provide probably the safest and best means of relieving most of the pain of childbirth in most women.

PUERPERIUM OR PERIOD OF INVOLUTION

Within six to eight weeks after childbirth most of the structures of the maternal organism that underwent change during pregnancy return more or less to their prepregnancy state. The enlarged uterus, which at the end of gestation weighed about 1,000 g. (33 oz.), shrinks to a weight of about 60 g. (2 oz.). Accompanying this process of uterine involution, its lining membrane is almost completely shed and replaced by a new lining, which is then (six to eight weeks after delivery) ready for the reception of another fertilized ovum (egg). The greatly dilated neck of the womb and lower birth passage likewise undergo marked and rapid involution, but they seldom return exactly to their prepregnancy condition. As a rule, examination of a woman who has given birth accordingly reveals evidence of this. The markedly stretched abdominal wall also undergoes considerable involution, particularly if abdominal exercises are carried out. Although the zigzag intradermal tears (*striae gravidarum*) become smaller and silvery white, they do not completely disappear but remain as evidence of the marked and rapid stretching of the skin that took place during pregnancy. The breasts, unlike most of the other organs, continue to increase in size. By the second or third day following childbirth they become so distended that they are painful. After the milk comes in on the third day this distension recedes somewhat, but the breast enlargement persists as long as lactation continues. If the child is not allowed to nurse on its mother's breasts, lactation ceases within a short time and mammary involution follows.

See MATERNAL AND CHILD HEALTH; OBSTETRICS; EMBRYOLOGY, HUMAN; *see* also references under "Childbirth" in the Index volume.

See A. C. Beck and A. H. Rosenthal, *Obstetrical Practice* (1958); R. A. Hingson and L. M. Hellman, *Anesthesia for Obstetrics* (1956).
(A. C. BK.)

CHILDE, V(ERE) GORDON (1892–1957), Australian prehistorian who made a systematic study of European prehistory in the third and second millennia B.C., seeking to evaluate the relationships between Europe and the orient and to examine the structure and character of the barbarian cultures of the western world in antiquity. Born at Sydney, New South Wales, on April 14, 1892, he began his research at Oxford under Arthur Evans and John Linton Myres on problems of archaeology as affecting the Indo-European languages, publishing *The Aryans* in 1926. In the following year he was appointed the first Abercromby professor of prehistoric archaeology in the University of Edinburgh, remaining there until 1946, when he became director of the Institute of Archaeology in the University of London. In many publications he presented a synthesis of knowledge covering a vast and complex field in a manner unique and authoritative, and made himself easily the greatest prehistorian in Britain of his generation, and probably in the world. *The Dawn of European Civilization* (1925) appeared in six successive editions up to 1957; *The Danube in Prehistory* (1929) is a classic of European prehistory. His insistence on an international approach founded a tradition of prehistoric studies, while his more popular works interpreted prehistory in terms of social and technological development. He died on Mount Victoria, New South Wales, on Oct. 19, 1957. *See* also Civilization and Culture: *Concepts of Civilization and Culture.*

See the obituary by S. Piggott in *Proceedings of the British Academy,* vol. 44, pp. 305–312 (1959). (S. Pt.)

CHILDEBERT, the name of three Frankish kings, of the Merovingian dynasty.

Childebert I (*c.* 495–558) was a son of Clovis and Clotilda. In the division of territory that followed the death of Clovis in 511, he received Paris as the capital of a kingdom which stretched from the Somme valley to Brittany and included the Seine valley and the cities of Nantes, Angers and Bourges. He annexed Chartres and Orléans after murdering the heirs of his brother Clodomir (d. 524). Childebert took part in campaigns against the Burgundians (523–534) thereby acquiring Mâcon, Geneva and Lyons; he forced the Visigothic king Amalaric to retreat toward the Spanish border (531); and, when Provence was ceded to the Franks by the Ostrogoths, received Arles and Marseilles (537). Having already tried unsuccessfully to despoil his nephew Theudibert I of Austrasia in 534, he attacked his brother Clotaire I in 540, and peace was restored only when the queen mother Clotilda intervened. Then, with Clotaire, he invaded Visigothic Spain (541–542). In this campaign, his greatest military exploit, he captured Pampeluna (Pamplona) but was forced to abandon the siege of Saragossa. He brought back the tunic of St. Vincent as a trophy; in its honour he built the monastery of St. Vincent (now St. Germain-des-Prés), where he was afterward buried. He died on Dec. 23, 558.

Childebert II (*c.* 570–595) was proclaimed king of Austrasia after the murder of his father Sigebert in Dec. 575. During his minority his mother Brunhilda (*q.v.*) struggled with the aristocracy for power in Austrasia; while his uncles, Chilperic I, king of Tournai, and Guntram, king of Burgundy, contended to enforce on him their protection. Childebert was adopted by Guntram in 577 and by Chilperic in 581, but when Chilperic tried to embroil him in an attack on Guntram in 583, the *minor populus* of Austrasia rebelled. After Chilperic's death in 584, Childebert and Guntram united against the claims of a pretender, Gundobald. They made a treaty at Andelot on Nov. 28, 587, arranging a new partition of Charibert's patrimony. Guntram received Sigebert's original share: Childebert took the city of Meaux, two-thirds of Senlis, and the cities and territories of Tours, Poitiers, Avranches, St. Lizier, Bayonne, Aire and Albi. When Guntram died in 592, Childebert annexed his lands. Hoping to become master of the whole Frankish kingdom, he then tried unsuccessfully to seize the small remaining territory of Clotaire II, Chilperic's son. Childebert had made several expeditions into Italy between 584 and 589, finally treating with the Lombards. He had also made contacts and sought an alliance with the Byzantine empire: 24 letters exchanged between his chancellery and that of the emperor Maurice are extant. He died in Dec. 595.

Childebert III (*c.* 683–711), a son of Theuderic (Thierry) III, was placed on the throne of Neustria by Pepin of Herstal in 695, but had no effective power. He died early in 711.

See F. Lot *et al., Les Destinées de l'empire en occident de 395 à 888* (1928), in G. Glotz (ed.), *Histoire générale* (*Histoire du moyen âge,* vol. i). (Je. H.)

CHILDERIC, the name of three Frankish kings, of the Merovingian dynasty.

Childeric I (d. 481 or 482) was king of the Salian Franks, who, in treaty with the Roman empire, had been settled since 428 in Belgica Secunda, between the Somme and the Meuse, making their capital at Tournai. The account given by Gregory of Tours of the first part of his reign is largely legendary: according to Gregory, Childeric, son of Merovech, was expelled by his subjects and took refuge in Thuringia with a certain king Basin, whom he repaid by seducing his wife, Basine. When Childeric was recalled by the Franks eight years later, Basine followed him. Their child was Clovis (*q.v.*). Childeric's role as a barbarian ally of the Romans was important. He helped their *magister militum* Aegidius to repel the Visigoths near Orléans in 463 and, at the request of Count Paulus, Aegidius' successor, he attacked the Visigoths again in 469. Soon afterward he cleared the district around Angers of Anglo-Saxon pirates. Childeric died in 481 or 482 and was buried at Tournai. His tomb, discovered in 1653, was found to contain a stone slab engraved with his name and some rich cloisonné ornaments.

Childeric II (649–675), the second son of Clovis II and of Bathilda, was proclaimed king of Austrasia in 662, in place of the rightful heir Dagobert, son of Sigebert III. He reigned under the joint tutelage of his aunt Himnechildis (Dagobert's mother) and of Wulfoald, the mayor of the palace. When his elder brother Clotaire III, king of Neustria and Burgundy, died in 673, Ebroïn, the Neustrian mayor of the palace, tried to introduce Clotaire's and Childeric's youngest brother, Theuderic (Thierry) III as his successor. But the Neustrian magnates, whom Ebroïn had not consulted, appealed to Wulfoald and Childeric II and swiftly deposed Theuderic. Childeric thus became master of the kingdoms of Neustria and Burgundy as well as Austrasia. He quickly forgot his promises to respect the customs of each kingdom and he sent into exile in the monastery of Luxeuil, Leger, bishop of Autun, who had severely censured his conduct. Childeric II was the last Merovingian to attempt the exercise of genuine authority, but he lacked political ability. A party hostile to Austrasian rule grew up in Neustria and Childeric was assassinated, while hunting near Chelles, between Sept. 10 and Nov. 15, 675.

Childeric III (d. 755) was the last Merovingian king. Effective power in France had long been wielded by the Carolingian mayors of the palace, but the revolt which followed the death of Charles Martel in 741 made it wise for his sons Carloman and Pepin the Short, in 743, to place Childeric III, a Merovingian of questionable legitimacy, on the Frankish throne, so that they could dissemble their authority behind his name. Carloman entered a monastery in 747 and when Pepin felt sufficiently secure to have himself elected king of the Franks (751), Childeric was deposed and confined in the monastery of Sithiu, near Saint Omer. He died in 755.

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CHILDERMAS: *see* Innocents' Day.

CHILDERS, HUGH CULLING EARDLEY (1827–1896), English statesman who was a fervent supporter of William Gladstone and served the Liberal party ably in several departments, was born in London on June 25, 1827, and educated at Wadham college, Oxford, and Trinity college, Cambridge. Emigrating to Australia in 1850, Childers rose rapidly in the civil service before becoming a member of the cabinet in the newly created parliament of Victoria in 1856. He was also a founder of the University of Melbourne and its first vice-chancellor. Returning to London in 1857 as agent-general for Victoria, Childers soon entered British politics and business in the City. Elected Liberal member of parliament for Pontefract in 1860, he became financial secretary to the treasury (1865–66), where his ability impressed Gladstone. In 1868 Gladstone appointed Childers first lord of the admiralty—an office he managed successfully until his retirement through ill-health in 1871. He was chancellor of the duchy of Lancaster in 1872 but resigned to make way for John Bright a year later. Childers returned to active politics in 1880 as Gladstone's secretary for war, succeeding the prime minister as chancellor of the exchequer in 1882. His orthodox budgets were well received until 1885, when proposals for increased taxation contributed to the fall of a divided government. Defeated for the first time at Pontefract as an advocate of Home Rule, Childers was returned for

South Edinburgh in 1886 and became home secretary in Gladstone's brief third ministry. He retired from parliament in 1892 and died in London on Jan. 29, 1896.

See Lieut. Col. E. S. Childers, *The Life and Correspondence of Hugh C. E. Childers*, 2 vol. (1901). (A. F. T.)

CHILDERS, ROBERT ERSKINE (1870–1922), Irish writer and political agitator, whose support for the republican cause in the civil war which followed the establishment of the Irish Free State led to his execution for treason, was born in London on June 25, 1870. He was a first cousin of Gladstone's colleague Hugh Childers. Educated at Haileybury and Cambridge university, he was from 1895 to 1910, apart from service in the South African War, a clerk in the house of commons. After 1910 he devoted himself to propaganda for the cause of Home Rule and in July 1914 he landed a cargo of rifles for the Irish volunteers at Howth, near Dublin, in his own yacht. During World War I, however, he served with distinction in the British forces before joining (1917) the convention set up to evolve some form of Irish settlement by consent. His advocacy of Home Rule grew quickly into full support for an Irish republic: in 1921 he was elected a Sinn Fein deputy for Wicklow. That year he was secretary to the Irish delegation for the talks preceding the Anglo-Irish treaty, but, dissenting from this agreement, sided with the republican opposition which resorted to civil war. He was taken prisoner at his home in County Wicklow on Nov. 10, 1922, court-martialed on a charge of unauthorized possession of a revolver and executed on Nov. 24.

As a writer, Childers is best remembered for *The Riddle of the Sands* (1903), a brilliant spy story which was the fruit of his enthusiasm for yachting and for the secret service. He also wrote vol. v of *"The Times" History of the War in South Africa* (1907). (D. G.)

CHILD LABOUR. In Europe, North America and Australia and New Zealand, children under 15 rarely work except in commercial agriculture, thanks to the effective enforcement of laws passed in the first half of the 20th century. But millions of children (some as young as seven) still toil in the quarries, mines, factories, fields and service enterprises of less industrially developed countries. They make up more than 10% of the labour force in some countries in the middle east and from 2% to 10% in much of Latin America and some parts of Asia. Few, if any, laws govern their employment or the conditions under which work is performed. Restrictive legislation is barred largely by family poverty and lack of schools.

The movement to regulate child labour began in Great Britain at the close of the 18th century, when rapid development of large scale manufacturing had resulted in the exploitation of very young children in mining and industrial work (*see* COAL AND COAL MINING: *Mining and Miners*). The first law, aimed at controlling the practice of apprenticing pauper children to cotton mill owners in 1802, was ineffective because it did not provide for enforcement. In 1833 the Factory act did provide a system of factory inspection. Organized international efforts began with the first International Labour conference in Berlin in 1890. Although agreement on standards was not reached at that time, similar conferences and other international moves followed. In 1900, the International Association for Labour Legislation was established at Basel, Switz., with branches in at least 16 countries, to promote child labour provisions as part of other international labour legislation. In 1919, the treaty of Versailles contained provision for an International Labour organization (ILO) to be affiliated with the League of Nations and to include all its members.

A few years earlier, just at the turn of the 20th century, aggressive campaigns were under way in the United States to combat widespread child labour. In 1832, two-fifths of the factory workers in New England had been children; and by 1870 the census had reported that 750,000 children between ten and fifteen years of age were working throughout the country. Their number increased steadily from 1870 to 1910.

Agitation for compulsory school attendance legislation had begun in the 1820s. In the 1840s, Connecticut, Massachusetts and Pennsylvania had passed laws limiting the hours of employment of minors in textile factories. By the 1870s, the Knights of Labor had started the campaign for state laws prohibiting the labour of children. By the turn of the century, conditions in canneries, the glass industry, anthracite mining, etc., had begun to attract considerable attention. The number of child labourers in the south had tripled in the decade ending in 1900. In 1904 the National Child Labor committee was organized, and it was chartered by congress in 1907. The committee investigated conditions in various states and industries and led the successful push for state legislation to regulate child labour. By 1920 census reports began to reflect a decline in child labour that continued in the 1930s. The slowness of certain states to adopt legislation, however, and the lack of uniformity of state legislation led to demands for federal regulation. Attempts to secure congressional regulations were set aside by the supreme court in 1918 and 1922 (*Hammer* v. *Dagenhart; Bailey* v. *Drexel Furniture Co.*). In 1924 a child labour amendment was submitted to the states but was never completely ratified. Nevertheless, minimum age standards were incorporated in 500 separate industrial codes adopted under the National Industrial Recovery act (1933–35). In 1936 the Walsh-Healey act was passed with minimum age standards imposed on suppliers of goods produced for the federal government and in 1937 the Sugar act was passed with a minimum age for employment in cultivating and harvesting sugar beets and cane.

But it was the enactment of the Fair Labor Standards act in 1938 that signified the beginning of the end of child labour in the United States. This federal law set the minimum age at 14 for employment outside of school hours in nonmanufacturing, at 16 for employment during school hours in interstate commerce, and at 18 for occupations called hazardous by the secretary of labor. Other state and federal laws, the increasing mechanization of industry, the growth of labour unions and the enlightenment of progressive business and industrial leaders all contributed to the elimination of child labour (except in commercial agriculture, especially the employment of migrant labour, in which area the National Child Labor committee was still working in the second half of the 20th century).

In Europe and Asia, progress was reversed during and after World War II. Children were required to do the work of adults, some even as soldiers. In the most devastated countries, they sank to levels unprecedented in the 20th century, engaging in hazardous and sometimes illicit work.

In 1944, the International Labour conference adopted a declaration that redefined the aims and purposes of the ILO. Further action in 1945 and 1946 provided that any member of the United Nations might become a member by declaring its formal acceptance of membership obligations. Other countries could be enrolled upon the vote of the conference. Much of the ILO's work was devoted to setting standards. The report it published in 1960 on law and practice among more than 70 member-nations showed serious gaps in protection afforded young workers in nonindustrial employments, including agriculture and handicrafts. Governments that needed help in formulating and enforcing standards received technical assistance from the ILO. Its experts helped in drafting labour codes and laws containing basic provisions, in setting up labour inspection services and in training staffs. Regional conferences in the 1950s gave special attention to the problems of young workers in agriculture, coal mines, inland waterways and the construction industries and to elementary protective measures needed in the middle east, Asia and Latin America.

The newly emergent countries of Africa sought membership of the ILO soon after attaining independence and by the 1960s were gradually ratifying where possible international labour conventions and modeling their labour legislation on the provisions of the international labour code. Most states inherited from the former colonial administrations laws restricting the employment of children. Legislation in Ghana, for example, dating from 1948 prohibits the employment of persons "under the apparent age of fifteen years" except where such employment is with the child's own family and involves light work of an agricultural or domestic character only. The difficulty has been in providing regular inspection to see that the laws are observed. Workers' and employers' organizations co-operate with labour and factory inspectorates in enforcing the law in shops, offices and factories. Other more indirect social pressures have to be brought to bear against child labour on farms and in rural village craft workshops.

With the provision of more schools and teachers for primary education and the rapid expansion of educational programs as undertaken in Ghana and Nigeria, for example, pressures have been exerted on parents and relatives to release their children for schooling. In areas of scattered population boarding schools at the post-primary grade help to keep the elder children at school. If emergent states could continue to support expanding school systems and aim to introduce compulsory free primary education, as did Ghana in Sept. 1961, school attendance inspection would check further child labour offenses.

Resistance to releasing children for school has been found to decline in areas where adults participate in mass literacy campaigns and can see for themselves the positive economic benefits associated with literacy and the acquisition of new knowledge and skills brought by the extension services of health, agriculture and community development departments of government.

The development of patriotic youth movements associated with political parties and, in independent states, with the school system, and the formation of young farmers' clubs are agencies reaching out to the remote country districts and precipitating change. These in turn may bring a new form of exploitation of children and young people in hard physical work, as has been observed in Guinea and the People's Republic of China, through the ambitious construction tasks and projects set by over-zealous party officials.

Information on child labour throughout the world is published regularly in ILO periodicals (the *International Labor Review* and *Industry and Labor*). Information on child labour in agriculture and youth employment in the United States is published by the National Committee on Employment of Youth, a division of the National Child Labor committee, in its pamphlets and periodicals (the *American Child* and *Youth and Work*).

See CHILDREN, LAWS CONCERNING; CHILD WELFARE; *see* also references under "Child Labour" in the Index volume.

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CHILD PSYCHOLOGY AND DEVELOPMENT.

Child psychology seeks to give a systematic account of the ways in which the mental processes of children differ from those of adults, of the manner in which they develop from birth to the end of adolescence, and of the mental differences observable between one child and another. Pronouncements on these topics, sometimes based on shrewd observation, sometimes purely fanciful, are to be found in the writings of the early educationists, such as J. A. Comenius, R. Ascham, J. J. Rousseau and J. H. Pestalozzi. But, as a branch of scientific inquiry seeking to establish its conclusions on a firm empirical basis rather than on casual experience or unverified speculation child study is of comparatively recent growth. F. Froebel and J. F. Herbart both insisted that the training of the child, whether at home, in the kindergarten or at school, should be founded on psychological principles; yet for the most part their views on mental development were purely deductive, derived as corollaries to their philosophy of society and mind.

The first attempts at methodical observation were those of Charles Darwin. In 1875 he began to keep a day-to-day record of the progress of one of his own children, collecting and recording the data after the manner in which, as a naturalist, he would have observed some strange animal. A few years later a more elaborate study along similar lines was published by the German physiologist W. T. Preyer (*The Mind of the Child*, 1881). This set the fashion for a series of such studies. In 1891 G. Stanley Hall decided that the time had come to establish an American periodical, the *Pedagogical Seminary*, devoted entirely to child psychology and pedagogy. Shortly afterward James Sully founded an Association for Child Study in Britain. During the first half of the 20th century many important researches were initiated in various countries by highly original investigators—A. Binet in France, E. Meumann in Germany, E. L. Thorndike and A. Gesell in the United States and J. Piaget in Switzerland. Nearly every contemporary university has a department devoted to the subject.

METHODS AND TECHNIQUES

As in other branches of modern science, two main types of procedure are used in child psychology: experiment, wherever the essential variables can be deliberately produced or controlled, and observation where experiment is impossible. In both cases every effort is made to secure information in quantitative form. This implies not merely measuring the variables (the chief causes and effects) but also measuring the frequencies with which different values are encountered and the intensity of the relation between two or more variables. As a result, child psychology has come to be largely a statistical study.

Methods.—The techniques employed depend partly on the nature of the problem to be investigated and partly on the available sources of data. The chief methods of obtaining information are the following:

1. Observations by parents, relatives, teachers or social workers, recorded in the form of diaries, school record cards, personal files, official reports or the like.

2. Data elicited by direct questioning of parents, teachers or others concerned, either at interviews or through questionnaires. Whenever possible, the questions are framed so that a quantitative assessment or rating is secured (stating, for example, the frequency with which a certain type of behaviour is noted), or the presumed strengths of particular traits are assessed on a comparable scale (*i.e.*, one that may be compared with assessments obtained in the same way for other children).

3. The past productions of the child himself, surviving in the form of paper records, such as letters, stories, essays, poems, drawings and musical compositions.

4. Memories of childhood set down in an autobiographical document, or given in reply to questions addressed by mail or personally, or compiled from material collected by psychiatrists in the form of case histories.

5. Direct answers by the child when interviewed by a professional psychologist together with incidental notes on his demeanour, and systematic observations on the behaviour of the child at play as recorded by a trained observer; for the latter purpose a special playroom equipped with a one-way window or screen is often used so that the children are unaware that they are being watched.

6. The performances of the child when tested in the classroom or the psychological laboratory; the tests may be either verbal or nonverbal, given in group form to a number of children at once (as in school examinations), or to each individually and alone (as with tests involving elaborate apparatus).

7. The introspective reports of the child explaining (or professing to explain) how certain test problems were attacked and solved, what kind of imagery was used, what difficulties were involved, or again what were the reasons or motives for certain actions; here should be included direct studies of the child's unconscious processes by psychoanalytic procedures, *e.g.*, the familiar techniques of dream analysis or free association.

Problems.—The questions studied by child psychologists fall into three main groups.

1. Attempts, based on actual observation and experiment, are made to describe the course of mental development either of the child as a whole or of some particular function, trait or type of

behaviour. Here two modes of approach are possible: the so-called "normative" approach which takes, as it were, cross sections of the developmental process by examining different individuals, or more often a number of typical individuals, selected to represent successive ages; and the "genetic" or longitudinal approach, which follows up the same child, or the same sample of children, year after year. In both cases quantitative assessments are indispensable for purposes of comparison. Hence the commonest but by no means the only procedure consists in the application of standardized tests.

2. Intensive studies may be made of certain basic mental processes regardless of their history or mode of development. Here, for example, belong the detailed studies of the process of learning and its various conditions and results. A wide variety of methods may be used according to the nature of the process studied.

3. The problems that have been most fully studied are those of individual differences and, in particular, the relative influence of heredity and environment on their nature and degree. Here, in addition to measuring the processes or performances of the child, it is also necessary to measure those of his parents, brothers and sisters and, if possible, other relatives, and also to study and assess the conditions in his material and social environment. Since the basic problem is a comparison of two or more variables, special statistical techniques based on the analysis of variance or the calculation of correlations are needed to secure exact results.

Classification of Mental Characteristics.—If the mental differences between children at different ages, or between one individual child and another, are to be described, it is necessary to adopt some kind of classificatory scheme for distinguishing the essential characteristics, and to use an agreed vocabulary of descriptive terms, each carefully defined. A good deal of psychological research carried out on children has been directed toward this end, the main procedure being the statistical technique known as factor analysis. (*See* PSYCHOLOGICAL TESTS AND MEASUREMENTS: *Factor Analysis.*) Ancient writers, in particular Plato and Aristotle, and later the scholastics, gradually worked out a simplified scheme based mainly on observation and introspection and expressed in a Greco-Latin nomenclature. This is the basis of the popular psychological vocabulary now used by teachers and indeed by most people. The underlying theory has been progressively modified in the light of later biological, physiological and experimental work, but in the main, with these and other minor rectifications, this traditional scheme has been confirmed by modern statistical research.

Broadly speaking, it appears that we can distinguish between (1) cognitive (*i.e.,* intellectual and practical) characteristics on the one hand and (2) affective and conative (*i.e.,* motivational) characteristics on the other. Further, under each main heading a distinction can be drawn between (*a*) relatively specific components entering into certain limited groups of characteristics and (*b*) a more general component underlying the whole set. Thus among the cognitive traits must be considered (1*a*) a number of special abilities not unlike the old-fashioned faculties, consisting partly of formal abilities such as observation, memory and imagination and partly of capacities for dealing with different kinds of material (verbal, numeral, spatial, visual, auditory and the like). According to the views of British psychologists, we must also consider (1*b*) a general all-round ability called intelligence. Similarly, on the motivational side (2), there appear (2*a*) a miscellaneous set of personality traits or tendencies (the simpler corresponding roughly to the old-fashioned instincts or emotions, the more complex to what are variously called interests, sentiments or complexes) and various underlying temperamental characteristics, and (2*b*) a general factor, usually termed general emotionality.

MENTAL DEVELOPMENT

Stages of Mental Growth.—Generally speaking the time required for an animal to become full grown varies with its size: a mouse matures in three months, an elephant in 20 years. If differences in size are allowed for, it will then be found that the period varies with the degree of intelligence attained by the creature when adult. No other creature has so long a period of childhood as the human being. The guinea pig, the lamb and the colt can walk, run and fend for themselves almost from birth; the newborn human baby is helpless. Cats and dogs reach full size and are able to mate when between 12 and 18 months old, gorillas and chimpanzees when they are ten years old; but with man sexual maturity is postponed until about the 13th year and full size and strength until about the 20th. Thus of all living creatures man is allowed the longest time to mature and to learn.

Most of the traditional descriptions of the child's development divide the entire period from birth to maturity into a series of well-marked stages. The limits and the designations of each vary from one writer to another. In general, however, an arbitrary but convenient method which divides childhood into three phases of equal duration is preferred. Indeed it is often maintained that a critical change overtakes the child every seven years, the close of the first being marked by the beginning of the second dentition, that of the second by the onset of puberty, and the last by the legal coming of age. Each of the broader divisions is then commonly subdivided into two successive sections. This yields six stages in all: (1) infancy: (*a*) babyhood, 0–3 years, (*b*) early school period, 4–7 years; (2) childhood: (*c*) junior stage, 7–10 years, (*d*) senior or prepubertal stage, 11–14 years; (3) adolescence: (*e*) puberty, 14–17 years, (*f*) late adolescence, 18–21 years.

In point of fact, mental development shows no sharp or sudden breaks. It resembles a steady advance up an inclined plane, smoothed by a gentle curve at the beginning and end, not a jerky ascent from one level to another by a succession of clearly defined steps. Nevertheless, for purposes of exposition it will be convenient to keep more or less to the traditional scheme.

General Theories.—Several notable attempts have been made to bring the whole course of mental development under the terms of some general scheme or formula.

Stratification Theory.—One of the most popular theories in the past has been what is sometimes called the stratification theory. The adult mind is depicted as built up of superposed layers or strata, laid down during the successive stages of childhood. This view, it will be noted, treats the distinctions between the several stages as much more than mere conveniences of exposition or administration; it supposes them to be based on certain natural or intrinsic changes. According to an ancient view, the child's sensory capacities are developed first; then his motor capacities (walking, speech, simple manual skills); then memory; and last of all imagination and reasoning. Among modern writers, Jean Piaget has been the most vigorous supporter of the view that development proceeds by a succession of stages, each qualitatively different from the last. He, too, recognizes four main stages with age limits much the same as those indicated above.

Recapitulation Theory.—A somewhat similar theory explains the distinctive features of the various stages, and the regular order in which they unfold, by assuming that they recapitulate the successive phases through which the animal kingdom has evolved in progress from the one-celled organism to man. "Each individual," it is said, "climbs up his own ancestral tree." This recapitulation theory yields subdivisions slightly different from that of the stratification theory and was suggested by the way in which certain features of the human embryo (gill slits, tail, hairy coat) seem to repeat similar features exhibited by its adult ancestors, in much the same order. Obviously the principle cannot be accepted as universally true, since sexual reproduction would then start during infancy and a maternal interest in dolls only toward puberty.

Growth Curves.—Later investigations of the actual course of mental development by means of standardized tests have shown that the essential changes consist mainly in a quantitative increase in the complexity, efficiency and organization of processes which are present in an elementary form at or soon after birth, rather than in a succession of qualitatively different stages with fresh capacities or instincts maturing at the beginning of each. Graphs of physical development (*e.g.,* for height and weight) reveal a slight acceleration in longitudinal growth about the time of the

1st. 7th and 15th years (rather earlier with girls) followed in each case by a longer phase of accelerated increase in breadth and weight, showing a series of "springing up" periods followed by "filling out." There are analogous fluctuations in mental growth, roughly parallel in time to the physical fluctuations, new advances being followed by periods of consolidation. But, except at the very beginning and end of childhood, the variations in rate of growth are decidedly small, particularly if average data instead of those for single individuals are taken. Indeed in most measurable characteristics, notably memory, reasoning and general intelligence, the annual increments, at least from about age 4 or 5 to 13, are almost equal, so that the curve is virtually a straight line. During the first year or so after birth there is a marked acceleration, and with the onset of puberty a marked retardation; and from age 15 onward the annual increments are almost negligible. Hence the whole curve is S-shaped and can be neatly expressed by the equation for what is called a "logistic" curve—the curve commonly used to describe the growth of both human population and populations of microscopic organisms. Moreover, with this formula the slight rhythmic fluctuations can be included by inserting extra terms. It applies, however, only to those functions in which the changes are quantitative rather than qualitative, and to curves based on averages; curves for individual children are far more irregular.

Each of the foregoing theories contains a minor element of truth, but each would be misleading if treated as covering all the known facts.

Prenatal Development.—Mental development begins well before the child is born. Knowledge of the development of the human fetus is derived from three main sources: (1) reports by the mother of her own experience of the movements of the unborn child; (2) observation of the fetus by stethoscopic, electrical, X-ray and other modes of examination; (3) the study of living fetuses removed by operation where termination of pregnancy has been necessary on medical grounds. In the living fetus the earliest movement of importance is the heart beat, which can be demonstrated during the third week of pregnancy. At the end of eight weeks stimulation of the skin will provoke perceptible movement, vague at first but definitely localized later on. By the fourth month respiratory movements may be detected, though of course the liquid environment precludes true lung breathing. At this age the cortex of the brain consists only of a single layer of cells; but it now differentiates rapidly into five main layers, developing from within outward. At birth, the outermost layer, which subserves the highest functions, is still only about half the proportionate depth it attains in the adult. The differentiation starts first in the motor area, then appears in the visual area and finally spreads to the frontal lobes. During the last two or three months of pregnancy it is possible to secure electroencephalograms from the fetus by placing electrodes on the mother's abdomen. Finally, during the last three or four weeks, movement can be provoked by loud sounds, and experiments based on auditory stimulation indicate that something very like learning may occur even before the child is born.

From early times it has been widely believed that the mother's thoughts or experiences may directly influence the unborn child. No doubt if they are serious enough to impair the mother's physical health, the child's general development may suffer as a result. But, except for the chemical interchange between the two blood streams and the transmission of infections or their products, there is no way in which the mother's condition can affect the child.

Newborn Child.—Postnatal development, like prenatal, proceeds partly by differentiation, partly by integration. As a result of the growth that has already taken place before birth, the newborn infant is no mere automaton. He comes into the world as a fairly well organized creature with an extensive repertory of responses, chiefly those needed for the preservation of life (such as breathing, feeding and avoiding painful stimulation). During the first week or so he is asleep for 60% to 80% of the day, usually in spells of three or four hours. An increasing amount of his waking time, however, is spent in movements which are at first more or less random and spontaneous. In the main, behaviour proceeds from a generalized total pattern of movement to a specialization of partial or localized movements within it. Contractions of the larger muscles, of the muscles nearer the trunk and particularly of muscles nearer the head end are mastered first; control of the finer muscles, of the more distal parts and the lower extremities, much later.

From the outset, however, certain definite reactions are carried out in response to specific stimuli. The earliest are those excited by hunger. At birth the mouth is a far more efficient organ than the hand, both for touch and for prehension. The reflexes for lip searching, sucking and swallowing are all fully effective. As Samuel Pepys noted in his diary (1667), if an infant's cheek is touched the head turns and the lips open to grasp the finger. Visual reflexes also can be aroused, but reactions to auditory stimuli are more difficult to elicit. The birth cry is only a respiratory response; but subsequent cries, evoked by pain, discomfort or any violent stimulation, form a regular part of the innate equipment of the newly born.

The later development of sensory consciousness is similar to the development of movement. The older view, that the child at first experiences separate sensations within himself, then "projects" them into outer space and later still combines them into objects, is decidedly misleading. To begin with (as William James puts it), "the baby, assailed by ears, nose, skin, and entrails at once, feels it all as one great blooming buzzing confusion." Against this general background certain intrusive sensations stand out and seem to attract discriminative notice, and appropriate muscular reaction follows.

After birth there is no further multiplication of the cells in the brain; but their fibres continue to proliferate and branch for some months and, according to some physiologists, for a good many years to come. The motor area is well advanced at 10 or 11 months. The speech area lags behind by several weeks. Of the rest of the brain cortex, the areas for the sense of movement and for vision and then the other projection areas are the earliest to mature. The regions around them develop next, and the so-called association areas last of all. The frontal region is not fully developed until about the fourth year. (*See* also BRAIN.)

First Year.—For the first few years of life the typical achievements of the average child have been tabulated month by month on the basis of numerous tests and observations, and the results provide a standardized scale for assessing the progress of any given individual. The range of individual differences, however, is considerable. The order in which various capacities or reactions develop is by no means the same for every child; a child may be precocious in one respect and slow in another.

Before the end of the first month the average infant can hold up his head, grasp one's finger and make several sounds besides crying. He follows a moving light with his eyes and is startled by unexpected noises. During the next month or so he shows adaptive changes in behaviour—for example, with regard to feeding habits—which indicate simple learning. On the other hand, some of the earlier reflexes, such as the "suspension grasp" and "startled clasp" (reflexes which some regard as legacies from our arboreal ancestors) soon begin to fade. By the age of six months he has started to crawl, can hold a spoon and will clutch at a ring. Manual exploration now becomes one of his main occupations: he has an urge to touch, finger and grab at all he can reach. By ten months he can stand up when held. By the end of the year he can point with his finger, walk if led, obey simple requests and even articulate two or three duplicated sounds, though rather by way of expressing his feelings in the presence of an audience than with any clear notion that they are associated with definite persons or objects.

During the first few weeks there is little differentiation between the emotions. Soon it becomes possible to distinguish reactions of three types—distress, delight and simple excitement. At one month there is a difference between the cries of pain, of hunger and of mere discomfort; by three months, pleasure is expressed by smiling and vocal gurgling; and a couple of months later it is easy to distinguish between the expression of fear, anger, grief and even disgust (*e.g.*, at an unpleasant taste).

By the end of the first year the child already has a personality of his own. His social consciousness is displayed by sensitivity to approval and disapproval. He can inhibit actions when forbidden, and he becomes shy or coy in the presence of strangers.

Second Year.—By the age of 13 months the average child is able to stand alone and, a week or two later, to walk alone. By the middle of his second year he can pull a toy on a string and climb upstairs, and by the end of the year he can jump, run and kick a ball along the floor. His skill with his hands will have increased: at the beginning of the year he can unwrap a sweet and shortly afterward scribble clumsily with a pencil on paper; at about 18 months he can build a tower of three or four blocks and, by the end of the year, turn a screw, make perpendicular and horizontal strokes and throw a ball into a basket.

The child has now entered the stage of symbolic vocalization. By 14 months the average child is able to use two or three words with an appropriate meaning, and as soon as he discovers that things have names he displays great interest in the process of naming. Wide individual differences are discernible. The gifted child learns to walk a month earlier than the average, and to talk about three months earlier. Girls are slightly more precocious than boys. At 18 months the child should be able to use half a dozen words intelligently and combine them in pairs (*e.g.*, "Bow-wow gone"). By the end of the year he should have a spontaneous vocabulary of 20 words or more and know the meaning of 300 or 400. He can name half a dozen familiar objects and use sentences of four or five syllables.

Fairly dependable bowel control is commonly acquired by about 19 months and bladder control during daytime a month or so later (though delay in achieving such control should cause no concern). At the end of the year the child can give help in dressing or undressing himself. He is now awake for about ten hours each day, and is thus free to get better acquainted with the world around him. Since he can run about by himself, he is becoming more independent of his parents. The natural result is an occasional clash of wills, and, as the psychoanalysts have amply demonstrated, the way the child is treated in these situations during the first two or three years of life may affect his whole character for the future. If another child is born or brought into the house, he may display marked jealousy; and he is still oriented more strongly toward adults than toward those of his own size. At a party or a nursery school he shows far more interest in the things around him than in the persons, and in his play is more likely to ignore other children than to join in their games.

End of Babyhood.—During his third and fourth years the child makes rapid intellectual progress. This is shown most clearly in his use and understanding of language, the most intellectual acquirement at this age. Here, however, much depends on his family. Tests of fairly large samples show that by the age of three the average child already uses pronouns, plurals, past tenses and two or three spatial prepositions (for instance "in," "under" or "behind"). At three he can repeat two numbers, at four years three numbers and at five four numbers. At the age of four he can count four pennies, and at five he can copy a square. His talk is no longer concerned only with his immediate wants or feelings but expresses ideas and communicates them to others: in a word, it has become socialized rather than egocentric.

During the second and third years there is, as a rule, a manifest increase in imaginative activity. A large element of make-believe enters into the child's play and gives it a purpose and meaning. When resting, he begins to amuse himself with daydreams. The commonest subjects are the child's own self-glorification, the possession of coveted toys, the presence of an imaginary playmate and fanciful reconstructions of the personalities of those with whom the child is in closest contact. Cinderella's grieving over the death of the kindly mother and the cruelty of the unkind stepmother and her older sisters, and her dreams of a fairy godmother coming to her rescue and gratifying all her wishes, are typical of the fantasies in which many children now begin to indulge. Like other forms of play, these imaginative exercises serve a useful function. The child can consider how he may interpret the world in a more reasonable way, he can think out his wishes and fears without immediately facing the problems of reality, and he can rehearse his own behaviour, and so adapt it a little better to the actual situation when the time arrives.

Throughout this period the child should be gaining increased control over his emotions. Crying that results from distress usually declines, though crying from anger will probably increase. During the third year of life fear is evoked by such stimuli as loud noises, strange persons and being left alone. By the age of five such reactions are quite exceptional. What he now fears are anticipated or imagined misfortunes—accidents, bodily injuries, the dark and being punished or scolded. Anxiety arising from emotional conflict or guilt is increasingly common. Individual emotional differences become more and more conspicuous, varying according to each child's personal experiences and social environment.

Five to Seven Years.—This stage corresponds with the first years of school attendance. The child is now rapidly acquiring a basic notion of the world of reality in which he lives. He has already discovered that objects have a permanent identity, unchanged by motion or temporary concealment; that there is a space surrounding him, in which he and other things can move; and that causal effects can be produced by other agencies besides himself. His knowledge of the life of human beings has hitherto been gained largely by imitating their actions in his play, but now, if he is not unwisely repressed, he will increase his fund of information by badgering his parents with unending questions.

By the age of six he should be able to take fairly good care of himself and to act in a group. He can probably hop, skip and jump, dress and undress, tie a bow and use scissors. He no longer grasps his pencil with a fist-hold but with a finger-hold, and his drawings of men, houses, trains and the like are readily recognizable. His memory is good enough to be of practical service. He can repeat sentences of about 10 or 12 syllables, and execute an order involving three distinct instructions. His retentiveness is rapidly improving, but he learns best by doing, not by sitting down and listening or repeating things mechanically.

Entry into school confronts the child with new social situations, and this results almost at once in new social problems and a rapid social development. Instead of just crying or whining he now expresses his wants and complaints in words; instead of merely displaying temper or force he seeks to work his way through his difficulties by the aid of language. He is able to join in small co-operative enterprises, playing with one or two others at keeping house or shop, or with a larger group in games organized by the teacher. He associates with both sexes quite easily, but on the whole spends more time with his own. Quite frequently he has to defend himself and his possessions, and so becomes conscious of himself as a person with a status. He has developed a conscience and finds it difficult to conceal or to bear any sense of guilt. But as yet he has acquired no broad ethical principles, except the simple maxims of his parents or teachers.

Junior Stage.—During the earlier years of school life the child's performances in various directions are closely correlated. If he is bright, he is usually bright all round; if dull, dull all round. About the age of seven, however, special abilities and disabilities begin to be increasingly noticeable. It will therefore be instructive to consider the various mental processes that are important for school work, beginning with the most elementary—that is, sensory capacity.

At seven the eye of the child is still underfocused and ill adapted for close work. Books for the teaching of reading should therefore be printed in fairly large letters, diminishing year by year to about 11 or 12 point at the age of 11 or 12. At every age girls have on an average a somewhat poorer visual acuity than boys, but their colour discrimination is superior.

By the age of seven, auditory acuity is as good as it ever will be, but the discrimination of pitch continues to improve for three or four years. Throughout the junior period, however, harmony arouses very little interest, and even melody, as a rule, has less appeal than rhythm. The boys' favourite rhythm is the march rather than the waltz. Girls seem to take quite as readily to triple time as to double, and by age eight or nine, if not before, have already picked up the more popular dance measures.

The kinesthetic sense (the muscle-and-joint sense), through which we feel the position of our limbs and hands and fingers, is of special importance for practical work in school. It increases remarkably throughout the school period and is partly responsible for the rapid improvement in manual dexterity.

The ability to control movement develops later than the ability to interpret simple sensation. During infancy the child learns how to use the larger muscles of the trunk and limbs, and during the junior period he learns the finer control of the more delicate muscles, those of the eye, the tongue and especially the fingers. Throughout these years he is pre-eminently active. The average boy already shows greater muscular strength than the average girl. The difference is as yet comparatively small, but it reveals itself in the differences between the games and the physical exploits of the two sexes. In finer finger work, however, girls are somewhat superior to boys, though in drawing, at least up to puberty, boys are slightly better.

The mental imagery of the child during these earlier years is extremely concrete. The adult, particularly the educated adult, thinks in terms of unspoken words; the child thinks in terms of actual sensations—recalling or imagining the object or situation as it would be presented to the eye, the ear, the sense of touch or movement. During infancy, it would seem, his imagery is largely tactile and kinesthetic. During the junior period, however, the majority of children develop into visualizers, a few into audiles. The particular store of images with which the child's mind gets stocked, the working content of his thoughts, depends chiefly on his immediate environment. Motion pictures, television and, to an increasing extent, books and magazines appreciably enlarge its range; but, except among those who are exceptionally bright, observant or imaginative, it still remains far more limited than teachers generally assume.

It used to be a commonplace of educational textbooks that the period from age 7 to 14 is the best period for memorizing and the period from 14 to 21 the best period for reasoning. Both generalizations are somewhat misleading. Standardized tests reveal nothing like the sudden growth in memory or, later on, in reasoning that is popularly assumed. From the earliest years up to maturity the power to memorize improves at a fairly uniform pace. It appears stronger only because at this stage it is easier for the inexperienced youngster to learn things by rote than to understand their reasons.

Both memory and reasoning work through association; but in mechanical memory the associations between one idea and another are not made conscious or explicit, whereas in reasoning the child not only associates the two things but also perceives how they are related. The commoner and simpler relations such as those of space, time, number, similarity, difference and contrast can all be grasped by the average child before the age of seven, provided the material is sufficiently elementary. Reasoning, however, depends not simply on the direct perception of relations such as these, but on the perception of relations between these relations. At the age of five a child can discover which is the bigger of two boxes or the heavier of two weights. Not until nearly seven can he solve such problems as "Tom is bigger than Jim; Jim is bigger than George. Which is the biggest of the three?" By seven or eight years of age most children can manage the elementary forms of deductive reasoning. Their improvement, as the years go by, consists chiefly in the number and variety of relations they can organize into coherent logical arguments of increasing length and complexity. The systematic study of children's attempts at inductive reasoning is comparatively recent. Much has been done in this direction by J. Piaget and his co-workers. The main conclusion to be drawn from their work is that inductive thinking usually depends, far more than deductive thinking, on a specialized knowledge of the particular subject or field to which the thinker's problem belongs.

During the junior period the child's emotional interests become more objective and more clearly defined. Owing to his growing strength, size and independence he seeks a wider radius of movement. He spends more of his time outdoors, playing in the street if he lives in town, roaming the fields and woods if he lives in the country. The upholders of the recapitulation theory maintain that within the remaining period of childhood (from the age of seven up to puberty) it is possible to distinguish four successive phases, each lasting about two years and corresponding to the hunting, pastoral, agricultural and commercial stages of primitive man. Although children's spontaneous play exhibits much that seems to support this parallel, the exceptions in regard to ages and order are too numerous to justify any assumption of direct biological transmission. At the beginning of the junior period the child's play is still for the most part individualistic. Even when two or three children are playing together, each child still tends to play against the others rather than with them. Among the youngest, simple games of chase are extremely popular, and much time also is spent in hurling things, aiming at targets with sticks or stones, and hunting birds or stray cats, often regardless of cruelty. This is followed by games of competition—fighting, wrestling and mimic combats with toy pistols or imaginary machine guns. Indoors, boys become increasingly attracted by tales of battles by sea or land, films of heroic adventure and television thrillers. With girls these self-assertive impulses come to the fore in a different way; they love to dress up, dance, recite and pose in front of an audience, and before the junior period is over some will be secretly trying the effects of cosmetics. After World War II, however, a liking for boyish activities and for stories or programs intended for boys became increasingly common among girls.

Puberty and Adolescence.—According to the recapitulation theory, the stage of adolescence represents in the individual the final phase of the evolution of the race—that which marked the transition from the primitive to the civilized era. At this stage, it is supposed, a new group of innate faculties and impulses emerges and matures. The doctrine is still widely accepted by teachers, educationists and those who write about teen-agers, but the element of truth it contains is rather slender, and the majority of psychologists incline toward a simpler theory. All the apparent modifications that take place at this stage, they hold, are really secondary effects of one fundamental change—the maturing of the sex glands. Yet even this theory demands some qualification. First, the psychological changes do not show anything like a constant relation to the physiological changes; they arise sometimes earlier, sometimes later, and are spread out more widely. Puberty in fact is not a sudden crisis but rather the culmination of a long process of growth which has been proceeding steadily from birth, though at varying rates in different individuals. Secondly, as later research has shown, many of the psychological characteristics that once were commonly supposed to result from internal physicochemical changes are to a large extent determined by external alterations in the scholastic, domestic and financial circumstances of the individual; for example, in those social classes in which children leave school or college comparatively late, appearance of these characteristics is appreciably delayed.

On the intellectual side, the most noticeable feature of the whole pubertal period is the way in which mental growth, like physical, gradually slows down and comes eventually to a halt. This is most clearly seen in the average measurements of general intelligence at successive ages. There is first, at an age that seems to vary with the age at which the pubertal period begins, a slight quickening of the pace, and then toward 13 the annual increments get smaller and smaller, until after about 16 it is hard to detect any further increase. Again there are wide individual differences. The brighter children continue developing till a later age than the others; the dull and defective come earlier to an arrest. Changes in special abilities are somewhat more irregular. During early adolescence nearly all boys and many girls become for a time more clumsy and awkward in their movements and untidy in their general behaviour, as may be seen, for instance, in the deterioration in handwriting that is so often noted. The growing reliance on speech, reading and bookwork tends to make mental imagery increasingly verbal, particularly among the brighter boys. Just after puberty, particularly among girls, there is often an outbreak of creative imagination. Daydreaming, sometimes morbid, sometimes helpful (as in thinking over possible careers), becomes for a while much commoner and at times concentration on work is apt to suffer.

Reasoning now undergoes a change of type. Up to the age of about 10 or 11 it proceeds roughly in conformity with the traditional subject-and-predicate logic, but thereafter the child tends increasingly to argue in terms of propositions. This becomes obvious if what is implicit in his thinking is written out in a formal notation: with the younger child little more than the calculus of classes is required to express his arguments; with the older. inferences belonging to the calculus of relations and propositions become increasingly frequent. The tendency to reason in propositions results largely from the growing habit of discussing things self-consciously with other people, particularly other children ("Jim said it's a bird; but everybody knows birds have feathers; if you ask me, I'd say it was a bat"). Children, of course, are as unfamiliar with the laws of logical syntax as they are with those of grammatical syntax. They pick up both by incidental learning in the form of implicitly apprehended schemata, blank frames that are filled in by the concrete data suggested. Just as the rules of grammar can be taught, so (as a few enterprising schools have shown) logical techniques may also be taught with appreciable benefit to the child's way of thinking and behaving.

It is, however, changes in emotional, social and moral attitudes that distinguish the period of adolescence most conspicuously. To begin with, the final maturing of the reproductive system strengthens the sex instinct, and a marked interest in the opposite sex now manifests itself in the majority of youths and girls. As with many animals toward the mating season, there is an increasing fondness for personal adornment and self-display. Gregarious tendencies are shown by the growing frequency of team games and informal clubs or cliques. During the preadolescent stages boys in particular begin to cling more closely together in little bands or social groups. When they leave school, they are apt, in the absence of other facilities, to form organized gangs of their own. They invent codes, passwords and perhaps a secret language. They engage in spirited enterprises and predatory ventures which may end in downright delinquency. Play becomes increasingly rough; and humour takes the form of slapstick comedy and practical jokes, at times amounting to thoughtless cruelty. Power is sought and enjoyed for its own sake, regardless of consequences. Thus nearly all the primary emotions are for a time intensified, and as a result the teen-ager appears a bundle of contradictions, now shy, now aggressive, at one moment yearning for solitude and the next for company. Hysterical laughter or giggling is followed by a spell of dejection or weeping and even thoughts of suicide, violence to persons or property by moods of heartbroken penitence. He may, in short, exhibit an emotional instability which at any other stage would be regarded as a definite neurotic disorder. With British children these tendencies reach their height at about 15 or 16; with American children, it would seem, a year or two earlier.

On the social side there is at first an increasing impatience of authority and at times an obstinate independence of parental control. The adolescent, whether boy or girl, tends more and more to adopt the code and the attitude of others of his own age rather than those of the adults around him. This may even bring with it a stubborn resistance to traditional conventions. Yet all the time the consolidation of these different emotional tendencies is going on apace. Codes of behaviour, guiding interests, sentiments for various persons, repressed emotional complexes, ideals, good or bad, moral or nonmoral, are being shaped and finally fixed. Adolescence is thus a crucial period in the formation of character. It includes the peak ages for juvenile delinquency and the periods during which religious problems and religious experiences are most profoundly felt. (*See* also Adolescence).

INDIVIDUAL DIFFERENCES

The picture of mental development outlined above is that of the average child brought up in an average civilized environment. Each child is a unique individual, however, and few are average in all forms of behaviour. Since most people (including teachers, educationists and many psychologists) are familiar only with one narrow section of their own community, they seldom realize the vast range of individual variation. The investigation of such differences has been carried out chiefly during the school period as it is then easier to obtain representative samples of complete populations or age groups. Detailed information about the child's personal and family history can be more readily procured, and the children themselves have more time to spare for interviews and tests and are well accustomed to being questioned and examined.

The main problems of such research are to determine first the nature and extent of the differences among individuals and secondly the causes or conditions which tend to produce them, so that they can, if necessary, be forestalled or remedied. The causes themselves fall under two main headings: (1) genetic (or, as they are popularly termed, inborn or hereditary) factors and (2) postnatal or environmental factors. All observable characteristics are the product of both, each set interacting with the other.

The characteristics most strongly influenced by genetic constitution are those that are most immediately dependent on anatomical structures (*i.e.*, on the sense organs and various parts of the central nervous system) or on biochemical influences (*e.g.*, the hormones secreted by the endocrine glands). The laws governing the hereditary transmission of such characteristics are the same as the laws that govern the transmission of bodily characteristics; viz., the so-called Mendelian principles. Most mental differences are quantitative rather than qualitative, a matter of tendency rather than type, and so far as they are innate, they must therefore be the result of multifactorial inheritance; *i.e.*, of genes whose effects are small, similar and cumulative. The distribution of such differences conforms with the so-called "normal" curve: average or intermediate grades are the commonest, and the larger the deviation from the mean, the rarer it is. Moreover, contrary to popular opinion, inheritance, as thus determined, is responsible not only for resemblances but also for dissimilarities. Hence occasionally quite bright children may be born to parents who are extremely dull.

So far as intellectual differences are concerned, the characteristic most fully studied is innate general cognitive ability or what older psychologists called "intelligence." As we have seen, during the early years the child's mental development is largely dependent on this initial capacity, since environmental influences have not yet modified the effects of heredity, and more specialized abilities or disabilities do not, as a rule, manifest themselves until later. Differences in intelligence can be roughly assessed by intelligence tests; but such tests need to be constructed, applied and interpreted by trained psychologists. About 75% of the differences so revealed are attributable to genetic constitution. (*See* also Psychological Tests and Measurements.)

The range of the differences is unexpectedly wide. Among 1,000 children aged 10 by the calendar, the dullest may have a mental age of only 4 or 5 and the brightest one of 15 (that is, in terms of the intelligence quotient, a range of 50 to 150); in larger groups these limits will be exceeded. The amount of deviation increases with age: a child who is retarded by 1 year at the age of 5 will be retarded by 2 years at the age of 10 and by 3 at the age of 15. This is one of the reasons commonly urged for classifying pupils of 11 and upward in different "streams" or different schools. To some extent the differences are related to differences in social class, but within each social class the individual differences range over 80 or 90 points and the absolute number of gifted children in the lower social classes, owing to the greater size of the group, greatly exceeds the number in the professional classes. (*See* Retarded Children.)

In order to give each child the type of education his particular allowance of ability deserves, it would be desirable to assess his innate potentiality at the earliest possible age. Longitudinal studies, in which children have been followed up during the whole school period and often to the time when they have settled down to their adult occupations, show that such attempts are only partly successful. Except in cases of gross mental deficiency, estimates of ability made before the age of six are highly unreliable. Even after that age, scores obtained at a single sitting are still not accurate enough for scientific research. In studies where the assessments have been based on at least two examinations at the beginning and end of the follow-up period, there is a fairly high agreement; with intervals of 10 or 15 years, correlations between 0.65 and 0.75 have been reported.

By "special abilities" the psychologist understands those hypothetical capacities which make for efficiency in particular fields of work, over and above that conferred by general intelligence. Here the differences are far more difficult to assess and far less is known about their inheritability. According to the rather meagre evidence, it seems that special abilities (and disabilities) for verbal, numerical and manual work, for mechanical memory and for certain types of imagery often run in families. The occurrence of infant prodigies in mathematics and music suggests that such gifts rest in part on a genetic basis. But the widespread notion that every child can be classified into one of three types—intellectual, practical and technical—at the age of just over 11 is grossly mistaken. During adolescence specialization becomes much more clearly marked, though it is always difficult to say how far it is due to late-maturing genetic differences and how far to emotional or environmental factors—to new interests, for example, resulting from personal motivation and external influences rather than from a specific intellectual endowment.

The motivational factors themselves are far more susceptible to social than to intellectual influences. As we have seen, the chief genetic bases appear to be inheritable differences in what older writers termed instincts, with their associated emotions. And there is some slender evidence that an excessive strength of such primitive impulses as anger, fear, sex and possibly migration tends to run in families. General emotional stability is almost certainly determined to a large extent by the individual's innate constitution, and the differences which suggested the ancient doctrine of temperaments must also rest in part on genetic variations (*see* Temperament). According to this doctrine (modified by factorial research and formulated in modern terminology) it is possible to classify most individuals according to four main tendencies arranged in antithetical pairs, extrovertive and introvertive, euphoric (optimistic) and dysphoric (pessimistic). The differences are largely a difference of degree; and here, too, the mixed or mediocre types are as usual the commonest.

In the main, however, the development of character consists in the progressive organization of the child's emotions about certain key ideas to form what are variously called sentiments, interests, attitudes or complexes. The earliest relate to persons—mother, father, sisters and brothers—and the later to teachers, playfellows and friends. Impersonal sentiments relate to possessions, hobbies, games and later on to various intellectual pursuits. Many of them, as the psychoanalysts have shown, may be more or less unconscious. Here lie the most important clues to differences in individual personality. The sentiment which exerts the widest influence on behaviour is the child's "self-regarding complex" or "ego-ideal" as it is sometimes termed. How far these various character qualities can be assessed by projection tests, clinical interviews and the like is discussed elsewhere. (*See* also Ego; Attitude; Sentiment; Psychological Tests and Measurements: *Tests of Personality and Temperament.*)

Within a free society the status eventually attained by a particular child when he reaches the end of the developmental period depends on three main factors. Their mode of operation has been admirably elucidated by studies of social mobility carried out in the United States, Great Britain, France, Sweden, Denmark and Belgium, in all of which the main conclusions are virtually the same. First, the child's innate general capacity sets an upper limit to what he can ultimately achieve but is seldom the deciding factor. In an industrial community with a modern educational system, it will (with a few notable exceptions) be the child's educational attainments rather than sheer intelligence that determines his eventual vocation; and the education he receives may still depend partly on the financial resources of the family or the opportunities available in his district. Secondly, within the limits which intelligence has set, motivational factors are of prime importance, and these depend not merely on the strength and stability of the child's innate temperament but also on the interests and aspirations that he has acquired during his earlier years. Thirdly, and perhaps most influential of all, there is the continued pressure of the child's social environment. The aims, the ideals, the daily urging of his parents will affect him chiefly during the more plastic stages of his mental life, though their effects will not always take the direction intended. The parents' influence on the child's development, intellectual as well as motivational, is strongest in the smaller family. But the parents' attitudes will in turn be largely the product of the system of customs and values that prevails in the social groups to which they belong. As the child grows older, these various social influences will tend to affect him more directly, notably through his companions. The school itself has to take all this into account, and its guiding purpose therefore should be to determine, at the earliest possible age, the child's intellectual and temperamental potentialities; then to direct and develop them so far as may be practicable; and, finally, to equip him for that type of career for which nature seems to have marked him out. *See* Personality; Psychology; Concept Formation, Psychology of; Educational Psychology; Psychology, Social; *see* also references under "Child Psychology and Development" in the Index.

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CHILDREN (ARTICLES ON). The principles of child care from birth until the walking-alone stage are outlined in Infants, Care of. Supplementary information will be found in Maternal and Child Health. The physical and mental progress of the typical child from infancy through adolescence are described in Child Psychology and Development.

Children, Diseases of, discusses the major hazards to child health, and the advances of modern pediatrics in overcoming them. Nutritional problems are described, in conjunction with those of adults, in Diet and Dietetics; Nutrition; and Vitamins.

Articles dealing with psychological questions are Psychology, Abnormal; Defense Mechanisms; Personality; and Psychiatry: *Child Psychiatry.* Psychological Tests and Measurements discusses various types of aptitude, intelligence and personality tests. Retarded Children deals with the problems of physically and mentally handicapped children: specific handicaps are discussed in Blind, Training and Welfare of and Deaf and Hard of Hearing, Training and Welfare of. The problems of the left-handed child are treated in Handedness. Exceptionally gifted children are discussed in Gifted Children.

Articles concerned with the legal status of children include Children, Laws Concerning; and Child Labour. Delinquency is treated in Borstal System; Children's Court; and Juvenile Delinquency.

Day Nursery discusses facilities for the care of young children of working mothers. Provision for orphaned and abandoned children is described in Adoption and Child Welfare.

Articles devoted to children's organizations include Boy Scouts; Boys' Brigade, The; Camp Fire Girls; Girl Guides; Girl Scouts; Four-H Clubs; and Future Farmers of America. The origins of familiar games are discussed in Children's Games and Sports. The history of juvenile literature is summarized, and the best-loved works of various eras and styles are cited, in Children's Literature.

Educational principles and methods and the rise and development of national school systems are reviewed and discussed in EDUCATION, HISTORY OF. PRE-ELEMENTARY EDUCATION is devoted to the education of children of the youngest age group. Among many articles dealing with the older groups are ELEMENTARY EDUCATION and SECONDARY EDUCATION. Educational topics of a general nature are treated in such articles as COEDUCATION; and the articles listed in EDUCATION (ARTICLES ON). The child is discussed in the context of society in CIVILIZATION AND CULTURE: *Role of Childhood*, and in FAMILY: *Influence of the Family on Individual Personality.*

CHILDREN, DISEASES OF. The major developments in pediatrics, the special branch of medical science that deals with the prevention and treatment of diseases of children, took place after the turn of the 20th century. Prior to that time there existed but little exact knowledge of, or great interest in, the special problems of child health. Infants and young children were regarded merely as miniature adults whose physical, mental and emotional disorders required no special consideration beyond that afforded mature persons. As a result of this attitude and the undeveloped state of medical science and practice, the incidence of disease and the mortality rates among children were appalling; 20% to 40% of all infants born alive died during the first year of life. Of the total deaths in the entire population, three out of four occurred in children under 12 years. However, as a result of revolutionary advances in the field of pediatrics and intensive application of sound public health principles, death rates among children in the more advanced parts of the world had been reduced by the early 1960s to one-tenth of those figures.

Differences in Children.—One of the most important steps in the progress of modern pediatrics was the recognition by both medical practitioners and laymen of certain fundamental differences between the child and the adult. Because of his state of immaturity, the infant or young child differs from the mature person physiologically, psychologically, immunologically and anatomically. The constant changes in functional patterns incident to growth and development impose different standards for health appraisal and for nutritional, medicinal and other health requirements in the very young.

Throughout the wide range of diseases affecting infants and children, the concept of prevention predominates that of treatment in the mind of the properly oriented physician. Fortunately, advances in the sciences of genetics, nutrition, microbiology, immunology, epidemiology, hygiene and sanitation made it possible for medical practitioners and public health officers to exercise a large measure of control over many of the most devastating physical diseases. Improvements in diagnostic laboratory techniques together with revolutionary developments in pediatric surgery and treatment with drugs and immune blood serums reduced the dire effects of certain nonpreventable diseases to a minimum as well.

Classification of Diseases.—The diseases that affect infants and children may be classified according to the nature of their causes, the particular organ systems primarily involved or a combination of these methods. Since pediatrics is based upon the concepts of growth and development of the individual, the pediatric physician must take into account, so far as is feasible, all factors known to influence the orderly course of these normal processes from the moment of conception throughout the periods of infancy, childhood and adolescence. For example, such determining factors as heredity, prenatal influences (including maternal illness) and injuries incident to the process of birth explain most cases referred to as diseases of the newborn.

Hereditary and Congenital Disease.—Examples of the hereditary diseases are hemophilia, erythroblastosis fetalis, familial periodic paralysis, certain nervous and mental diseases, many cases of inborn errors of metabolism and a tendency to allergic disorders, such as infantile eczema and bronchial asthma. Of the congenital diseases known to be acquired by the infant before birth as a result of maternal disease, syphilis, toxoplasmosis and certain anatomical anomalies, *e.g.*, congenital cataracts and possibly malformations of the heart, are best known. Prematurity of birth, the leading cause of mortality among infants, is caused in the main by fetal anomalies or by impaired health of the mother during the period of gestation. Accidents incident to the birth process, such as asphyxia (suffocation), brain hemorrhage, fractures and muscular paralyses, may result in immediate death or may be followed by such consequences as retarded mental development, epilepsy and cerebral palsy.

Nutrition Disorders.—Disorders of nutrition, together with the alimentary or enteric diseases, presented the most serious of all problems involved in the care of infants and young children prior to the time when their specific causes were discovered. Thereafter, however, it became possible to prevent the major number of these entirely, or to effect a cure in most instances, once the disease had developed. The nutritional requirements of children for normal growth and development and for normal functioning of the organ systems of the body are greater, in relation to the individual's size, than those of mature men and women. The essential food substances required are water, protein (essential amino acids), energy foods (carbohydrates and essential fatty acids), vitamins and minerals (calcium, iron, iodine, magnesium, potassium, sodium, phosphorus, chloride, sulfur and the so-called trace elements). (*See* NUTRITION.)

Prolonged deficiency of any one or any combination of these essential nutritional factors causes more or less specific symptom complexes. (*See* MALNUTRITION.) For example, unless water is furnished for young children and infants in required amounts, a state of underhydration ensues. This is manifested by dryness of the skin and mucous membranes, fever, interference with normal circulatory and secretory functions, and obvious discomfort from intense thirst. Severe protein privation in the young interferes with building new and maintaining pre-existing protoplasm in the living cells of the body and interferes with blood protein formation. Insufficient intake of fats and carbohydrates to satisfy the energy needs of the body likewise limits growth. Of the minerals, calcium and phosphorus are required for bone formation and for certain other vital cellular functions. Magnesium plays a role in cellular function somewhat similar to that of calcium. Sulfur derived from certain essential amino acids of the diet (methionine and cystine) plays a specific role in the formation of certain all-important substances, such as enzymes, insulin and glutathione. Iodine is essential for synthesis of thyroxin, the hormone secreted by the thyroid gland that is essential for normal growth and development. Iron is an essential constituent of the red blood cell pigment, hemoglobin, which carries oxygen from the lungs to all parts of the body. A deficient intake of this element results in the development of a common form of anemia. The monovalent elements (*e.g.*, sodium and potassium), which together with the chloride, phosphate and bicarbonate ions constitute the chief electrolytes in the body fluids, serve essential roles in maintaining the normal chemical environment of all living cells, as well as the normal acid-base balance. Alterations in their concentrations in the body fluids, whether caused by certain endocrine disorders, kidney disease, diarrhea, vomiting or profuse sweating, produce serious illness.

Vitamin Deficiencies.—Specific diseases develop from vitamin deficiencies in the diet. Deprivation of vitamin A manifests itself as xerophthalmia (conjunctivitis) and also as night blindness arising from disturbed function of the retinal enzymes and pigments. A variety of disease states occur in infants and growing children deprived of different members of the vitamin B complex. The best known of these are beriberi (caused by lack of thiamine); pellagra (deficiency of niacin); ariboflavinosis (lack of riboflavin) and megaloblastic anemia of infants (lack of folic, or folinic, acid and vitamin B_{12}). Dietary deficiency in vitamin B_6 or pyridoxine is one known cause of convulsions in infants. Scurvy is caused by inadequate amounts of ascorbic acid (vitamin C) in the diet. Rickets is caused by a deficiency of vitamin D in the diet, unless the skin is exposed directly to ultraviolet light waves. Hemorrhagic disease of the newborn infant is caused by a relative deficiency of vitamin K in the mother's diet during her period of pregnancy. These deficiency diseases rarely occur, however, if the diet contains sufficient amounts of natural foods, including milk, meats, egg yolk, fish liver oils, fresh citrus fruits, green vegetables, salt and water. Cure of existing vitamin deficiency diseases is accomplished most promptly by administration of the missing vitamin in concentrated or synthetic forms. Many genetically conditioned diseases are known to be due to absence or dysfunction of essential enzyme systems. Some of the latter are related to hormonal and vitamin actions.

Diseases Caused by Organisms.—Many serious diseases of childhood are caused by pathogenic or parasitic living organisms. Such diseases are classified into general categories according to the type of pathogen responsible for the particular disease state. For example, there are (1) the bacterial diseases, caused by microscopically visible germs; (*2*) the viral diseases, caused by specific viruses too small to be seen with ordinary optical microscopes; (3) the rickettsial diseases, caused by an intermediate type of microorganism; (4) the mycotic diseases, caused by invasion of the tissues by certain plant molds or moldlike organisms; (5) the animal parasitic diseases, caused by unicellular animal parasites (protozoa); and (6) the diseases caused by infestation with comparatively large and complex animal parasites, such as worms.

Most of the communicable diseases customarily referred to as childhood diseases are caused by pathogenic organisms. For information about these diseases, such as mumps, measles and whooping cough, *see* articles under the disease name and Bacterial and Infectious Diseases.

Respiratory Diseases.—The common respiratory diseases of infancy and childhood, such as the common cold, infantile pneumonitis, influenza, atypical pneumonia (all caused by specific viruses) and the bacterial pneumonias (caused by various types of bacteria) are more serious infections in infants than in older children. While attempts to prevent them by vaccination had met with no success by the early 1960s (except for short periods in the case of influenza), sulfonamide and antibiotic drug therapy had proved to be amazingly effective in the treatment of infections caused by bacteria. Unfortunately, such therapeutic agents are far less, if at all, effective in the treatment of respiratory diseases caused by viruses.

Tuberculosis.—The treatment of tuberculosis is greatly improved if the combined use of three antituberculous drugs—streptomycin, isoniazid, para-aminosalicylic acid—is begun early in the course of the disease. The value of immunization with attenuated tubercle bacilli (BCG [Bacillus-Calmette Guérin]) remains controversial. Among populations where the disease incidence is comparatively low and where it is feasible to discover and isolate active cases through community-wide programs of tuberculin testing and chest X-ray surveys, attempts to immunize would appear to be unnecessary.

Congenital Syphilis.—Congenital syphilis can be prevented by treating the mother with antibiotics or arsenical drugs before the infant is born, or it may be cured in the infected baby or older child by use of these drugs.

Cystic Fibrosis.—This childhood illness was first recognized as a separate disease entity in 1938. Its cause is unknown although apparently linked to inherited metabolic defects. The disease is expressed by two main sets of symptoms: a voracious appetite without gain in weight and a persistent cough that fails to clear the respiratory tract of the thick, sticky mucus that accumulates there and interferes with breathing or leads to secondary infections such as pneumonia or bronchitis. It is believed that about one child in 600 live births is affected. The symptoms may appear immediately after or several years after birth. The disease has a high (80%) mortality, although mild cases may survive to adulthood. By the early 1960s no cure for the disease had been established, although patients were helped by a diet high in protein and calories but low in fat, supplementary feedings of vitamins A and C and the administration of antibiotics and extracts of pancreatic juices from animals.

Other Organic Diseases.—Meningitis, lymphadenitis (inflammation of the lymph glands) and bacteremia (bacteria in the blood), caused by meningococci, streptococci, pneumococci, staphylococci, *Hemophilus influenzae* and certain other bacteria, can usually be treated successfully with sulfonamide and antibiotic drugs. Infections caused by the gonococcus yield readily to modern chemotherapy also, as do typhoid, typhus and malarial fever.

Many of the congenital malformations of the heart and blood vessels, the gastrointestinal tract, the nervous system and the extremities are amenable to surgical treatment.

The underlying cause of acute rheumatic fever is repeated streptococcic infections. Chronic rheumatic heart disease may be a serious complication. Reappearance of streptoccal infections can be prevented by serial treatments with penicillin in small doses.

Advances in endocrinology made possible the successful hormone treatment of such disorders as diabetes mellitus, spontaneous hypoglycemia, diabetes insipidus, parathyroid tetany, adrenal insufficiency, adrenal hyperactivity, pituitary insufficiency, hypothyroidism and certain diseases of the sex glands.

Mental Disease.—Mental, emotional and social maladjustments in children have tardily gained recognition as having health significance quite comparable with that of the common physical or organic diseases. The functional and organic components of a child's illness may at times be so thoroughly fused as to require use of the special techniques of the psychiatrist for its successful diagnosis and treatment. Appreciation of this fact gave origin to the branch of child psychiatry designated as psychosomatic pediatrics. Prevention of such disorders by consistent application of proper mental hygiene is obviously of paramount importance.

See Metabolism, Diseases of; Viruses: *Human Virus Diseases;* Infants, Care of: *Keeping a Well Baby Well;* Maternal and Child Health.

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(I. McQ.)

CHILDREN, LAWS CONCERNING. Since the middle of the 19th century there has been a steady increase in legislation designed to protect children from ill treatment and to offer them the advantages of secure and healthy childhoods. The present article is primarily concerned with the development and content of such legislation in England and the United States; certain aspects of the law relating to children in other countries are discussed in the articles devoted to particular legal systems, such as German Law; Roman Law.

Additional material on law, as well as related services and institutions, is contained in Child Labour; Child Welfare; Social Service. Special topics are treated in Adoption; Bastard; Legitimacy. For the legal responsibility of children, *see* Children's Court; Contract; Criminal Law.

ENGLAND

Legislative Development.—The tendency to intervene in family care of children where it falls short of standards set by the state is of recent origin. Under the *patria potestas* of Roman law, wide powers of life and death were allotted to the head of the family. These powers were not carried over to the European feudal systems of law, although these systems reflected Roman civil law in stressing the family's importance and in maintaining strict controls by means of the family council and curatorship over children. In England, however, there was no general legal principle that all children must have guardians. As a result, child protection doctrines evolved slowly. Under the common law, guardianship, an outgrowth of feudal land law, conferred a right that was profitable to the guardian. Only gradually did guardianship become a trust for the benefit of the ward. By the 13th century, rights of wardship were recognized which enabled a feudal lord, upon the death of a tenant leaving an infant heir, to administer the tenant's estate as guardian during the heir's minority. English law, by the Statute of Marlborough in 1267, penalized the guardian for waste but did not require that he be called to account for any other type of abuse.

Over several centuries, guardianship, whether of the natural parent or other guardian, has slowly been recognized as including the right of custody of the child, control over his education and religious training, consent to his marriage, right of chastisement, right of enjoyment of his services, and control of his estate subject to the use of a sufficient portion for his education and maintenance. By an act of 1660 the father was given power to appoint by will or deed a guardian for his children to act after his death. Between this date and the Guardianship of Infants act, 1886, the mother was helpless to interfere with the father's appointment. Under provisions of this act, however, she could be designated as guardian if the father had made no appointment, or as joint guardian if he had, and she was also permitted to appoint a guardian to act after her death. In 1925 legislation placed the parents on an equal footing regarding the guardianship of their children. Similar progress has occurred with respect to rights of custody. In the course of a century the mother's position improved from one of utter subjection to the father's will to an equal or perhaps even superior claim to custody.

In England, the court of chancery, in the delegated exercise of the authority of the sovereign as *parens patriae*, assumed wardship if rights of guardianship were abused, and applied the property as far as necessary for the maintenance of the child. The courts gradually acquired control over abuse of the power of chastisement and heard actions for assault against the person concerned, whether parent, guardian, teacher or employer. If punishment resulted in the death of the child, the charge was for murder or manslaughter.

Guardianship law, as it evolved, concerned children who were heirs to land. If a child had no property of his own, legal provision for his care and supervision was sadly lacking. Although provision by way of grant of relief was made for destitute children as early as the 1601 poor law, not until 1889 were poor law officials authorized to assume parental rights of control over deserted children. The authority of the poor law officials was further extended in 1899 to include orphans and children of parents who were disabled, imprisoned or unfit to care for them. In the same period the position of private "rescue" societies devoted to the care of children of neglectful parents was strengthened by passage of the Custody of Children act, 1891. It authorized the courts to refuse to enforce a parent's right to the custody of his child if the parent had abandoned or deserted him or was unfit to provide for his care. Similar powers were developed in continental countries, particularly in France and later in Belgium and Denmark.

In Great Britain and on the continent of Europe the growth of children's laws extended to the protection of life, the prevention of ill treatment or cruelty, the regulation of dangerous occupations, the imposition of employment restrictions and the compilation of a great children's charter. In England ill-treatment proscribed by law originally consisted of blows or threats and was gradually broadened to include neglect to supply necessaries. The Offenses Against the Person act, 1861, imposed punishment for the exposure of infants and for neglect or ill-treatment of apprentices or servants. The Poor Law Amendment act, 1868, made it an offense for parents to neglect to supply necessaries (*e.g.*, food, lodging, medical aid and clothing) for their children. At the instigation of the National Society for the Prevention of Cruelty to Children, a series of statutes aimed at preventing cruelty to children in their own homes was passed in 1889 and progressively extended between 1894 and 1933.

Measures to protect life included the Infant Life Protection act of 1872, passed one year after a parliamentary investigation of baby farming (the boarding of infants for pay), and a similar act of 1897, as well as an act of 1908 protecting infants maintained for pay by foster parents. Infant life protection laws were buttressed, commencing in 1874, by statutes providing for compulsory registration of births and deaths.

The 19th century was punctuated by struggles over the regulation of child employment in England, the United States and continental Europe. In all countries the initial stage of the child labour movement was marked by an appeal for shorter hours of work. Legislation in England initially concerned the labour conditions of apprentices and of chimney sweeps, on whose behalf efforts were made for a century before effective regulation of chimney sweeping was secured. The Health and Morals of Apprentices act, 1802, limited the child's workday in cotton mills to 12 hours, prohibited night work, and required instruction in elementary subjects. The Factory act of 1833, which further limited the hours of work to nine per day, extended regulation to all textile industries and introduced a scheme of national inspection to secure enforcement of the restrictions on employment. The history of child labour legislation in England may be traced through various industries as one type of employment after another came within state regulation. By the late 19th century more adequate machinery for the enforcement of regulatory standards had been created and certain occupations of a particularly hazardous nature had been altogether barred to children. Restrictions on the employment of children in casual occupations and amusements were finally imposed in 1903 and extended by the Education acts of 1918 and 1921 and the Children act of 1932. The employment of children in injurious work, in street trading, or at night was prohibited.

Paralleling the enactment of child labour laws was a series of education acts passed in the late 19th and early 20th centuries. The parent's obligation to educate his child, like the obligation of support, was one of the common law's "imperfect," or unenforceable, duties. Because the obligation existed, however, the earliest education laws dealt only with the instruction of destitute children. Beginning with an act of 1834, poor law officials had a responsibility for the elementary education of all children under their care. The education of children who were employed in mills and factories was provided for in the factory acts, which required instruction periods as one aspect of the regulation of child labour. The pattern of half-work, half-school which became popular in England can be traced to these beginnings. The year 1870 marked the passage of the first piece of comprehensive education legislation, the Elementary Education act, which permitted every school board to compel parents to send their children to school. Six years later the law asserted it to be a parental duty to cause every child to receive efficient elementary instruction and provided penalties for failure to discharge this duty.

By the beginning of the 20th century a belief in the obligation of the state to provide general protection for children was gaining acceptance in countries of the western world. England's Children act of 1908 was looked upon as signifying the new point of view. This act, a consolidating measure which drew together for the first time the amending laws and piecemeal legislation accumulated over several decades, publicly emphasized the social rights of children. It embodied the earlier laws for infant life protection and prevention of cruelty to children. Protective measures for child health and morals controlled the sale of tobacco and prohibited the presence of children in brothels, in bars and on street corners for the purpose of begging. Progressive changes were made with respect to the hearing of charges in juvenile courts, and a large number of statutes relating to probation and the reformatory and industrial schools were consolidated. The act also contained a provision for visiting and inspecting the voluntary homes widely used by the poor law officials in an effort, which proved to be largely ineffective, to establish a minimum level of child care.

In the Children and Young Persons act of 1933, heightened interest in the treatment of juvenile offenders was reflected in changes respecting the constitution and procedure of the juvenile courts and the forging of a much closer link between the work being carried on for delinquent and neglected children and the work of the local education authorities. The act extended state responsibility for child welfare to that group of children in need of care and protection and conferred increased powers on local authorities to enable them to carry out their duties for this group, as well as for the delinquent and neglected. The prevailing emphasis in the 1933 act was upon rehabilitation of the child by means of removal from his inadequate home and by provision of a substitute family. The child's welfare, thus regarded, entailed lodging greater power in the court and local authority and led to closer supervision of voluntary homes and agencies, under whose auspices much of the substitute family care was made available.

Following investigation by the Curtis committee of 1946, the Children act, 1948, embodied the committee's far-reaching recommendations. Responsibility for the care of children who have been deprived of normal home life was placed on the local authorities. The act enlarged the authority's power of assumption of parental rights over children under their care and widened their duty to act as fit persons at the behest of the courts; at the same time it directed the authorities to undertake rehabilitation of the child in his home and to aim at all times, in those cases where substitute family care was required, for the restoration of the child to his own family. Administrative powers were centralized in the home office and a stricter control of voluntary organizations was imposed.

Modern English Law.—At the outset it is necessary to attempt some definition of terms. Those who have not attained the age of 21 are known as "infants," and the status of infancy has certain disabilities attached to it: an infant does not enjoy the franchise, either in parliamentary or municipal elections; he may not marry without the consent of his parent or that of a court of competent jurisdiction; his capacity to enter into contracts is limited. In addition there are a certain number of by no means uniform statutory definitions of "children" and "young persons." In connection with either of these terms it would be useless to look for, or to try to formulate, any single comprehensive definition; the right approach, in relation to any statute dealing with either, is to ask what, for the purposes of this act of parliament, do the words "children" or "young person" mean?

The words "child" and "children" have, obviously, meanings which are important in law as expressing a relationship. In statutes, deeds and wills alike, a "child" is generally a legitimate child unless the context indicates otherwise, although there are exceptions to this rule, particularly in connection with national insurance and family allowances. For the purposes of the Fatal Accident acts, by which the personal representatives of a person killed by a wrongful act have a right of action for the benefit of the deceased's relatives, dependence rather than a particular legitimate blood relationship is the criterion, and grandchildren, stepchildren, legitimated, illegitimate and adopted children are all included. The only rule is to look at the context and then to judge what the word means.

Modern English law prescribes care for children falling into five special categories: those deprived of normal home life, in need of care and protection, beyond parental control, handicapped in mind or body, or suffering from mental illness. The care of these children is shared by local authorities, voluntary organizations and state institutions. Voluntary homes are subject to control by the secretary of state.

Children deprived of normal home life, whether orphaned, abandoned or neglected, are committed to the care of local authorities who may, in suitable cases, assume parental rights. Care may last until age 18 and may be extended to 21 if necessary. Maintenance contributions are recoverable from the parents. Children in need of care and protection, if under 17, may be brought before the juvenile courts. As defined, these children include those who have fallen into bad associations through lack of parental care, who fail to attend school and who are the victims of violence or immorality. Any such child may be sent to an approved school or committed to the care of a probation officer or other fit person. Special medical or other treatment may be recommended. Children beyond the control of their parents or guardians, if under 17, may be brought before the juvenile courts and dealt with as children in need of protection. If they are already in the care of a local authority, they may be sent to approved schools on order of the court.

Handicapped children suffering from disability of mind or body may, under the Education act, 1944, be provided by the local authorities with treatment in special schools. Medical examination may be ordered, as well as attendance at the special school selected until age 16. Further assistance between the ages of 16 and 21 is given by the local authority under the National Assistance act, 1948, in the form of rehabilitation services and provision of work at home or elsewhere. Children who are mentally ill receive treatment under a variety of acts relating to mental treatment; facilities include outpatient child guidance clinics and centres provided by local education authorities as well as hospitals.

Paid foster care of children living apart from their parents is now regulated by provisions of the Children act, 1958. The statutory protection exists until age 15 but may be extended to 18. Local-authority visitors may inspect the homes and give directions as to the care of children living there. The number of children kept in the homes is subject to regulation, and local authorities may apply to a court for an order of removal of children from unsatisfactory premises to places of safety. Similar regulations apply, under the Nurseries and Child-Minders Regulation act, 1948, to places providing day care for children.

The employment of children is regulated by the Children and Young Persons act, 1933, the Education act, 1944, and various acts relating to factories, shops and mines. The restrictions relate to hours of employment, employment while of school age and intervals for meals, rest and holidays.

Various rules protect children in criminal proceedings. Provisions include separating children from adults; granting bail; notification of proceedings to the parents, guardians and local authorities; and the presence of children during court trials. Corporal punishment was abolished by the Criminal Justice act, 1948. Charges against children are usually heard in juvenile courts and detention is prescribed in institutions other than prisons.

(C. Wtr.; M. K. R.)

UNITED STATES

The tendency of United States law has been to enlarge the rights of the child and the measure of protection afforded him against ill-usage, exploitation, and hazards to health, morals and well-being. The common-law rule, by which the age of legal majority for both sexes is 21 years, has been generally adopted in the United States, except in a small group of states which has fixed the age of majority for females at 18 years. While the protective laws of the states differ considerably, certain general principles are widely accepted.

The first duty of the parents of children is to support them. This obligation rests principally upon the father, but, increasingly, state laws require the mother to share in its fulfillment. She is fully responsible for support after the father's death. Where the child would otherwise be likely to become a public charge, a variety of relatives may be held responsible for his support. The precise extent of the duty of support is determined by the law of each jurisdiction. Generally, it includes food, shelter, clothing, medical care and education. (As regards the support of illegitimate children, *see* Bastard.) The Social Security act of 1935 recognized the difficulty that a widow might have in supporting her child and, by means of a grant-in-aid program to the states, provided aid to dependent children (ADC) grants for the maintenance of the child and the relative who is his caretaker.

In addition to the duty of support, a parent is required to shield his child from evil surroundings or influences. He may not injure or be cruel to the child; the parent may, however, use physical force to protect his child from danger and may, under proper circumstances, impose reasonable correction. The conduct of any adult which tends to deprave the morals of a child or to endanger his health or well-being is punishable as a criminal offense.

Parents also have an obligation to secure their children's education. The development of compulsory school-attendance laws and of accompanying child labour legislation proceeded differently in the United States from that in England. The slow industry-wide extension of labour regulation and the pattern of half-time school that characterized the British development gave way in the United States to more comprehensive efforts to compel school attendance and prohibit employment. The necessity of education in a democracy was argued in support of requiring full-time education and prohibiting the employment of children under a specified age. Because of the difficulties inherent in the enforcement of both types of laws, great effort was exerted in the United States to bring the child labour and compulsory school attendance laws into harmony so that one would reinforce the other. Modern education laws require school attendance of children in the age range of 6 to 18 years, the upper limit most commonly set by statute being age 16, and penalize the parent or guardian for failure to comply. Paralleling these requirements are provisions of state and federal child labour laws which bar the employment of children in dangerous occupations or during periods of required school attendance and which regulate the conditions of work. Sixteen is a common minimum age for full-time employment.

It has often been said that the father has control and custody of the child and may determine where he shall live. Nevertheless, the modern tendency is to recognize an equal or larger right of the mother in these matters. In any case, the court's basis for award of custody is the welfare of the child, and either or both parents may be deprived of custody because of conduct which harms him. If one of the parents dies during the child's minority, the surviving parent assumes full control. If a child becomes an orphan or if his parents prove unfit to have his care, he may be committed in a judicial proceeding to the guardianship of a suitable person or social welfare agency. In some instances guardians of the estate will be required to deal with his property.

A guardian who is not the child's father or mother does not assume the full status of a parent. The precise nature of the rights and duties he does assume appears, in some states, to turn on whether the guardian has been nominated by the parent as a testamentary guardian or whether the guardian's appointment has been made under child welfare statutes authorizing state intervention for the removal of children from families in which inadequate child care prevails. In cases of the latter kind the guardian's role is often construed more narrowly, the courts apparently having in mind the existence of residual parental rights and the possibility of the child's return to his own family. In many of these cases, the demonstrated capacity of the parents to care for the child is too limited to support a reasonable prospect of rehabilitation of the family. To meet the contingency of long-evidenced parental neglect or inadequacy, some states provide for complete severance of the parental relationship through a termination of parental rights, thereby freeing the child for adoption or foster placement under a guardian's supervision.

By a decree of adoption (*q.v.*) the child becomes the lawful child of his adoptive parents. Legislation in mid-20th century sought to safeguard adoption proceedings by requiring an investigation of the prospective adoptive home and supervision of the child, once placed there, for a trial period before the final decree of adoption is granted. Because of abuses arising out of the casual transfer of children from their natural parents to irresponsible people, a number of states control the proper methods for transfer of parental responsibilities. The methods include guardianship or adoption proceedings and commitment orders of a juvenile court. In many jurisdictions the law also prohibits the bringing of children into one state from another for purposes of permanent care without the prior investigation and approval of the receiving state. Support for these laws stems from increased public awareness of the dangers of "black market" adoptions and the existence of other opportunities for exploitation or abuse of children resulting from ill-considered or harmful parental action.

Remarkable progress in the development of protective legislation has occurred since the beginning of the 20th century. Among the factors accounting for its growth are the decennial White House conferences on children and youth, the work of state commissions for the study and revision of child welfare laws, and the program of the United States Children's bureau. The White House conferences, first held in 1909 and followed thereafter by conferences in 1919, 1930, 1940, 1950 and 1960, have provided an important means of focusing national attention on the needs of children and the services they require. The conferences provide a forum for the interchange of professional opinion and encourage the participation of lay leaders drawn from youth groups and child-serving agencies of all kinds. The conferences have significantly advanced the cause of progressive child care in the nation.

One recommendation of the 1909 conference, whose participants were mindful of the major advances represented by the English Children act of 1908, was that each state periodically review and revise its laws pertaining to children. Beginning in 1911, when the first state commission was appointed for this purpose, the growth and consolidation of child welfare laws was markedly accelerated by the work of such commissions. In the years elapsing since World War II the work of state commissions or councils accounted for many of the significant changes which have been made in child welfare legislation. Most of the changes relate to adoption or to delinquency control and prevention.

The importance of state legislative changes can plainly be seen in the fact that most of the laws pertaining to children are found in state, rather than federal, statutes. At the beginning of the 1960s there was great variation in state laws relating to the proper care of dependent, neglected and delinquent children and in the administrative structures within which these laws were to be enforced. The 1909 conference on the care of dependent children, and all succeeding conferences, emphasized the need for each state to develop a strong department of public welfare whose functions would include the licensing of voluntary child-care agencies and institutions and the supervision of all public child welfare services, whether operated by cities, counties or the state. Licensing, or inspection and supervision, laws are designed to afford the child who must be cared for out of his home a measure of protection by establishing certain minimal standards for the operation of child care facilities. The licensing responsibility is usually discharged by the children's division of the state department of public welfare and customarily extends to children's institutions, child-placement agencies and day-care centres. The level of licensing standards and the extent to which they are enforced differ considerably from one state to another. The extent to which licensing reflects an insistence upon professional standards of child care also varies. Some jurisdictions appear to license primarily on the basis of fire and health inspections, without sufficient regard to the content of the program or to the qualifications of the staff in child-care facilities.

Despite the diversity of state child welfare legislation, the existence of reciprocal laws relating to the support of dependents and of an interstate compact on juveniles, to which a majority of states are signatories, provides a unifying influence on selected child-care programs. Certain federal statutes also establish national standards. The provisions of the Social Security act of 1935 and succeeding amendments have reduced areas of child dependency which had previously been the sole concern of the states and have created new federal grant-in-aid programs based on fulfillment of certain criteria. This act authorized three types of grants for maternal and child welfare services, as well as the aid to dependent children program, one of the categories of public assistance. The grants are for maternal and child health services, services for crippled children, and child welfare services. Of the three, child welfare service has been most intimately associated in each state with the administration of other laws pertaining to children in that jurisdiction. The 1930 White House conference on child health and protection had strongly emphasized the need for services to socially handicapped children and had pointed out the lack of existing county organization for child welfare work under state leadership. Under provisions of the Social Security act, child welfare services sought to assist state public welfare agencies in developing programs, in predominantly rural areas or areas of special need, for the protection and care of children. Child welfare, as defined in the act, includes work with delinquent, emotionally disturbed and mentally handicapped children, as well as dependent children, in their homes or in placement. Program plans must be worked out jointly by the state agency and the Children's bureau, the administering agency of the federal government. An important aspect of state plans has been their wide use of federal funds to provide professional education for child welfare workers. By an amendment of 1958 the emphasis on development of rural services was eliminated from the act; states may now allocate funds to areas of need, whether rural or urban.

The creation of a federal Children's bureau is another significant legacy of the 1909 conference on the care of dependent children. The bureau was established in 1912 to draw attention, at the national level of government, to the needs of children. Its functions include investigation and publication, and much of the nation's child welfare legislation is a reflection of the bureau's research and publicity. The bureau tends to concentrate on areas of child welfare which fall beyond the immediate concern of one state. In the 1950s, for example, it conducted numerous projects and conferences in the field of juvenile delinquency, drawing upon leaders throughout the nation; it has also been concerned with the plight of children of migratory workers, who are too seldom regarded as the responsibility of the individual states through which a season's travels may take them.

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CHILDREN'S COURT is a tribunal for juvenile offenders usually characterized by distinctive procedures and distinctive methods of treatment of children found to be delinquent. In many jurisdictions the court performs additional functions, particularly with reference to neglected and destitute children. It is generally conceded that the first juvenile court, in the modern sense of the term, was that established in Chicago (Cook county) by an Illinois statute effective July 1, 1899. Since that time juvenile courts have been established throughout the United States and in many other nations.

The juvenile court may be regarded as the culmination of certain tendencies of thought originating at least as early as the 18th-century enlightenment. In the common law of England and the United States a child below the age of seven was regarded as incapable of crime, but a child over the age of 14 was fully accountable. In the intervening years the child was presumed incapable of crime, but the presumption was rebuttable upon a showing that the offender understood the nature and consequences of his conduct. There are well-authenticated instances, both in England and America, of execution of the death penalty on boys twelve years of age and even younger. In many jurisdictions well into the 19th century no special provisions were made for the arrest, detention, trial or punishment of children of tender years. Thus, it is said that in 1853 there were more than 11,000 children from 5 to 17 years of age in prisons in England and Wales. The alleviation of these conditions became one of the primary objectives of humanitarian reform.

The first efforts at reform in the United States were concerned, not with the courts, but with the detention and confinement of juvenile offenders. The first of the juvenile reformatories was established in New York in 1825. Shortly thereafter similar institutions were opened in Boston (1826) and Pennsylvania (1828) and, ultimately, throughout the United States (*see* Reformatory). The movement to supply foster homes for neglected and destitute children also originated in New York with the establishment by Charles Loring Brace (*q.v.*) and others of the Children's Aid society in 1853. As early as 1861 Chicago provided a commissioner to hear cases of petty offenses by boys from 6 to 17. Separate trials for children were instituted in Boston in 1870; and New York, in 1892, created separate dockets and records, as well as special hearings, for juveniles below the age of 16. The system of probation (*q.v.*), which is an integral feature of the modern U.S. juvenile court, had its origins in practices developed in the Massachusetts courts. A Massachusetts statute of 1869 provided that an agent of the state board of charities should attend trials of children to protect their interests and to make recommendations for disposition of the cases. Between 1878 and 1898 Massachusetts established a state-wide system of probation, and the movement thereby initiated spread throughout the United States and to many other countries. These reforms were part of a broader effort in the 19th century to advance the welfare of children, which also included the expansion of public education, agitation against the abuses of child labour and the development of services for handicapped and dependent and neglected children. Similar movements for amelioration and reform attained prominence in many nations of western Europe.

After the creation of the first juvenile courts in the United States the movement spread rapidly throughout the world. Within ten years of passage of the Illinois act in 1899, twenty states and the District of Columbia adopted juvenile court laws. By 1945 legislation had been enacted in all of the United States. In England the basis of the modern system for trial and treatment of child offenders may be said to rest on the Children act, 1908, which required that trial of juveniles be conducted in separate courts and provided for various methods of treatment intended as instruments of rehabilitation rather than of punishment. The system created by the 1908 act has been frequently modified by subsequent legislation, including provision for improvement of services such as probation (*see* also Borstal System). Most advanced nations have adopted juvenile court legislation of some type, including France (1912), Germany (1923), Spain, Holland, Belgium, Austria, Hungary and the Scandinavian countries and Switzerland. Nations of the British commonwealth, such as Australia, Canada, South Africa and New Zealand, have well-developed systems. Juvenile courts may also be found in Israel, Iraq, Japan, various Latin American nations, and in many other countries. As might be expected, there are great variations in the theory and provisions of these statutes. The extremes are illustrated by the laws of England and Sweden. The former provide for tribunals with procedures very much like those of the ordinary criminal courts. Sweden, on the other hand, has established administrative boards, known as child welfare councils, which are not bound by the procedures or rules of evidence associated with the judicial process.

The movement leading to the establishment of the juvenile courts was founded on articulate and well-grounded dissatisfaction with the methods then generally employed in dealing with juvenile offenders. It is clear that the reforms were intended to be radical and far-reaching. A new tribunal of nonpunitive orientation was to be established. The juvenile court was described by a distinguished U.S. judge, Edward F. Waite, as one concerned with "doing something for a child because of what he *is* and *needs*." The concept of crime was deemed inapplicable to juvenile misconduct; instead, a new label, delinquency, was devised. The treatment afforded the child, as stated by the Illinois act, should "approximate as nearly as may be that which should be given by its parents." To achieve the ends of guidance and rehabilitation, substantial contributions were anticipated from such emerging behavioural disciplines as psychology, psychiatry and social work. In legal contemplation the child was conceived as a ward of the court and subject to the authority of the state in its role of *parens patriae*. Procedures were to be modeled upon those employed in courts of chancery. They were to be informal and adapted to the rehabilitative objectives of the court.

Juvenile court legislation in the United States varies considerably in its terms and in the degree to which the underlying philosophy of the juvenile court movement is given statutory expression. In most laws the definition of the basic term "delinquency" is broad and, in some respects, vague. Typically the concept includes not only acts that are otherwise defined as criminal but many that do not result in sanctions if committed by adults, such as associating with immoral persons or incorrigibility. The upper age limits of children subject to the jurisdiction of the court vary between 16 and 21, but the usual provision includes those below the age of 18. In some states the juvenile court has original jurisdiction over all cases of juvenile misconduct, but in many of these its jurisdiction may be waived. Others limit the court's jurisdiction by excluding cases of offenses punishable by death or life imprisonment. A few states grant no exclusive jurisdiction to the juvenile court except in cases of children below the age of criminal capacity. In such states children may be tried either before the juvenile court or the ordinary courts of criminal jurisdiction. Many juvenile courts have been given responsibility for the protection and care of neglected and destitute children as well as delinquents. Frequently adults may be tried before the court for contributing to the neglect or delinquency of children. Legislation typically contains provisions for the initiation of proceedings, detention of children whose cases are awaiting disposition, procedures to be employed in the hearings and the modes of treatment that may be applied. Some states have created family courts with jurisdiction over a wide range of issues involving domestic relations as well as those ordinarily within the competence of the juvenile court. An increasing number of courts have been created with procedures in some respects similar to those of the juvenile court but with jurisdiction over youthful offenders above juvenile court age.

Despite the rapid acceptance of the juvenile court in the United States and throughout the world, serious problems have attended its operations. It is clear that many of the hopes and expectations of those who were part of the juvenile court movement in its early stages have not been fully realized. The reasons are many and complex. In some jurisdictions the juvenile court has not received appropriate financial and public support. One result has been that the personnel of the court is not always sufficient in numbers or of adequate quality. In many urban communities the social workers staff, which is relied on to secure needed information for sound disposition of the cases and to provide probation supervision of many of those adjudged to be delinquent, is required to assume case loads so burdensome as to preclude proper performance of its functions. Salaries are often too low to recruit and retain persons of proper training and experience. Frequently, adequate medical, psychiatric and counseling services are not available to the court. Public and private institutions for the commitment of children requiring confinement are often limited in number and restricted as to type. In some jurisdictions the methods of selecting the judge are inadequate to insure leadership by competent persons sympathetic with the objectives of the court. Certain fundamental and elementary objectives, such as separating adult from juvenile offenders during periods of detention, are not always fully attained.

The juvenile court has also been criticized on other grounds. One of the most important questions which has been raised with increasing frequency in the United States since World War II relates to the procedures employed by some juvenile courts in delinquency hearings. One fundamental objective of the founders of the juvenile court was to create a tribunal with procedures substantially different from the formal adversary processes of the criminal courts. Many critics have asserted that the tendency toward informality sometimes leads to carelessness in determining whether the child has committed acts that constitute delinquency. The problem may be aggravated by the vagueness of statutory definitions of delinquency, lack of precision in the language of petitions charging juveniles with delinquent conduct and absence of provisions for the appointment of counsel to represent the interests of indigent persons before the court.

When it established a new state-wide family court in 1962, New York attempted to meet such criticisms by providing a substantive definition limiting juvenile delinquency to acts that would be crimes if committed by adults. A separate new category of "persons in need of supervision" was created to handle cases involving truancy, incorrigibility and other acts formerly classified as juvenile delinquency.

The Family Court act also provided for a system of "law guardians" to represent juveniles and required that the court must advise juveniles of their rights to counsel and of their right to remain silent—rights ordinarily available only under criminal procedure.

In many other jurisdictions genuine progress has been made in improving the functioning of the court and integrating its operations with other essential programs relating to juvenile delinquency. The juvenile court remains one of the most important social inventions of the modern period.

See also JUVENILE DELINQUENCY; CHILDREN, LAWS CONCERNING; CHILD WELFARE.

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CHILDREN'S GAMES AND SPORTS. As a child grows up and learns to play the traditional children's games and sports, he is in a sense often re-enacting the childhood of the human race, for children's games have preserved a glimpse into the prehistoric customs of the past. The "work" of adults in one age becomes the "play" of children in another, through children's imitation of the magical rites and marriage and burial customs of their elders. The study of the origins of children's games is a fascinating and distinct branch of anthropology, ethnology and folklore. For example, Oats, Peas, Beans and Barley Grow is a singing and acting game that had its origins in prehistoric fertility rites at the time of spring planting; the jump step of the game derives from the magical belief that the crops would grow as high as the dancer could jump. The French game of *L'Avoine* carries out all the motions of sowing, reaping, binding and threshing the crop. The Mulberry Bush, beloved by every kindergartner, is a survival of ancient spring festival dances in which the Maypole, or a sacred bush, is encircled by the dancers.

Other children's games, especially such team pursuit games as Prisoner's Base or We Are the Romans, derive from children's imitation of the skirmishes and warfare of adults. The game of tag (Tig, Tigge) may have had its origin in adult flight from an evil spirit, witch or devil, from whom one was safe if one touched wood or iron; this belief is preserved in such popular names for tag as Touch Wood, Horney and *Die Hexe Kommt* ("the witch comes"). The preservative magic of touching wood may have come from a pagan belief in the magic power of sacred trees. Iron is "safe" because, according to folklore, fairies and sprites are said to fear iron "more than any earthly thing."

Games are a distinct species or form of play, varying from the simplest pastimes to the most complex, organized and ritualistic team games and sports. There are informal play activities that seem to develop spontaneously in every country, the most notable being that of ball-playing. No doubt the first balls were stones, given magical significance by primitive peoples. It is said an ancient Gaelic game of lobbing stones gave rise to cricket. The early American Indians made balls of yucca leaves, the Eskimos used animal skin stuffed with reindeer moss. Balls of stitched skin filled with bran have been found in Egyptian tombs. The loveliest classical allusion to the game is found in book vi of the *Odyssey*, where "white-armed Nausicaä" plays ball with her maidens. Two ball games in progress are shown in relief on a relic of 5th-century B.C. Athens. Both are team games, played with curved, hockey-type sticks.

Leapfrog seems to be as old as it is universal. The *Satyricon*, a 1st-century A.D. work ascribed to Petronius, describes how a boy climbed the back of Trimalchio and cried out, "Bucca, bucca, quot sunt hic?"—the very game that English boys play, crying, "Buck, buck, how many horns [fingers] do I hold up?" The same refrain is used in an old parlor game of Forfeits.

Very few children's games can be said to be "invented"; they evolve spontaneously from generation to generation, in response to children's innate urge for playful activity. There are regional as well as national differences in games, but it is very common to find the same form of play, although often under different names, in different countries. Blindman's Buff, for example, is universal, and as late as the 17th century was played by adults. In Shakespeare's day it was called Hoodman-Blind, as the Elizabethans reversed their hoods to play. The *Menagier de Paris*, a 14th-century treatise for the instruction of a young wife, describes ladies playing tiers, or Blindman's Buff, and it is mentioned by Rabelais as one of the games that Gargantua played as a child. The early Egyptians played it, as did the ancient Greeks, who called it the Brazen Fly. The Romans called it *migare dicitis*, the modern Italians, *Mosca cieca*. The German version is Blind Cow; the Spanish, Blind Hen.

Tops, hoops and kites are ancient and universal playthings. Virgil in the *Aeneid* speaks of whirling tops lashed around empty courts, and American Indian children and Eskimos were expert at spinning their tops on ice. Chip Stones and Peg in the Ring were English top games, and in Japan top spinning or *koma asobi* continues to be an art. In spring, the exiled Ovid recalled, "Nunc pila, nunc celeri volviture orbe trochus" ("Now flies the ball, now rolls the whirling hoop"), and Roman girls skipped ropes made of vine leaves. (*See* also GAMES, CLASSICAL.)

The continuity of culture is reflected especially in the dramatic and singing games and pastimes, some of which originate in antiquity. One of the most famous is the Swallow Song of Rhodes. In ancient Greece bands of boys went from house to house in early spring, singing the song for reward. Greek boys still follow this custom each March 1, carrying a wooden swallow on a pole. Hunting the Wren, when boys come round with a live wren and sing for goodies, is still observed at the winter solstice by boys in the west of Ireland. A feather from the wren is kept as a charm, especially against shipwreck.

Many games still played by children once had magical significance. Draw a Bucket of Water hints of old well-worship rites. One of the many "arch" games played by children, London Bridge (*Brö Brö Brille* in Scandinavia, *Pont-Levis* in France) refers to the ancient custom of offering a human sacrifice at the foundations of bridges and buildings. The burning of a dummy on Guy Fawkes' day in England goes back beyond its obvious political reference—the Gunpowder plot (*q.v.*) of 1605—to pagan fire festivals at the winter solstice, when a propitiatory human sacrifice was offered. The popular nursery singing action game of Looby Loo, beginning "I put my right hand in," probably refers to an ancient rite with religious significance.

Other songs and ceremonials once part of adult life have also been spontaneously imitated and preserved by children through their innate love of dramatic play-acting. The ubiquitous ring games (*rondes* in French, rounds in the Middle English period) often lead back to primitive fertility rites and marriage customs. Go In and Out the Window, Poor Mary Sits A-Weeping and Sally Waters are singing marriage games. Drop the Handkerchief and Nuts in May represent the prehistoric custom of marriage by capture. The "nuts" of Nuts in May is a corruption of knots, or bunches of May flowers. Bunches of hawthorn were picked on May day to decorate the Maypole, the doors of houses and the "kissing bush," a relic of pagan worship of sacred trees and groves. A singing game called Posies is mentioned by Athenaeus, the Greek rhetorician (2nd century A.D.), and clearly resembles Nuts in May. Another curious survival of ancient spring festivals is the American folk game of Green!, derived from the old English game in which the person must be wearing something green or pay a forfeit.

One of the best-known funeral games is Jennie Jones, or, more properly, Jennie Jo (from the Scots *jo*, "sweetheart"). A long and complicated dramatic song carries the heroine through various domestic tasks to her death, then discards one colour after another until black is chosen for her funeral.

Thus, behind a popular kindergarten game or a casual game of tag may lie thousands of years of human custom. But the child absorbed in play is oblivious to all except the fun and joy of taking part in the game. Games are the child's first joining in group activity—one can almost say, in the human race. In the effortless, exhilarating act of playing with other children, he learns social interaction with his fellow beings and begins the first steps toward civilization and self-control. Games provide a natural outlet not only for his excess energy but also for his tensions, aggressions and emotions. As he grows older and takes part in more organized games and sports, he learns the principles of fair play and courtesy, of abiding by pre-arranged rules, and he learns to accept defeat as well as success with some degree of equanimity. Motivated by the sheer love of sport, he all unconsciously learns to join others in moving toward a common goal; his childhood ability to play with others will become his adult ability to work with others. It has been truly said that a child is not "playing" but "working"—toward becoming an adult. That is why children take their "games" so seriously, in a way adults often fail to grasp. (*See* also ELEMENTARY EDUCATION.)

Games Around the World.—For centuries box kites and bird and butterfly kites have been flown by boys in China, who glue ground glass to their kite string and try to cut down their opponents' kites, exactly as do boys in India. In Japan on the Boys' Festival on May 5, boys fly their kites, fence with curved wooden swords, wrestle, and race sailboats. In Europe and the United States, building and flying model planes is popular with boys in spring, and Mumblety Peg, played with a pocketknife, makes its annual appearance then.

Marbles, another traditional spring game, was played by the Romans, and was probably brought to Britain by the Roman legions. The first marbles were undoubtedly round pebbles with distinctive markings; now they are made of baked clay, glass, steel, marble and agate ("aggies"). There are many variant games, the "champ" game, often called Ringtaw, being played in a circle ten feet in diameter, with 13 marbles forming a cross in the centre. Each player "knuckles down" or touches one knuckle to the ground and, using his special "shooter," tries to strike the marbles out of the ring. Play is often "for keeps," each boy winning the marbles he knocks out. Variant games are Nine Holes and Hit and Span. Local children make up their own games and rules, passing them to the next generation. Marbles are a favourite sport with boys the world over—in India, when the rains begin and the dust settles; in Brazil, where they play *Gude;* in Africa, where they play *Jorrah*. In Iran, Turkey and Syria the game is played with knucklebones of sheep or balls of baked clay. Chinese boys play "kicking the marbles."

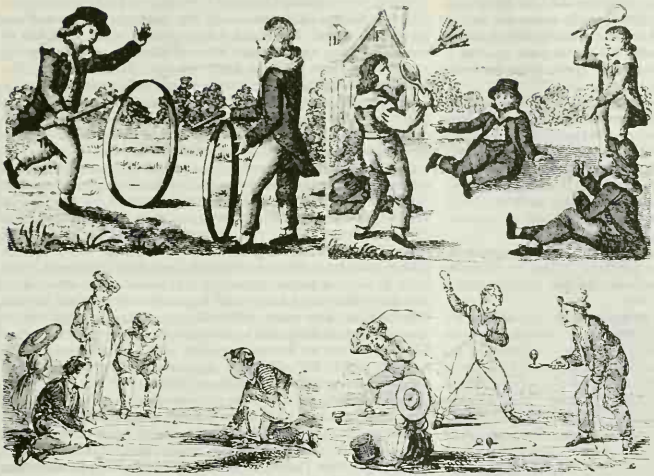
In Africa children play their version of London Bridge as a hunting game, the last one caught being "the only child." Greek boys play a game mentioned by Plato—Black and White, a tug of war derived from ancient political parties—and they also play exactly the same Duck on a Rock beloved by generations of Irish and English boys. In India boys enjoy *Guli Danda*, played with a ball and a bat; *Gul Tara*, "throwing to the stars," and Seven Tiles or *Atya-Patya*, both active team games. Japanese girls are fond of *Otedama*, juggling little bags of rice.

The Hawaiians at the Makahiki, or festival of games, bowl the *maika* stone. In the Philippines youngsters play *Bagal* by kicking a coconut shell. In Mexico one of the children's favourite games is Angel and the Devil, or the courting game, *Las Calabazas* ("the gourds"). Russian children enjoy Ting-A-Ling, derived from a legend of Moscow, the city of bells.

Children in every land play tag, with its countless variations. In India a player cannot be caught if his forehead touches the ground. In Japan—and Scotland, too—he must hold onto the spot where "It" tagged him. In the U.S., he is safe if he stoops, in stoop tag. In Russia he can join in *Gorelki*. In Israel children play a tag game called *Deeb* or Wolf, with the wolf chasing sheep. Italian children play Wolf and Lamb; Chinese children love to play Cat and Mouse.

Hide and Seek is another universal game, and one that readily lends itself to many variations. In Japan it is called *Kakurembo;* in Korea, *Syomu Pak Kakomu Tjil Hat Ki!* Counting out to decide who is "It" is a part of many games, and nonsense rhymes such as "Eeny, meeny, miney, mo" and "1–2–3 alaree [O'Leary]" are widespread. In Japan the boys and girls count out by the same finger game used in Europe, Paper-Scissors-Rock, or *Jankenpon*. Skipping rhymes are handed down from generation to generation, with new variants in every locality. (For an interesting modern study of the transmission of such material, see Iona and Peter Opie, *The Lore and Language of Children* [1959], based on observation of a selected group of British children aged 6–14.)

Finger games are popular around the world. Chinese children play a game with loops of grass blade, Borneo children play the fibre game. Japanese children love to fold paper figures, a craft called *origami*. Cat's cradles have reached a peak of artistry among primitive peoples, such as the American Navahos, the Eskimos and the natives of the Guianas, Cape York and Ghana. Among the Eskimos, the game is thought to have magical power.



(UPPER LEFT AND RIGHT) FROM "YOUTHFUL SPORTS" (1801); (LOWER LEFT AND RIGHT) FROM W. CLARKE, "THE BOY'S OWN BOOK" (1838) ALL BY COURTESY OF THE OPIE COLLECTION

CHILDREN'S GAMES AS PLAYED IN THE EARLY 19TH CENTURY: (UPPER LEFT) HOOPS; (UPPER RIGHT) SHUTTLECOCK; (LOWER LEFT) MARBLES; (LOWER RIGHT) TOPS

They play it at certain seasons of the year, making string figures such as "Seal Holes," "Two Polar Bears" and "Caribou in the Willows," and they believe in a "Spirit of String Figures" who can be driven away by making the figure "Opening A." Making string figures during the hunting or fishing season is taboo, however, for fear that the boys and men will become entangled in their harpoon lines.

Shuttlecock is found in different versions in different lands. The American Indians played *Onumba* with paddles and a twig tied with feathers. In China children kick a shuttlecock made with feathers and a piece of cash (a coin with a square hole in the middle). The game of Jackstones is also played all over the world, with any suitable object—pebbles, nuts, beans or metal jacks. In the very old game of Fives or Knucklebones, from which Jackstones descends, five pebbles or bones were tossed up in the air and caught in different ways.

Wherever there is snow and ice, winter sports are enjoyed by children. Skiing and skating are as popular with them as with adults; sledding is another lively winter sport. Many group games can be adapted to snow-covered ground—Fox and Geese, for example, with safety zones tramped out in the snow. Snow-Snake, a game of throwing sticks on snow, and Saddle Bags or Sky Shinny, a game somewhat like lacrosse (which comes from the American Indians), were favourites with American Indian children. The Eskimos played shinny on the ice with a ball of walrus tusk and sticks of walrus bone.

Holidays that are celebrated in different countries frequently have similar customs associated with them. *See,* for example, HALLOWEEN and CHRISTMAS.

Playing the games of other children in the world, if not with them, helps a child to build a foundation of understanding and acceptance. There are many collections of games from different countries, including Frances W. Keene's *Fun Around the World* (1955); *Children's Games From Many Lands,* edited by Nina Millen (1951); and Sarah Ethridge Hunt and Ethel Cain, *Games the World Around* (1941).

Outdoor Games.—Outdoors is the natural playground of the child. Especially popular games are simplified and informal versions of such games as softball, football and cricket (*qq.v.*), other ball games such as dodge ball, and team games such as Red Rover and Pom Pom Pullaway, which can accommodate almost any number of players on the two sides. Games that involve a great deal of running, such as various forms of tag, are good outdoor games; two favourite hide-and-seek games are Kick the Can and Sardines, where the players pile up in the secret hiding place. Many of the games played outdoors can be adapted to indoor rainy-day play in a gymnasium or recreation hall.

Water Games and Sports.—Many favourite sports, such as ball, tag and ring toss, can be played in the water and they encourage a child to develop his aquatic skills. Organized water sports are popular at camps and beach outings. A candle relay is played with lighted candles on blocks of wood, and in a water-treasure hunt the different treasures are placed at various water levels, encouraging a youngster to use his skills in diving and swimming. Water potato race, umbrella race, inner-tube race, balloon relay and break the balloon are aquatic adaptations of picnic games. Various tag games can also be played in the water. Simpler lake and seashore pastimes are skipping stones, playing Waves and Gatherers tag with shell collections, and racing toy sailboats.

Nature Games.—On picnics, hikes and at camp, children's games take on a new colouring from the world of nature. I Spy and See What I See are hiking games. Bird alphabet and nature lotto can be played at rest or while walking. Hare and hounds, treasure hunt and tree tag, where certain kinds of trees are "safe," are camp favourites. Many woodcraft contests are possible and are especially popular on camp field days. Traditional around the campfire are songs, skits, charades, group storytelling (begun by one person and continued by each participant in turn), riddles, 20 Questions and similar games.

Picnic Games.—Organized games and skill contests add to the fun of picnics and family outings. This is the time for team or relay races such as the sack race, in which each player stands in a burlap bag and hops to and from the goal, or the egg and spoon relay, in which the object is to get to and from the goal in the shortest possible time without dropping an egg carried in a spoon. Pitching horseshoes is a tradition at American picnics, as are singing and guessing games around the picnic fire.

Indoor and Parlor Games.—Parlor games are as old as the habitations of men. Sitting around the fire telling stories and playings games, singing and dancing are still favourite pastimes. Many of the old favourites of Victorian days, such as Charades (or "the Game"), 20 Questions, Concentration, Who Am I?, Scrambled Proverbs and Mind-Reading Magic, are still enjoyed. Word games, such as Ghost, Anagrams, Limerick Contest, Advertising (in which players recognize current slogans) and I Love My Love With an A, interest children of seven years and up. Favourite paper games are Dots, Hangman, Consequences, Ticktacktoe, Categories, Hidden Words and Salvo (Battleships). Games played round the table by generations of funlovers are Up Jenkins, Simon Says, All The Birds Fly (versions are found round the world), Do As I Do and Gossip. Another favourite parlor game is stunts, in which each player or couple must perform a stunt, usually within a time limit set by the master of ceremonies. The games of Forfeits and of Hot Cockles, in which the player tries to guess who slapped his outstretched palms, are centuries-old; the Egyptians are said to have played the latter. Lively group games are broom hockey, balloon volley ball, musical chairs and Going to Jerusalem. A traditional ice-breaker is "Who Am I"?—each guest wearing a card on his back with the name of another guest, which he must discover through conversation.

Leading Children's Games.—Directed play broadens a child's interests, both by teaching him new games and by teaching him how to play, and because it aims at involving all those present, it is particularly valuable in building group feeling. Resource books in this area are abundant and can be helpful for the parent planning a party as well as for the professional or volunteer recreation leader. Most such books include suggestions on how to lead as well as directions for particular activities suitable for various age levels.

Situations in which children cannot be active—such as traveling for an extended time or being confined to bed by illness—require special planning. Resource books helpful for such situations are included in the Bibliography.

See also PLAY, ANIMAL; articles on sports, such as BASKETBALL, SWIMMING and WINTER SPORTS; articles on games, such as CHECKERS, CHESS, HOPSCOTCH and JACKSTONES; and related activities such as ARCHERY, CHARADE, KITES and ROLLER SKATING.

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CHILDREN'S LITERATURE may be said to include all books written especially for children, other than textbooks (*q.v.*), and also the many books written for adults which have been widely read by children. The fascination of a story is as old as the human race itself, but the production of literature especially for young readers is modern, coming after the development of printing and book production, which in itself is a modern development (*see* BOOK). The following account of children's literature is mainly historical, tracing its development in Great Britain and the United States from Elizabethan times onward.

The Beginnings.—One of the first books intended for children was produced by William Caxton (*q.v.*), England's first printer. This volume, called *A Book of Courtesy* (1477), is now a scholarly curiosity, but Caxton's books intended for adults, including *Reynard the Fox* (1481), *Aesop's Fables* (1484) and his edition of Sir Thomas Malory's *Morte d'Arthur* (1485), are still read by children in modernized versions. *Aesop's Fables*, gathered from Egyptian and oriental sources, went through many hands before being collected by a 15th-century German, Stainhowel, translated into French by a monk of Lyons, Jules Machault, and at last put into English by Caxton. The tales of King Arthur came from the Welsh hero tales *The Mabinogion* (*q.v.*), and were paraphrased by Geoffrey of Monmouth and others (*see* ARTHURIAN LEGEND). Malory's version was written during his 20-year imprisonment in London, where he had access to the Greyfriars library, founded by Richard Whittington (*q.v.*), better known to children as "Dick Whittington, thrice Lord Mayor of London." Caxton altered Malory's text to suit his own needs, and for centuries the original manuscript was lost. It was not until 1934 in Malory's "Camelot," the city of Winchester, that the original manuscript was found in the library of Winchester college.

During the first century after the invention of printing, reading and writing were arts still largely confined to the clergy and to clergy-trained clerics who kept records and accounts. With the wider production of books, literacy increased and more children, particularly boys, were taught to read, not for pleasure but to help teach them morals and religion.

Of the few surviving 16th- and 17th-century books then read by children, *Aesop's Fables* was easily the most often translated and the most popular. The *Gesta Romanorum* (*q.v.*), a scrap bag of tales and fables, although not now considered a children's book, was read by them until the 18th century. As the limits of the known world expanded through the voyages of explorers, books of travel and adventure such as the *Voyages* of Richard Hakluyt (*q.v.*) appealed to children as well as to their elders. They also enjoyed Plutarch's *Lives*, which appeared in the well-known English translation by Sir Thomas North in 1579.

One of the earliest examples of the attitude that recreational reading was morally dangerous and might lead to idleness and "false beliefs" is found in Hugh Rhodes's *Book of Nurture* (*c.* 1545). He warns parents especially to keep their children from reading "feigned fables, vain fantasies, and wanton stories, and songs of love, which bring much mischief to youth" (F. J. Harvey Darton, *Children's Books in England*, Cambridge University Press, 1958, p. 45). A century later the Puritans held the same views, and the followers of Locke and Rousseau saw no good in such frivolities as fairy tales. Nevertheless, pedagogues believed in sugar-coating learning, and as early as the 18th century a rhymed alphabet "A was an Archer" appeared in *A Little Book for Little Children* by "T. W." The only copy extant, although undated, is believed to have been printed about 1712.

In spite of opposition among schoolmasters and clergy, exciting tales were available to children through the chapbooks (*q.v.*)—ill-written, badly printed, poorly illustrated booklets containing versions of such popular stories as "Robin Hood," "Jack the Giant-Killer" and "Tom Thumb." The earliest chapbooks probably came into existence in the 17th century, and by the middle of the 18th century they were being published all over the British Isles. Chapbooks even found their way to America, and some were reprinted there. One of the richest sources for chapbook stories was the work popularly known as the "Arabian Nights" (*see* THOUSAND AND ONE NIGHTS), brought to Europe in a French edition by Antoine Galland in 1704–12. Many of the stories, including those of "Ali Baba and the Forty Thieves," "Aladdin and His Lamp" and "Sinbad the Sailor," were soon translated into English and used in the chapbooks.

The paper in these booklets, though inexpensive by the standards of their times, has survived better than pulp paper of the 20th century, despite the fact that the books were almost literally read to pieces. Although many of them were unsuitable for children from a modern point of view—for the chapbooks were often coarse and outspoken, as well as brutal—these booklets furnished the most accessible reading for children for many years.

At the same time children's morals were not neglected. The so-called "Puritan" books, written to instruct, to save and to counteract those dangers of romance, adventure and other "nonsensical writings," were common at the same time as the later chapbooks. Many of the religious writings for children were didactic and oppressively narrow in their attitudes. Since from the Puritan point of view children were "not too little to go to hell," it is not surprising that parents should try to save them from damnation by exposing them to such books as James Janeway's popular *A Token for Children: Being an Exact Account of the Conversion, Holy and Exemplary Lives, and Joyful Deaths of Several Young Children*, and John Foxe's *Book of Martyrs*. Children apparently read many of these religious, moral tales, and some may even have enjoyed them. They at least satisfied a taste for the morbid, quite common among children, that is met in the 20th century by the horror "comic" books.

Out of Puritanism came the great writer John Bunyan (*q.v.*), whose *Pilgrim's Progress* was at once adopted by children. Although Bunyan deplored his own youthful reading of "vain" literature such as chapbooks, he nonetheless wrote a "thriller," the stirring adventures of Christian in his search for the Celestial City —a religious allegory full of pious discussions but also full of excitement and suspense. The modern child would find the original, with its long moralizing passages, too slow to hold his attention, but the abridged version by Mary Godolphin with bold, dramatic, black-and-white illustrations by Robert Lawson (1939) is still being read. Bunyan's attempts to write especially for children were less successful, though his verses originally entitled *A Book for Boys and Girls* (1686), later published as *Divine Emblems*, were certainly given to children for many years.

Divine and Moral Songs for Children (1715) by Isaac Watts (*q.v.*), the great hymn writer, was far more successful with children, and indeed became one of the most popular books of its period, running through a hundred editions before the middle of the century. It was also very popular in the American colonies and was reprinted there many times. It is now virtually forgotten; in fact, two of his moral songs are more famous in their parodied form in *Alice's Adventures in Wonderland*—"How doth the little crocodile" for Watts's "How doth the Little Busy Bee" and " 'tis the voice of the Lobster" for Watts's " 'tis the voice of the sluggard"—than in their original form.

Despite the popularity of importations, probably the most widely printed book of the American colonies was a school book, the *New England Primer* (*q.v.*). Ascribed to Benjamin Harris, a London bookseller who came to Boston, Mass., in 1686, the book went through numerous editions. It has been estimated that the number of copies printed between about 1690 and 1830 must have been over 6,000,000.

18th-Century Classics.—Some of the most enduring favourites among children's books date from the early 18th century. One, Daniel Defoe's *Robinson Crusoe* (1719–20), took an early lead in popularity and continued to be in demand. The first part was pirated and made into an abridged edition within four months of publication. Another abridged edition, published in 1722 by Edward Midwinter, became so popular that Defoe eventually bought a share in the abridgment. Most 20th-century editions for children are also abridged, some badly, others more acceptably.

The popularity of *Robinson Crusoe* was so great and the book had so many imitations that they were called *Robinsonnades* by French bibliographers. One of the best was *Adventures of Philip Quarll* (1727) by "Mr. Dorrington" (a pseudonym for Peter Longueville). There was also the still-popular *Swiss Family Robinson*, published at Zürich in two parts in 1812–13 by Johann David Wyss; an English translation by William Godwin, Shelley's father-in-law, appeared in 1814, and it has been suggested that Shelley helped in the translation. Later a French version was made by Mme de Montolieu, who added several incidents with Wyss's condescending consent, and the story was again added to by W. H. Kingston, in the version generally published now. In spite of its wordiness, unscientific "science" and prayerful interruptions, it is still popular.

Jonathan Swift's *Gulliver's Travels* (1726), like *Pilgrim's Progress*, was intended as an allegory for adults, but was also read by children for its breathless excitement, its daring voyages and its strange lands and people. Most versions for children include only the voyage to Lilliput and delete the savagely satirical material on Brobdingnag, the island of Laputa and the land of the Houyhnhnms and the Yahoos.

Philosophy and Plum Cake: John Newbery.—John Locke's *Some Thoughts Concerning Education* (1693) is among the first books on educational theory to consider the child as something more than a miniature adult. Locke's observations, made during his experiences as a tutor of several children, had great impact both in England and on the continent, and had a direct effect on children's books through John Newbery (1713–67), for whom the Newbery medal is named. The son of a Berkshire farmer, Newbery moved to London in 1744, finally settling at St. Paul's Churchyard in his shop "Bible & Sun," in 1745. His friend Oliver Goldsmith describes him in *The Vicar of Wakefield* as a philanthropic bookseller who wrote many books for children and was always rushing from one thing to another—for he also sold "fever powders" and other items. Though he was not the first bookseller to specialize in books for children, Newbery is perhaps the best known; his special gift was publicity and he was one of the first successful book advertisers.

In 1744 Newbery brought out *A Little Pretty Pocket Book* designed especially for children: small enough for childish hands to hold, and probably bound in the Dutch gold floral boards used so often on his later books. No copy of the original edition exists, but the first American edition, published in 1784 by Isaiah Thomas in Boston, has been made available to the public in facsimile.

Although Newbery liked to please children, he always considered the parent or nurse who held the purse strings. In *A Little Pretty Pocket Book* he addressed instructions to the nurse on the care of children, and he did not neglect to insert moral admonitions, of a gentler kind, however, than the fearsome precepts of the Puritans. Good merchant that he was, he encouraged the idea of material reward for virtue, and his slogan "Trade and Plumb Cake forever, Huzza" might well apply to Newbery himself.

Newbery was also credited with the publication of *Mother Goose's Melody; or Sonnets for the Cradle* (*c.* 1765), which was reprinted in America about 1785, and at least twice has been reprinted in facsimile from that edition. The date of the original edition remains conjectural, as the earliest surviving copy is dated 1791. It was not the first book of nursery rhymes published but was apparently the first to use the term "Mother Goose" for rhymes instead of tales.

Several other books of nursery rhymes appeared during these years: *The Famous Tommy Thumb's Little Story-Book* (*c.* 1754), reaching America in 1758; a collection entitled *The Top Book of All* (*c.* 1760); and *Gammer Gurton's Garland* (1784).

The authorship of one of John Newbery's most important publications, *The History of Little Goody Two Shoes* (1766), is often attributed to Goldsmith. Newbery also published the *Lilliputian Magazine*, significant as a forerunner of later children's magazines although it lasted only a year (1751).

Books of all kinds were also being published for children in Europe, according to an amusing footnote in Percy Muir's *English Children's Books, 1600–1900* (1954), which quotes a German schoolmaster who visited the Leipzig Book fair in 1787: "No other form of literary Manufactury is so active for young people of all grades and classes . . . Almanacks . . . newspapers . . . journals . . . collections . . . stories . . . comedies . . . dramas . . . geography . . . history . . . physics . . . logic . . . for children, and unlimited variations on the same theme, so that the literary doll shops are crammed all the year round . . . but especially . . . when loving parents and aunts and uncles may be attracted by the appositeness of the notice 'Christmas Gifts for good children!' " (used by permission of the publisher, Frederick A. Praeger, Inc., 1954). He lists nearly as many categories as one would find in the 20th century, with the exception of space travel.

Rousseau and Didacticism.—The great social changes of the latter half of the 18th century had their effect on writers of children's books. Particularly influential were the ideas of Jean Jacques Rousseau (*q.v.*), whose *Émile* (1762) fascinated a generation of educators. Locke believed that children should be invited, not beaten, into learning, using their natural curiosity as a stimulant. Rousseau believed that children should be accompanied into learning, with a wise teacher always at hand to answer questions and to clarify the situation when the self-taught child becomes confused. Other writers, taking up Rousseau's device of a fictional guide, created a multitude of parents, relatives and teachers who knew all and told all. As a result books became more didactic than ever. Even now the curse of the conversational uncle explaining the universe to the inquisitive child occasionally mars an otherwise good factual book.

During this time a group of female educators laid a heavy didactic hand on writing for children, not yet entirely lifted. The group included Sarah Fielding (1710–68), who wrote *The Governess: or, the Little Female Academy;* Anna Laetitia Barbauld (*q.v.*), who wrote *Hymns in Prose for Children* (1781) and had a masterly command of English; and Mrs. Sarah Trimmer (1741–1810), whose educational magazine for adults, *The Guardian of Education*, reviewed children's books, condemned all fairy tales and had considerable effect upon English education of the day. Another successful woman of the moral school of literature for children was Mary Martha Sherwood (1775–1851), whose *The History of the Fairchild Family* (1818–47) was still in print in the United States as late as 1931. A lighter touch was furnished by Catherine Sinclair, who infused a spirit of laughter and naturalness into her *Holiday House* (1839).

Maria Edgeworth (*q.v.*), another author for children much influenced by Rousseau, wrote stories that, although didactic, were skilfully plotted and show a genuine understanding of children. "Rosamond and the Purple Jar," one of her best-known tales, is contained in her first collection, *The Parent's Assistant* (1796).

Among the men affected by Rousseau's educational ideas were Arnaud Berquin (1749?–91) in France and in England Thomas Day (*q.v.*), whose *Sandford and Merton* (1783–89) was widely read for over a generation.

Charles Lamb wrote contemptuously of these writers to Coleridge in 1802. Yet he, with his sister Mary, was persuaded by his publisher, W. Godwin, to "rewrite" Shakespeare's plays for children and produced *Tales From Shakespeare* (1807), a book still available in numerous editions. Another book he and Mary Lamb wrote, *Mrs. Leicester's School,* more about than for children, was in print as late as 1949.

Verse and Poetry.—After Isaac Watts, verse for children seems sparse until the early years of the 19th century. The one brilliant exception, William Blake's *Songs of Innocence* (1789), was largely ignored at the time; not until the 20th century has it been considered an indispensable part of children's poetry. In the 18th century there was considerable question as to the value of poetry or verse for children; both Watts and Mrs. Barbauld doubted whether children had the ability to understand its artifices. The prejudice against it was finally broken down by the publication in England of *Original Poems for Infant Minds* (1804–05) by "Several Young Persons" including Ann and Jane Taylor (*qq.v.*). These gay, moral, "cautionary" rhymes for the nursery became vastly popular. Kate Greenaway illustrated the Taylors' poems in 1883, and Edith Sitwell wrote the introduction for a selection of their verses published in 1925 called *Meddlesome Mattie, and Other Poems for Infant Minds.* "Twinkle, twinkle, little star," the most famous poem either wrote, was included in their *Rhymes for the Nursery* (1806).

The first two popular books of "frivolous" verses, William Roscoe's *The Butterfly's Ball and the Grasshopper's Feast* with six coloured engravings after William Mulready, and Mrs. Catherine Dorset's *The Peacock "at Home,"* were both published in 1807. Their combined sale of 40,000 copies in their first year is a respectable one even in 20th-century terms. Cheerful, imaginative, good fun and charmingly illustrated, they inspired a number of imitators, but still remain somewhat outside the main stream of children's books of their time. Some of their popularity must have been due to their format: about four inches square, with large type and plenty of pictures. Although lithography was coming into use in children's books, these illustrations were done on copperplate, the colour being applied by hand.

The United States at this time seems to have been content for the most part to accept imported poetry, but two original American contributions to verse still popular are Sarah Josepha Hale's "Mary Had a Little Lamb" (1830), and Clement Moore's *A Visit From St. Nicholas* (1822), better known as *The Night Before Christmas.*

Fairy Tales and Fantasy.—In France, at the close of the 17th century, fairy tales became the rage at court. The most notable collection was Perrault's version of eight fairy tales, published in 1697 as *Histoires ou contes du temps passé, avec des moralités,* subtitled *Contes de ma mère l'oye.* The tales were "The Sleeping Beauty," "Little Red Riding Hood," "Bluebeard," "Diamonds and Toads," "Cinderella, or the Little Glass Slipper," "Hop o' My Thumb," "Puss in Boots" and "Riquet With the Tuft." They were ascribed to Charles Perrault (*q.v.*), a member of the Académie Française. Perhaps because Perrault felt it undignified to admit to their authorship, the tales were published as by his son Pierre Perrault d'Armancour, and their authorship has been much discussed; Percy Muir (see *Bibliography*) believes that the son was in reality the author, as the title page indicates. In any event, the tales were certainly traditional.

By 1729 Perrault was translated into English by R. Samber, although no actual copy earlier than 1741 has yet been discovered. In consequence some of the earlier English fairy tales, such as "Jack the Giant-Killer" and "Tom Thumb," took on lustre and were again permitted a hearing in polite circles.

Perrault's tales were but a sampling of the flood of folklore published in France. Two authors whose work is still read are Mme d'Aulnoy (*q.v.*) and Mme de Beaumont, whose stories include "Beauty and the Beast."

In spite of the influence of Perrault and the success of *The Butterfly's Ball* and imitations of it, English children's books in the late 18th and early 19th centuries became more and more moral and informational. Only a few collections of the older, well-known tales, such as *Popular Fairy Tales* (1818) edited by Benjamin Tabart, were still available.

Then the work of two German philologists, Jacob and Wilhelm Grimm (*qq.v.*), created a new vogue for fairy tales. Their *Kinder- und Hausmärchen,* published in Germany in 1812–15, was translated into English by Edgar Taylor, illustrated by George Cruikshank and published in England as *German Popular Stories* (1823–26). Grimms' fairy tales have remained in print and have been translated into various languages.

"Goldilocks and the Three Bears" is often attributed to Robert Southey because it appeared in his *The Doctor* (1834–37), but an original manuscript of "The Three Bears" written and illustrated by one Elizabeth Mure, dated Sept. 1831 and now in the Osborne collection of the Toronto public library, Toronto, Ont. (see *Bibliography*), claims the story to be an old folk tale.

Hans Christian Andersen (*q.v.*), the Danish genius whose impact on children's literature is still felt, appeared in English first in Mary Howitt's translation of *Wonderful Stories for Children* (1846). Translations soon appeared in America, and the stories have been available for over a hundred years, in many languages, English translations and editions. The M. R. James translation (1930) gives the sources of some of Andersen's tales. Seven were genuine Danish folk tales, such as "The Wild Swans." Most of the rest, such as "The Tinder Box," Andersen claimed to have heard as a child, but "The Emperor's New Clothes" is from a Spanish source, and several, such as "The Steadfast Tin Soldier," are original.

With increasing interest in this kind of story, fairy tales began to be gathered from many sources. Anthony Montalba's collection of *Fairy Tales of All Nations* (1849) was illustrated by Richard Doyle. Annie and Eliza Keary's translations from the Norse, *The Heroes of Asgard* (1857), and Sir George Dasent's translation (1859) of the Norwegian folk tales collected by Peter Asbjørnsen (*q.v.*) and Jørgen Moe appeared first in England, then America. Mary Frere collected Hindu tales in *Old Deccan Days* (1868). It appeared in the United States in 1869. A selection of 12 stories edited and illustrated by Katharine Pyle, entitled *Fairy Tales From India,* was published in the U.S. in 1926.

Probably the most comprehensive collections of folk and fairy tales and original fantasy were gathered by Andrew Lang (*q.v.*) in numerous volumes named for various colours beginning with *The Blue Fairy Book* (1889). Lang also wrote some original tales. Joseph Jacobs (1854–1916) not only collected stories for his volumes of *English Fairy Tales* (1890), *Celtic Fairy Tales* (1891), their sequels and others but, like Lang, adapted and retold them as he felt necessary—especially those told in dialect or found in chapbooks, ill-written in the first place. Both Lang and Jacobs were scholars, and they based their changes on a sound knowledge of variants found in all folklore. Early editions contained notes regarding changes.

U.S. writers also contributed to the rising interest in folk literature, especially in myths and legends. Washington Irving gave children his original stories, "The Legend of Sleepy Hollow" and "Rip Van Winkle"; Nathaniel Hawthorne's *A Wonder-Book* (1852) and *Tanglewood Tales* (1853) contained stories from Greek mythology considered suitable for children. Shortly thereafter appeared Thomas Bulfinch's famous *The Age of Fable* (1855), which in revised and enlarged form is still found in many libraries. In *Uncle Remus: His Songs and Sayings* (1880) Joel Chandler Harris (*q.v.*) brought American versions of Negro folklore to children.

Original fairy tales sprang up everywhere. *Le Avventure di Pinocchio* (1882), by Carlo Collodi (pseudonym of Carlo Lorenzini), the story of a puppet who comes to life, was first translated into English in 1892 and has appeared in many editions. Among the distinguished English authors who wrote for children were Charles Dickens; John Ruskin, whose *King of the Golden River* (1851) is a spirited fairy tale with a sombre fascination; and William Makepeace Thackeray, whose *The Rose and the Ring* (1855) is a gay nonsense tale. Charles Kingsley (*q.v.*) retold Greek myths in *The Heroes* (1856), but is even more famous for his original story *Water-Babies* (1863).

Of all the writers of original fantasy, Lewis Carroll (pseudonym of Charles Lutwidge Dodgson; *q.v.*) is probably the most acclaimed. *Alice's Adventures in Wonderland* (1865) and *Through the Looking-Glass* (1872) are known not only in English but in many other languages, despite the difficulty of translation. Both were brilliantly illustrated by John (later Sir John) Tenniel after Carroll's own illustrations for his original manuscript *Alice's Adventures Under Ground*, first published in facsimile in 1886. None of Carroll's other books equaled these first two in fame, although *The Hunting of the Snark* (1876) is well known, and *Sylvie and Bruno* (1889–93), *Phantasmagoria and Other Poems* (1869) and *A Tangled Tale* (1885) have their devotees.

Nonsensical writing for children had not been unknown before Lewis Carroll's work. *Old Mother Hubbard* and *Dame Wiggins of Lee* and other nonsense nursery rhymes had appeared earlier. Edward Lear (*q.v.*) had written the *Book of Nonsense* (1846) and introduced children to such gloriously silly verses as "The Owl and the Pussy-Cat." He, like Lewis Carroll, invented nonsense words now a part of the language. Lear also illustrated his nonsense and gave the limerick (*q.v.*) its world-wide fame.

Earlier the tall tales of Baron Munchausen (*q.v.*) by Rudolf Erich Raspe had been translated from the German, as had Heinrich Hoffman's *Struvelpeter* or *Slovenly Peter* (1848), with its wildly coloured pictures and verses of "Awful Warning." Written by a German physician for the entertainment of his own children, it was subsequently translated into several languages.

George Macdonald, a friend of Lewis Carroll, wrote fairy tales of a different kind. *At the Back of the North Wind* (1871), *The Princess and the Goblin* (1872), *The Princess and Curdie* (1883) and the short tale, *Light Princess*, all have a serious undercurrent and an eerie sense of other-world happenings. Children of the 20th century still respond to the feelings of adventure, suspense and basic moral security of these stories.

There were also others in England writing original fantasy, such as Jean Ingelow, Dinah Maria Craik (née Mulock) and Oscar Wilde, whose *The Happy Prince and Other Tales* (1888) was outstanding for older children.

Among U.S. authors, Frank R. Stockton, Christopher Pearse Cranch, and most important Howard Pyle (*q.v.*) were writing original fairy tales and retelling old ones. Pyle not only brilliantly retold *The Merry Adventures of Robin Hood* (1883) and a four-volume version of the "King Arthur" stories, but also wrote his own folk tales in *Pepper and Salt* (1886), *The Wonder Clock* (1888) and *The Garden Behind the Moon* (1895). In 1919 *The Wonder Clock* sold six times as many copies as were sold the first year after publication. Fairy tales had come into their own.

Children's Magazines.—Although scores of children's magazines have been started, few have had a long or successful existence. Yet even among the short-lived ones, a considerable body of work by some of the more famous children's authors has appeared. Very few periodicals for children appeared in either the U.S. or Great Britain during the 18th century. In England, John Marshall seems to have made two attempts in his short-lived *Juvenile Magazine* (1788) and *The Children's Magazine*, begun in 1799. The first juvenile magazine in the U.S., also called *The Children's Magazine*, lasted only from Jan. to April 1789.

Near the beginning of the 19th century, *The Minor's Pocket-Book* managed to last about a dozen years in England. Jane and Ann Taylor were among its contributors. *The Child's Companion* began in 1824, lasting into the 20th century, and *The Children's Friend*, begun in 1825, was flourishing in the 1860s. These are probably the first long-lived, successful English magazines for children. Other early English children's periodicals included *The Infant's Magazine*, *The Youth's Monthly Visitor* and *The Youth's Miscellany of Knowledge and Entertainment*.

Among the earlier U.S. juvenile periodicals to have had some influence was *The Juvenile Miscellany* (1826–34), edited by Lydia Child.

In 1827 *The Youth's Companion*, a U.S. weekly, began its long and honourable career; it continued under its original name until 1929, when it merged with *The American Boy*, which continued until 1941. *Peter Parley's Magazine*, begun in 1832, was owned and edited by the original Peter Parley (pseudonym of Samuel Goodrich; *q.v.*), who also managed *Merry's Museum*, edited for a time by Louisa May Alcott. Goodrich's success both in the U.S. and England was extraordinary. He not only owned and edited magazines but was the author of at least 120 volumes of factual material for children, of which over 7,000,000 copies were sold during a 30-year period. He was widely pirated, and there were at least seven Peter Parleys in England, all adding to the flock of hack writing purporting to be his.

In contrast to Peter Parley with his emphasis on facts, Felix Summerly, (pseudonym of Sir Henry Cole) produced a set of books of fantasy in his *Home Treasury*, beginning in 1841, designed to bring back to English children their heritage of nursery rhymes and tales of folk and fancy. The battle between fact and fancy continues into the 20th century, although most persons concerned with children's literature believe there is a place for both kinds of writing, provided they are skilfully done.

By the middle of the 19th century, children's magazines became firmly established. In England the short-lived but excellent *The Charm* (1852–54) appeared, followed by the *Boy's Own Magazine* (1855–74) with well-known contributors and prizes. Thus began a spate of periodicals for children that lasted half a century. They included family magazines such as *Aunt Judy's Magazine* (1866–85) named by its founder, Margaret Gatty for her daughter, Juliana Horatia Ewing (*q.v.*), who was later its editor. Mrs. Ewing wrote as well as edited, and her first story appeared in Charlotte Yonge's children's magazine *The Monthly Packet* in 1861. In 1866 also appeared the first of the "penny dreadfuls," *The Boys of England*, edited by Charles Stevens.

The United States produced numerous children's periodicals, with contributions from many of the distinguished authors on both sides of the Atlantic. Lucy Larcom edited *Our Young Folks* (1865–73), in which appeared Thomas Bailey Aldrich's *The Story of a Bad Boy* (1870) and some of the humorous *Peterkin Papers* by Lucretia P. Hale. Other contributors included Louisa May Alcott, Theodore Roosevelt, Celia Thaxter, Mayne Reid and poets such as Longfellow, Whittier and Lowell. Later the magazine was sold to Scribners to become part of the even more famous *St. Nicholas Magazine* (1873–1939), which under the editorship of Mary Mapes Dodge, author of *Hans Brinker: or, the Silver Skates* (1865), gained world-wide fame. Established authors such as Kipling, Frances Hodgson Burnett, Howard Pyle, Sarah Orne Jewett, Mark Twain and Jack London wrote for *St. Nicholas*. In 1898 there was added to the magazine the St. Nicholas league, a section publishing original writings by young readers; among the many well-known authors of the 20th century who first appeared there were Edna St. Vincent Millay, Ring Lardner, Elinor Wylie, Bennett Cerf and Edmund Wilson.

The Riverside Magazine for Young People (1867–70), planned and edited by Horace Scudder in Boston, published 17 of Hans Christian Andersen's tales, some for the first time. Scudder learned Danish to be certain the translations were adequate. Scudder's anthology, *The Children's Book* (1881), was long the outstanding one in the United States, and his influence on children's literature was both worthwhile and lasting.

Harper's Young People, like *The Youth's Companion* a U.S. weekly, began in 1879 and continued for 20 years. Its editor, Kirk Munroe, also wrote many popular tales, including *The Flamingo Feather* (1887). *Wide Awake* (1875–93), another U.S. periodical, published well-known authors, both British and American.

The famous English boys' magazine, *The Boy's Own Paper* (1879–1912), had a long career under the editorship of George Andrew Hutchinson. World-wide in scope, it was read not only by adventurous boys but by their equally adventurous sisters. Romance, adventure, school stories, all appeared there, including much of the work of Jules Verne (*q.v.*), the first of the science fiction writers.

Children's magazines of the 19th century reflect the change of emphasis in children's literature from the pious, didactic tales appearing in the first part of the century, through the factual, fantastic and realistic tales appearing in the second half. By the end of the century middle-class children throughout the English-speaking world had access to a great body of well-written, well-produced reading material. No longer were books and magazines accessible only to the few.

Picture Books of the 19th Century.—Although a few picture books were published before the 19th century, it was not until then that the needs of the younger children were recognized. Improved printing techniques also made picture books commercially attractive.

The first picture book is usually considered to be *Orbis sensualium pictus* (Eng. trans., *The Visible World in Pictures* [1659]), published in Nürnberg in 1658 and attributed to a Moravian bishop, John Amos Comenius. The *Orbis pictus* was a combination of picture book, Latin text and natural history. The text, with the Latin and the corresponding German in parallel columns, was accompanied by copperplate illustrations of "the world of sensible things." Soon after its publication the German portion was translated into English by Charles Hoole; this edition remained in print in England until 1777 and was widely used as a textbook.

Although there must have been other picture books, long since lost, there is little record of them, and it was the end of the 18th century before Thomas Bewick (*q.v.*), an outstanding wood engraver, illustrated several books for children.

The Butterfly's Ball was one of the first of the 19th-century picture books. Although several important illustrators of children's books, such as George Cruikshank, Richard Doyle and John Leech produced good work, the reproductions were not generally good. A colour process invented in 1835 by George Baxter pointed the way to a method of producing coloured illustrations from wood blocks developed by the skilled craftsman, Edmund Evans. A whole new field developed and the work of three great illustrators was made available to children.

Walter Crane brought a missionary's zeal for graphic art and a classical taste to his work for children. More decorative than illustrative, his work is somewhat dated, but *The Baby's Opera* (1876) and *The Baby's Bouquet* (1878), with tunes arranged by his sister Lucy, are still available. Besides numerous picture books of nursery tales, he illustrated Mrs. Mary Louisa Molesworth's *Carrots*, *The Cuckoo Clock*, Judge Parry's retelling of *Don Quixote* and Grimm's *Household Stories*.

Kate Greenaway (*q.v.*), encouraged by Ruskin, developed her own world of children in *Under the Window* (1879) and *Marigold Garden* (1885), illustrating her own verses. *A Apple Pie*, *Mother Goose*, Robert Browning's *The Pied Piper of Hamelin*, and surprisingly, Bret Harte's *The Queen of the Pirate Isle* are among the well-known books for children that she illustrated.

Randolph Caldecott (*q.v.*), for whom the Caldecott medal was named, is perhaps the one of these three illustrators whose work is most enduring. His gaiety, sly humour, liveliness and storytelling qualities are implicit in all his work, and in his illustrations for William Cowper's *John Gilpin* (1878) for example, his loving re-creation of the English countryside of his childhood makes it now come alive for children.

At the turn of the century Beatrix Potter (1866–1943) published at her own expense a tiny book most persons consider a folk tale—*The Tale of Peter Rabbit*, later (in 1902) published by Frederick Warne with coloured illustrations. This classic of the nursery has become increasingly popular, and in 1959 alone sold 24,000 copies. She wrote several other miniature classics, most of which are masterpieces of structure and suspense.

Shortly after the appearance of *Peter Rabbit* the work of L. Leslie Brooke (1862–1940) made its appearance in England and America. His nonsense picture book *Johnny Crow's Garden* (1903) achieved a sale of 3,600 copies in 1959. Besides the sequels *Johnny Crow's Party* (1907) and *Johnny Crow's New Garden* (1934), Brooke illustrated a few nursery rhymes in *Ring o' Roses* and four nursery tales in *The Golden Goose Book*, including a "Three Bears" and "Three Little Pigs" whose illustrations are masterpieces of storytelling, humour and the detail so loved by children. He also illustrated some of Lear's longer poems.

School, Home and "The Wide, Wide World."—The second half of the 19th century saw the development of a variety of different kinds of stories for children, particularly those centred around school, home and world-wide adventure.

Thomas Hughes's *Tom Brown's School Days* (1857) is usually conceded to be the first school tale, and was followed by many others, including such sentimental ones as Frederic Farrar's *Eric, or Little by Little* (1858) and such vigorous, humorous tales as Kipling's *Stalky and Co.* (1899). From the United States came Edward Eggleston's *The Hoosier School-Boy* (1883) and Ralph Henry Barbour's *The Half Back* (1899). School stories soon became sport stories, a type very successful in the 20th century.

Stories for girls in England tended to be domestic in tone, or romantic novels such as Charlotte Yonge's *The Heir of Redclyffe* (1853), R. D. Blackmore's *Lorna Doone* (1869) or Charlotte Brontë's *Jane Eyre* (1847). American girls seemed to be drawn to sentimental, lachrymose tales such as *The Wide, Wide World* (1850) by Elizabeth Wetherell (pseudonym of Susan Warner) or to such series as Martha Finley's interminable "Elsie" books beginning with *Elsie Dinsmore* (1867) and remaining with her through her grandmotherhood. The English novelist G. B. Stern in her autobiography, *Monogram* (1936), made an interesting analysis of Elsie. Of the numerous other series, some of the more durable ones include Susan Coolidge's "Katy-Did" series, beginning with *What Katy Did* (1873), and Margaret Sidney's *Five Little Peppers and How They Grew* (1881) and its sequels, dealing with the everyday life of a large family of limited means; both series have appealed to a wide audience for many years, the Sidney books perhaps being better known.

The outstanding children's author of this time in the United States was Louisa May Alcott (*q.v.*), daughter of the Transcendentalist Bronson Alcott. Her *Little Women* (1868–69), based on her own family life, has delighted generations, as have other of her warmhearted, sensible family tales, such as *An Old Fashioned Girl* (1870) and *Eight Cousins* (1875). Most of her stories are still in print.

Widely read both in England and in America, Frances Eliza Burnett (*q.v.;* née Hodgson) wrote romantic, sentimental tales thrilling to girls of the 1880s and 1890s. Many a boy, however, had cause to hate *Little Lord Fauntleroy* (1886), whose influence on Victorian mothers put the unwilling young males in velvet and lace. *Sara Crewe* (1888), enlarged to become *The Little Princess* (1905), and *The Secret Garden* (1909) both were popular when published and are still read.

During the early 19th century English adventure tales still emphasized religious fervour and moral tone, although narrative became increasingly important, as in Capt. Frederick Marryat's tales, *Mr. Midshipman Easy* (1836), *Masterman Ready* (1841–42) and *Children of the New Forest* (1847). Read with judicious skipping, these stories are entertaining even now. Other English writers popular with boys were W. H. Kingston, founder of *Kingston's Magazine for Boys* (1859), R. M. Ballantyne, author of *The Young Fur-Traders* (1856), *The Coral Island* (1857) and others; G. A. Henty, who covered the world in numerous historical tales such as *Under Drake's Flag* (1883); and Thomas Mayne Reid, writer of highly romantic tales. These adventure writers were similar in that they addressed their tales to a youthful audience, not to the adult as had Sir Walter Scott, whose romances *Ivanhoe* (1820), *The Talisman* (1825), *Quentin Durward* (1823) and others were adopted by young people.

It was not until 1881–82 that the adventure story appeared with no purpose but to entertain. Originally entitled *The Sea-Cook*, Robert Louis Stevenson's *Treasure Island* has become the prototype of the well-written adventure and, curiously, was first published serially in a "penny dreadful" called *Young Folks*.

After James Fenimore Cooper's *The Last of the Mohicans*

(1826), *The Deerslayer* (1841) and others, primarily written for adults, adventure tales in the United States were largely in the hands of the "hack writers" of numerous series: Oliver Optic (pseudonym of William Taylor Adams; *q.v.*), whose output included 116 full-length books and who was also editor of a children's magazine; Harry Castlemon (pseudonym of Charles Austin Fosdick [1842–1915]), who produced 58 titles; and Horatio Alger (*q.v.*), whose *Ragged Dick* (1867) was the first of many "rags to riches" stories so popular in their day.

Among the many authors of adventure tales for boys a few names stood out, among them Charles C. Coffin, Noah Brooks, James Otis Kaler, and Howard Pyle. The great name of the period, of course, was Mark Twain (*q.v.*), whose *The Prince and the Pauper* (1882), *The Adventures of Tom Sawyer* (1876) and *The Adventures of Huckleberry Finn* (1885) are still enjoyed by children.

Although U.S. and English writers ranged the world and time for material, children also welcomed stories by writers from other lands in English translation. Many came from France, including Paul du Chaillu, Alphonse Daudet, Verne, Ferdinand Fabre and Mme de Segur.

Perhaps no other book of its time with a foreign background has been more beloved by girls than *Heidi* by the Swiss author Johanna Spyri (1827–1901); the first English translation appeared in 1884, and there have been many later editions. Other books by Miss Spyri were translated into English but none reached the popularity of *Heidi*. From Sweden came another great book, *The Wonderful Adventures of Nils* (Eng. trans., 1907), by the Nobel prize winner Selma Lagerlöf.

In the latter part of the 19th century poetry for children was enhanced by the publication of Robert Louis Stevenson's *A Child's Garden of Verses* (1885; published originally as *Penny Whistles*, 1883), a collection whose high quality justified its wide and lasting popularity. In the U.S. Laura Richards, Eugene Field (*q.v.*) and James Whitcomb Riley were popular. In England, Walter de la Mare's first collection, *Songs for Childhood* (1902), appeared, to be followed by others up to and including his comprehensive anthology *Come Hither* (1923), whose only fault was omission of the editor's own poetry. The poetry of Rose Fyleman and Eleanor Farjeon is better known through selections in anthologies. A. A. Milne's *When We Were Very Young* (1924) and *Now We Are Six* (1927) are still popular, as are his two prose works, *Winnie-the-Pooh* (1926) and *The House at Pooh Corner* (1928). In 1960 *Winnie Ille Pu*, a Latin translation of *Winnie-the-Pooh*, became a surprise best seller in the U.S.

U.S. poets appreciated by children include Dorothy Aldis, Harry Behn, Elizabeth Coatsworth, Rosemary and Stephen Vincent Benét, Vachel Lindsay and Carl Sandburg.

Developments in the 20th Century.—Great Britain and the United States both have their share of writers of fantasy in the 20th century, among whom are Kipling; James M. Barrie; Edith Nesbit; Kenneth Grahame, whose *The Wind in the Willows* (1908) is one of the great children's books; W. H. Hudson; Pamela L. Travers; Hugh Lofting; Anne Parrish; C. S. Lewis; Rumer Godden; J. R. R. Tolkien; E. B. White; Carolyn Sherwin Bailey; Mary Norton; and James Thurber.

Animal stories have become increasingly popular with children since the days of Anna Sewell's *Black Beauty* (1877), with many kinds available. Horse stories seem to appeal to girls and dog stories to boys. Other animals from mice to panthers are subjects for many popular books.

By the beginning of the 20th century the public-library movement was well established in America, but it was not until after World War I that children's librarians began to exert a considerable influence on the production of children's books. Although during the period of the war comparatively little of note was published, afterward both Great Britain and the U.S. benefited by new talent and by an influx of refugee artists and writers who brought new ideas to both writing and illustration. The work of such well-known illustrators as Arthur Rackham, Edmund Dulac, N. C. Wyeth and Louis Boutet de Monvel was augmented by that of Willy Pogany, the Petershams, the d'Aulaires, Ludwig Bemelmans, Boris Artzybasheff, Feodor Rojankovsky, Jean de Brunhoff and many others.

The first children's bookshop in the United States, managed by Bertha Mahony, opened in Boston in 1916. In 1924, under her editorship, *The Horn Book Magazine* began publication. It was the first magazine to be devoted entirely to books and reading for children and young people and is now a standard reference in its field. Anne Carroll Moore, superintendent of work with children in the New York public library, began the first serious reviews of books for children in *The Bookman* in 1918, and in 1924 her column "The Three Owls" began to appear weekly in the *New York Herald-Tribune*. (A selection of these columns in book form, also entitled *The Three Owls*, was published in 1925.)

The first children's book week in America was sponsored by the Boy Scouts of America in 1919. Now called Book Week, it is usually observed early in November each year.

The increase in interest among librarians and others concerned with children's welfare led to greater sales of children's books, which in turn encouraged publishers to add a separate department concerned exclusively with the selection and production of children's books. Louise Seaman headed the first such department at the Macmillan Company from 1919 to 1934. Her good taste and understanding of children's needs were of incalculable value in establishing rapport between publishers and librarians, teachers and parents. May Massee, another distinguished pioneer in children's books, became children's editor at Doubleday, Page & Co., and later established the same department for Viking Press.

The high standards shown by these two editors set the pattern for the whole industry and developed many new approaches, making an artistic as well as a commercial success of their work. By the late 1920s most major publishers in the United States had children's editors, and later several publishers devoted their efforts to children's books exclusively. Most children's book editors have been women, as few men in the first half of the 20th century concerned themselves with books for the young. This has created an imbalance (now being remedied) that has not always worked to the advantage of the child reader.

Although the publishing of books for children increased after World War I, it was not until the publication of William Nicholson's *Clever Bill* (1927) and Wanda Gág's *Millions of Cats* (1928) that new picture books became important. A whole group of artists began turning their talents in this direction, and new processes of photolithography made larger editions possible.

By the 1930s mass-produced, inexpensive picture books were available, including the series entitled "Happy Hour Books," published by Macmillan, later supplanted by the publication of the still more inexpensive "Little Golden Books." The depression of the 1930s reduced the number of children's books published, but the lower costs made possible editions of a richness and beauty impossible to duplicate later.

Children's magazines in the United States, in the meantime, were losing ground. After the demise of *St. Nicholas Magazine* in 1939 —another casualty of the depression—there were none in the United States to equal it. *Boys' Life*, the official Boy Scout magazine, and *American Girl*, the official Girl Scout magazine, are still available, as are *Jack and Jill*, *Child Life* and numerous magazines sponsored by various religious groups, the quality of which in many instances was improved greatly in the period after World War II. *The Young Elizabethan*, formerly *Collins Magazine*, is an English periodical that has made a place for itself in the United States as well. But the whole magazine field, particularly in the United States, has felt the competition of paperback editions of books, school activities, movies and television.

During World War II the terrible destruction of book stocks in the air raids on London, the paper shortage both in England and the United States and the shortage of steel that caused the melting of plates of many important but slow-moving titles, eliminated a great many excellent books. Prohibitive costs prevent their being reprinted.

At the same time, the increase in the number of school libraries, especially in elementary schools, increased the demand for all kinds of children's books, and by the early 1960s the number available was enormous. In 1919 about 430 new titles were published in the United States; in the 1960s the number of new titles had more than tripled and there were also many new editions of older titles reprinted. The variety is staggering. Animal stories, biography, history, science, fiction, poetry and picture books are but a few of the categories of children's books for all ages. Outstanding in the field of realistic fiction are Laura Ingalls Wilder's "Little House" stories, based on her childhood in the pioneer sections of the midwest. They are lasting contributions to children's reading.

An interesting development after 1950 was the emphasis put upon easy-reading books planned for the beginning reader. Prior to the 1940s no major publisher realized the need, but by 1945 a few firms, such as Holiday House, produced attractive ones. A very successful easy-reading book of the 20th century was *The Cat in the Hat* (1957), a nonsense story in verse written and illustrated by Dr. Seuss (pseudonym of Theodor Geisel). The vocabulary was limited to 250 words and the book could be read by some first- and most second-grade children. As a change from dull, humourless primers, it caught popular attention.

Children's Book Awards.—Frederic G. Melcher, editor of *Publishers' Weekly*, established the John Newbery medal award given annually since 1922 "for the most distinguished contribution to American literature for children"; later he added the Caldecott medal awarded since 1938 "to the artist of the most distinguished American picture book for children" published in the United States during the previous year. The first Newbery medal was given to Hendrik van Loon's *The Story of Mankind*. Robert Lawson has won both: the Caldecott medal in 1941 for *They Were Strong and Good* and the Newbery medal in 1945 for *Rabbit Hill*. Joseph Krumgold won the Newbery medal twice, in 1954 for *. . . and Now Miguel* and in 1960 for *Onion John*, as did Elizabeth Speare, in 1959 for *The Witch of Blackbird Pond* and in 1962 for *The Bronze Bow*. The Caldecott medal was won twice by Robert McCloskey, in 1942 for *Make Way for Ducklings* and in 1958 for *Time of Wonder*, and by Marcia Brown, in 1955 for *Cinderella* and in 1962 for *Once a Mouse*. The books were published in the year preceding the award.

Great Britain's award for outstanding books for children, the Carnegie medal, named for Andrew Carnegie, was established in 1937; the first award went to Arthur Ransome's *Pigeon Post*. These and other prizes have stimulated librarians, for the choice is theirs, and focused their attention on the new as well as the old.

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(Q H.)

CHILD WELFARE embraces those services and institutions concerned with the physical, social and psychological well-being of children, and it is particularly concerned with children lacking normal parental care and supervision. Although some stirrings of interest in the welfare of children may be discovered in the deep shadows of both religious and secular history, it was not until the beginning of the 17th century with the enactment of the poor law (*q.v.*) of 1601 in England that any sustained and organized efforts were made. This law was to determine in a large measure what was done for dependent children both in England and the United States for the next three centuries. As to orphan and destitute children, this law and its successors provided that local governments might (1) set them to work along with adult paupers if they were old enough; (2) apprentice them to learn a trade; (3) auction them off, if they were very young, to the lowest bidder who would agree to care for them in his own home; or (4) send them to the poorhouse. The provision of food and clothing in the child's own home, if he had parents, was another possibility.

All of these methods of child care were brought to America by the colonists and later became the basis of a system of local care in the United States that was not finally abandoned by some states until the passage of the Social Security act in 1935. Children placed in work and free homes often were exploited and neglected, and those consigned to the local poorhouses were demoralized by exposure to the decrepit, insane and handicapped adults who also lived in these institutions.

The earliest attempts to rescue children from the harshness of the poor law were made by voluntary organizations, often religious, and took the form of separate institutions for children. Prior to 1800, there were seven orphan asylums established in the United States, and in England foundling homes and other children's institutions under private auspices were in existence as early as 1552. In European countries the church, through a variety of institutions, provided most of the care for dependent children until well into the 20th century.

There has been wide variation from nation to nation and from time to time in what constitutes child welfare services. In underdeveloped countries and in the aftermath of war and disaster these may be just the essential measures to keep children alive, such as emergency feeding, shelter and simple public health precautions. In the western world and particularly in the larger cities, child welfare includes a range of highly specialized services that go far beyond physical survival and deal with such problems as personality development, vocational guidance and use of leisure time. The general standard of living, the level of education and the financial resources of the country are among the factors which determine what the child welfare standards will be.

The following presentation is organized on the basis of various forms which child welfare may take rather than on descriptions of systems in effect in individual countries. They may be divided into services to children living in their own homes and those for children who must live away from their homes.

CHILDREN IN THEIR OWN HOMES

The most widely accepted principle of modern child welfare is that every child needs a home and family of his own. A ringing statement of this principle, which has been repeated around the world, was adopted at the first White House Conference on the Care of Dependent Children in 1909: "Home life is the highest and finest product of civilization. It is the great molding force of mind and of character. Children should not be deprived of it . . . for reasons of poverty." The abiding importance to children of a secure home life and affectional ties with parents has been urged so persuasively by child welfare experts and psychiatrists that the cornerstones of most child welfare programs are the services aimed at preserving and strengthening the child's own family.

Income Maintenance.—Supplying or supplementing family income so that parents can maintain a home for their children is usually the first such service to be provided. Assistance may range from the distribution of food, medicine and clothing to complex systems of social insurance. In addition to programs of general family relief, special assistance to broken families is widespread. Originally limited to widows with young children and known as mothers' pensions in the United States, the newer laws tend to provide wider coverage and extend to deserted and unmarried mothers and to families where the father is incapacitated.

A number of countries followed New Zealand's lead in the passage of so-called family allowance laws. Unlike public assistance, these allowances are not based on a means test but on the number of children in the family. These small weekly amounts serve as companion measures to other income maintenance programs which frequently make no provision for dependent children of the recipients. Among the countries which provide family allowances are Canada, France, Great Britain, Italy, the Scandinavian countries, Spain and Switzerland.

Social insurance schemes offer the broadest protection against the risk of children's being removed from their homes for economic reasons. Starting in Germany in 1883, the idea of social insurance spread slowly at first but received wide acceptance after World War II. Among the common hazards to home life which social insurance systems attempt to provide against are death, unemployment, sickness, industrial injuries and temporary disability of parents. (*See* SOCIAL SECURITY.) With increased acceptance of income maintenance as a basic governmental responsibility, the efforts of voluntary and religious agencies concerned with family life shifted from relief-giving to other ways of assisting parents such as family counseling and other services described below.

Maternity and Child Welfare.—Although child welfare increasingly stresses social services, public health and medical services usually are the first to be organized in new and underdeveloped nations. This recognizes the fact that the infant and maternal death rates are the primary indices of a nation's progress in child welfare.

Infant welfare clinics were established in some colonial territories after World War I by determined and energetic government officials supporting the pioneer work of missionary doctors. In the Gold Coast (now Ghana) women doctors of the Scottish mission inaugurated infant welfare services in 1924 and, associated with these, a voluntary agency to undertake home visits. The clinics were retrenched during the 1930s and only in a few centres were services kept going by the Red Cross. Protein malnutrition was first described clinically as a result of infant welfare studies in the Gold Coast by Cicely Williams, who gave it the name of kwashiorkor which had been used by the people themselves to describe the condition it produced in children without knowing its cause.

In many countries, particularly in Africa and Asia, the first steps were public health attacks on such diseases as yaws, tuberculosis, malaria and leprosy, and efforts to improve child nutrition. This was often followed by instruction of native midwives in the simple principles of hygiene. The assistance of the United Nations Children's fund (UNICEF) and the World Health organization (WHO) was particularly significant in inaugurating these basic programs of infant and maternal welfare. The industrialized countries have gone far beyond this with the provision of professional prenatal, delivery and postnatal care for mothers without reference to their ability to pay. Infant welfare clinics where expert advice may be obtained on getting children off to a good physical as well as emotional start are widely available in Great Britain and the United States. (*See* MATERNAL AND CHILD HEALTH.)

Birth control as a measure to strengthen the family was recognized officially by such countries as Denmark with the authorization of Maternity Aid institutes where contraceptive information was given; by Poland, where abortion was legalized in 1956 and a Planned Motherhood association founded in 1957. Even more pronounced was the trend toward promoting methods of family planning in Asia and the far east with India, Pakistan and Japan the most active.

Day Care.—Nurseries and nursery schools provide a special service that frequently is necessary for successful care of children by their own families. The need for this service most frequently arises when the mother is either forced or chooses to leave the home during the day to work. One of the legacies of World War II was a tremendous increase in the number of working mothers. Facilities for the care of their children are provided under a variety of auspices—governmental agencies, voluntary agencies, commercial proprietors or, in some instances, industry itself. The nursery provides supervised indoor and outdoor play, a midday meal and naps, as a minimum. In addition, there may be instructions in arts and crafts, reading, music and elementary hygiene.

Although originally thought of solely as institutions where children of working mothers could be assured of safe custodial care—and this remains their primary purpose—nurseries have come to serve other childhood needs. They are used where the physical or emotional capacity of the parents, poor housing or other unfavourable situations make it advisable for the child to be out of the home part of the day. They are also used for children who need the socializing influence of living with other children. Some nurseries are specially staffed with or have access to psychiatrists, pediatricians and social workers, and are used for the diagnosis and treatment of emotional problems of children and their parents. A separate form of care is foster day care. This is provided in foster homes which are selected and supervised by a social agency. These are usually to be preferred to the nursery for very young children who have to be apart from their mothers during the day.

Homemaker Service.—Recognition of the harmful effects on young children of even temporary removal from their homes led to the development in the 1920s of what is known as "homemaker" or "housekeeper" service. Homemakers, selected for their skills and personalities and supervised by family welfare or children's agencies, are placed in homes where the mother is temporarily unable to care for the family. Such services have become increasingly important as the number of families without relatives or obliging neighbours attempt to survive in the impersonal atmosphere of large cities. By 1959 "home-help" agencies were reported in more than 20 countries including Israel, Italy and Turkey, where the service had just been launched. In the Netherlands and Norway government funds were used to help cover the cost of home-help service.

Services for School Children.—The school is in a particularly favourable position to detect early physical and emotional problems of children and to provide services to prevent later and more serious developments. A comprehensive school program includes both medical and social services. Routine physical examinations to discover defective vision and hearing are most common because these directly affect the child's ability to learn. Psychological testing to discover children who need special education by reason either of limited or superior mental endowment is also widespread. Other items in a complete service include dental examination and treatment, vaccinations and immunizations, and the provision of supplemental foods and vitamins for children requiring them.

School meals for needy school children were first provided in Great Britain by voluntary agencies, such as the London School Dinners association, 1889. Investigation revealed the need to systematize the haphazard activities of voluntary bodies in this field. In 1906 the Provision of Meals act established the principle that arrangements for the provision of school meals were an integral part of the education system. By the outbreak of World War II free meals, other than milk, were being provided by only about half the local education authorities in Britain, but a great expansion of the service took place during the war and actual provision was put on a sound nutritional basis. The Education act of 1944 made it a duty of local education authorities to provide school meals and milk.

For city school children provision is made by some education authorities and voluntary agencies for holidays and teaching terms at camp schools situated on the coasts or in beautiful rural locations where healthy recreation and development is facilitated in open-air living.

Social services under school auspices were first directed toward enforcement of attendance laws; however, experience showed that mere legal enforcement did not successfully cope with the problem of truancy. The place of the old truant officer has been taken by the school social worker who works in a constructive rather than a punitive way with parents and is concerned with the infinite range of home conditions and emotional and psychological problems which may impede a child's educational program. Early detection by the school social worker of symptoms of behaviour disorders and the securing of prompt treatment constitute an important attack on the prevention of delinquency.

In west African territories of the British commonwealth, for example, the expansion of the primary school system served to focus attention on truancy, ill-health, neglect and irregular attendance because of arrears of fees, lack of books and old and dirty uniforms. Expansion also presented these countries with an increasing army of school-leavers looking for employment in the towns or anxious to secure further education at secondary school level. Social welfare and labour departments co-ordinated efforts to provide school welfare services, careers advisory panels and the encouragement of the formation of parent-teacher associations.

Help to children in choosing vocations and in planning advanced education is available in many secondary schools. By means of tests and counseling, both in groups and individually, vocational guidance counselors are able to help young people avoid entering blind alley occupations or embarking upon careers for which they are not fitted. (*See* PSYCHOLOGY, APPLIED: *Industrial Psychology: Vocational Guidance*.)

Protective Services.—Not all parents love their children and some are grossly incompetent and neglectful. Children of such parents require special protective services. Societies for the prevention of cruelty to children, organized under voluntary auspices, date from the middle of the 19th century and still exist under various names in some cities, although the trend has been to place responsibility for such services in the public child welfare agencies. In some jurisdictions probation officers of the family court or children's court carry on the work. Protective services are usually invoked on the complaint of neighbours or others aware of cases of parental abuse or neglect. The fact that the services are not sought by and may be resisted by the parents requires that the protective officers have special skills and that there be some adaptation in usual casework practices. Because removal of a child from his own home, even if it is not a very good one, is such a serious matter, all reasonable efforts are made to avoid this drastic step. Some situations are so menacing to the safety of the child that prompt action by the police and courts is necessary.

Children with welts and bruises and those whose emaciated bodies give evidence of neglect are not the only ones needing rescuing, although they are the ones most likely to be found in the case loads of protective agencies. Equally serious but less conspicuous are the emotional scars which many children bear. The subtler forms of emotional damage which parents can inflict on their children are only beginning to be recognized and the courts are still cautious in intervening. *See* also CHILD LABOUR; CHILDREN, LAWS CONCERNING; CHILDREN'S COURT; JUVENILE DELINQUENCY.

CHILDREN AWAY FROM HOME

Although modern child welfare places major emphasis on keeping children in their own homes, the unfortunate group of children who have to be removed from them absorbs more than half the time of all child welfare personnel, at least in the United States.

There have been marked changes over the years in the reasons children have lost their homes, and corresponding changes in the kinds of care provided for them. Whereas death of parents and destitution used to lead the list, in the second half of the 20th century this was no longer the case. Most so-called orphan asylums have almost no orphans and many of them have acknowledged this fact by dropping the word orphan from their institutional names. The income maintenance measures described earlier have helped to reduce economic dependency, and medical science and public health measures have succeeded in various ways in reducing the number of children who lose their parents by death. The steady decline in the number of mothers dying in childbirth, leaving young children behind, is but one example. The most frequent causes for removal of a child from his home are marital discord, parental irresponsibility and neglect, separation and illegitimacy. Temporary placement may sometimes be necessary because of behaviour problems of the child or family emergencies.

The changes which have taken place in the kinds of care provided are largely attributable to additions to knowledge from the fields of social work, psychiatry and child development. Many of the kinds of care described below are not new, but in their modern expression give much more emphasis to the emotional needs of children.

Adoption.—Adoption is an ancient institution that was recognized in the Babylonian codes of Hammurabi and legally regulated in Greece, Egypt and Rome. In these early civilizations as well as in the orient of modern times, the purpose was primarily to secure an heir. Adoption as a child welfare measure is almost exclusively a 20th-century innovation. Although *de facto* adoption of children had existed in England for years, it was not legally provided for until 1926. Modern adoption laws and practices have as their aim the safeguarding of three sets of interests: those of the child, the natural parents and the adoptive parents. The essential features of a good law are (1) consent provisions which assure that parental ties are not severed improperly or under duress; (2) requirements for thorough social study of the adoptive home in all cases before a decree is issued; (3) a trial period in the adoptive home with appropriate supervision before the decree becomes final; and (4) clear delineation of the legal consequences to all three parties at interest when the adoption is consummated. Because of the critical and delicate nature of the decisions involved in adoption, the importance of the social study cannot be overemphasized. Whenever possible this should be made by a social agency and placements by physicians and lawyers should be discouraged. Since a large proportion of adopted children are illegitimate, social and medical services should be available to the unmarried mother.

At one time adoption was thought of only for the perfect or near-perfect baby. This led to prolonged study and observation with the result that many children were not placed until they were a year old or even older. The change in practice to early placement, usually under three months, and the placement of children with physical and psychological defects, reflects a basic change in philosophy among adoptive agencies. Instead of emphasizing the requirements of the adopting family, the focus is on the needs of the individual child. The trend to early placement was encouraged by psychiatrists who warned against the dangers of emotional damage to infants kept in hospitals or nurseries for extended periods of time. In the United States many older children in institutions and foster homes are denied the benefits of a permanent home because of the refusal of natural parents to consent to adoption. The rights of even very neglectful parents may sometimes be too well protected.

The existence after World War II of large numbers of orphan and refugee children led to a sharp increase in inter-country adoptions. Because of the dangers inherent in hasty and impulsive decisions to place children in homes in another land and culture, the Child Welfare League of America formulated standards to guide such adoptions. The following precautions are recommended:

> Adoption outside a child's own country should be considered only when less suitable plans can be made for him in his own country. It is usually better for any child beyond the age of infancy to be adopted within his own country, and not to be transplanted to another culture. Inter-country adoption considerations should include placements for children with certain mental defects, and for children whose family or racial background presents a handicap to their acceptance and development in their own country. Extremely careful consideration should be given before a child is removed from his own relatives for adoption. Before deciding to relinquish a child for adoption, parents should be helped to weigh the consequences—emotional, psychological and legal—against apparent economic or social advantages. Unless the parents or relatives understand and accept the meaning of adoption in the culture of the child's new country, adoption should not be considered for the child. (*Standards for Adoption Service*, Child Welfare League of America, Inc., New York, 1958.)

(*See* also ADOPTION.)

Foster Care.—The two basic forms of foster care are placement with families or in institutions. At one time enthusiasm for foster family care ran so high as to threaten the future of institutional care. This was during the period 1920–1940, when children's institutions usually were of the large congregate type with regimented programs which permitted little recognition of the needs of individual children. It is now accepted that a children's agency should be able to make available both types of care since experience has shown that not all children can benefit from foster family care. For example, children whose experiences with their own parents have been emotionally devastating may not be able to fit into the intimacy of a foster family and may do better in the more impersonal life of an institution. The same is frequently true of emotionally disturbed adolescents.

Foster family care of children has its roots in the apprenticeship provisions of the early English and American poor laws. Under these laws, dependent children were placed with families to be supported and taught a trade. Typically, the period of apprenticeship was to age 18 for girls and 21 for boys. In exchange for his maintenance and trade training, the child was expected to work for the master or mistress. With the decline of apprenticeship after the middle of the 19th century, children continued to be placed in foster homes, without formal indenture—but still with the expectation that they would earn their keep. In the United States through organizations such as the Children's Aid Society of New York thousands of children from the crowded city slums of the east coast were transported during the last decade of the 19th century to free homes in small towns and on farms in the middle west. The objection to these earlier forms of foster care was that, once placed, there was often no supervision by the placing agency, and many children were exploited and overworked.

Modern standards for foster care emphasize careful selection of homes, close supervision of the children placed in them, and payment of board. Clothing, medical and dental care and allowances for the children are usually provided by the placing agency. Particularly important are the counseling services provided by the agency's caseworkers to foster parents. In the absence of such services children may be needlessly uprooted and shifted from one home to another with damaging results. These standards reflect a change in emphasis from the former concern with the foster family's employment requirements to a concern for the child's welfare.

Fostering children, with its emphasis on the importance of the substitute family and the child's relationship with the mother-substitute, has greatly increased the demand for foster parents and the exacting work placed upon child-care officers. In Great Britain since the Curtis report, 1947, and the Children act, 1948, shortages of both foster parents and children's officers have created public concern. It is open to doubt whether remuneration can be an important factor in deciding people to take a foster child. The most successful foster parents do it because they like to have children around them, and in Great Britain it was found that women who had had more than one foster child also had more children of their own.

The changes in institutional care of children have been of two kinds. Instead of the former monumental buildings with rows of beds in dormitories and children sitting silently at long tables in the dining rooms, the modern institution is more likely to be of the so-called cottage type. Under the cottage system these are small homelike units with living rooms and single and double bedrooms having from five to ten children along with a housemother or couple. Meals may be served in a common dining room although many cottages have their own dining rooms and have food delivered from a central kitchen. The purpose is to create a family rather than an institutional atmosphere. It should be noted that the shift from the congregate to the cottage type institution has been slower in Europe and in other parts of the world where the institutions are under religious auspices. A survey by the bureau of social affairs, United Nations secretariat, reported that by 1960 institutions with 50 or more children had practically disappeared in the United Kingdom and that progress had been made in underdeveloped countries such as Thailand in substituting cottage type for congregate institutions.

Less visible than the architectural changes, but more important, are the efforts made to understand and to meet the needs of the individual child. This individualization has come about largely through the introduction of casework services into institutional programs. The casework process is essentially a matter of study, diagnosis and treatment of social and emotional problems characterized by a concern for individual differences. In a children's institution the process begins before the child is admitted with a careful study of all the circumstances in his case. Within the institution the caseworker is concerned with the child's relationships with his own family, with efforts to rehabilitate the family looking to the child's eventual return and, where this is not possible, in making other plans for the child upon his discharge.

For children with severe behaviour and emotional problems, there are specialized institutions where psychiatric treatment is provided. Austria, Germany, England and the United States are among the countries which have pioneered in developing such residential centres. It should be emphasized that the treatment institutions are not for children suffering from brain damage or the mentally retarded, but for the emotionally disturbed and neurotic child. In some of these centres the children are under the direct care of a psychiatrist; more often, however, a psychiatrist serves in a consulting capacity. Because of the quality of the staff required and the ratio of staff to children, per capita costs in such institutions are very high.

HANDICAPPED CHILDREN

Broadly viewed, progress with the problems of the physically handicapped child has taken two forms: first and most important have been the efforts to prevent crippling conditions; and, second, a change in the philosophy of care for afflicted children. Efforts to prevent orthopedic disabilities have been notably successful with such diseases as bone and joint tuberculosis, poliomyelitis and osteomyelitis. These have been due to such public health measures as required tuberculin testing of cattle and to advances in medical science. The introduction of the Salk vaccine and the development of antibiotics have led to dramatic decreases in the number of children crippled by poliomyelitis and osteomyelitis. Attacks on the problem of congenital malformation have taken the form of research into hereditary factors, nutritional deficiencies and the toxemias of pregnancy.

Measurement of progress in the prevention of blindness among children (as with other handicapping conditions) cannot be reliably made because of the inadequacy of the statistics. In some parts of the world trachoma is still a common cause of blindness because of local health and sanitary conditions. In those countries where high standards of public health prevail, prevention of blindness has taken the form of safety regulation and legislation requiring prophylactic treatment of the eyes of newborn babies. A baffling ailment, retrolental fibroplasia, which produced complete or partial blindness in premature babies and was in some countries the largest single cause of congenital blindness, was brought under control after the discovery in 1954 that the disease is associated with the amount of oxygen used in incubators.

Progress has been made in estimating the extent of blindness and surveying its causes in wide areas of east and west Africa, Malaya and the middle east. Through the decade 1950–60 the Commonwealth Society for the Blind advanced the work for preventing blindness in west Africa from the formerly little known disease of onchocerciasis which frequently led to "river blindness." Diet deficiencies in west Africa have also been studied as a probable cause. The growth of territorial organizations for the blind, schools, workshops and training centres has progressed. Priority is to be given in the newly independent British Commonwealth countries to sending more blind children to school. In the early 1960s it was estimated that less than 1% of blind children were at school in most African territories, whereas probably more than 50% were at school in Trinidad, Jamaica, Cyprus and Singapore. Nigeria, with at least 20,000 blind children, had in 1959 only two schools for the blind, accommodating 37 children. A large-scale experiment was undertaken in Katsina province, northern Nigeria, to send blind children to normal day schools to be given special instruction by trained itinerant teachers in order to speed up the process of offering blind children some education.

The first attacks on the problem of mental retardation came with the enactment of sterilization laws. There were high hopes that by sterilizing feeble-minded persons who might become parents the problem would eventually be solved. This proved not to be the case since only a small proportion of mentally retarded children are born of feeble-minded parents. Prevention takes the form of research in the fields of biochemistry and genetics, and in improved methods of obstetrics including surgical intervention in cases of damaging conditions during pregnancy.

A summary of the changes in philosophy of care for physically handicapped children is found in the following statement:

> The physically handicapped have been handicapped in the past as much by the attitude of society as by their physical limitations. A changing attitude, placing emphasis upon abilities rather than disabilities, has accompanied the rapid growth in knowledge of the problem related to (a) recognition that the physical, mental, social, and emotional needs of the handicapped person are not different from those of the non-handicapped; (b) realization of the importance of capitalizing upon the potential contribution of the handicapped to social and economic welfare; (c) significant advances in medical care, therapy, educational methods, psychological evaluation, vocational evaluation and training, and prostheses. aids, and appliances; and (d) growth of integrated medical, social, educational, and vocational services in rehabilitation of the physically handicapped. (*Social Work Year Book, 1957,* New York, National Association of Social Workers, 1957.)

While custodial institutions for crippled and blind children had practically disappeared in England and the United States by 1960, institutions and special schools for feeble-minded and seriously retarded children were still common.

See also BLIND, TRAINING AND WELFARE OF; DEAF AND HARD OF HEARING, TRAINING AND WELFARE OF; REHABILITATION, MEDICAL AND VOCATIONAL; RETARDED CHILDREN.

INTERNATIONAL CHILD WELFARE

The first international child welfare congress was held in Paris, France, in 1883 with delegates from Europe and America, including the United States. Ten such congresses were held in London and European cities, the last in 1933. In 1928 the first International Conference of Social Work was held, bringing together the same professions and organizations which had organized the international child welfare congresses.

In 1916 the first Pan-American Child congress was held in Buenos Aires, Arg., and brought together delegates from the Latin American republics and the United States. Resolutions passed by the congress led to organization of the International American Institute for the Protection of Childhood, in Montevideo in 1927. The work of this organization was continued by the Inter-American Children's institute after its creation in 1948 as a specialized agency of the Organization of American States.

The International Union for Child Welfare, a voluntary federation of 69 national and international organizations, with headquarters in Geneva, Switz., which was created in 1920, had as its general objective the raising of standards of child welfare through consultative services and the stimulation of demonstration projects.

World Wars I and II were followed by emergency relief measures for children in devastated countries. Jewish, Protestant and Roman Catholic agencies from the more favoured parts of Europe and overseas, the Red Cross and other nonsectarian groups supplemented the work of governmental organizations. After World War II many children were privately aided through the Cooperative for American Remittances to Everywhere (CARE). (*See* also DISASTER RELIEF.)

United Nations Agencies.—Far more significant than the emergency wartime and postwar efforts to relieve misery was the development of international planning in behalf of the children of the world. A better world for children was envisaged in the Universal Declaration of Human Rights, approved Dec. 10, 1948, by the general assembly of the United Nations. Their interests were especially stressed in: "The family is the natural and fundamental group unit of society and is entitled to protection by society and the State," (art. 16, sec. 3), and "Motherhood and childhood are entitled to special care and assistance. All children, whether born in or out of wedlock shall enjoy the same social protection," (art. 25, sect. 2).

The United Nations created or encouraged the organization of services entirely or partly concerned with the welfare of children, and co-ordinated the work of these and other international agencies serving children, some of which were in existence before the UN was organized in 1945. Co-ordination of the work of the various specialized agencies and the UN became a principal responsibility of the Economic and Social Council and the administrative committee on co-ordination consisting of the secretary-general of the UN and the executive officers of the specialized agencies. The unprecedented organization and expansion of relief and child welfare services during the decade prior to mid-20th-century made their co-ordination a tremendous and urgent task.

The United Nations International Children's Emergency fund, after 1953 called the United Nations Children's fund (UNICEF), was established in December 1946 by the general assembly of the UN for the relief and rehabilitation of children in war-torn countries and for child health throughout the world. Though not a direct descendant, UNICEF inherited much of the responsibility for feeding children and providing other child welfare services which had been a part of the load carried by the United Nations Relief and Rehabilitation administration. Though UNICEF received much less financial support than UNRRA, it was less restricted in the number of countries it could enter and less subject to military and political controls. UNICEF was supported by voluntary contributions from governments and individuals; by 1960 an annual budget in excess of $20,000,000 was being contributed by 86 countries to support projects in 105 countries and territories. Approximately half the total amount was contributed by the United States. Prior to 1950 the fund provided a daily supplementary meal for 4,000,000 to 6,000,000 children and nursing and pregnant women. The program in the east, including the East Indies, consisted mostly of supplying medicines and equipment and training local personnel in techniques for the control of specific child welfare problems. In Europe and north Africa much progress was made in the world-wide campaign to test 100,000,000 children for tuberculosis. A resolution adopted by the general assembly of the UN, Dec. 1, 1950, revised the policy of UNICEF. Relief programs were replaced by emergency and long-range projects whereby supplies, training and advice were provided in underdeveloped countries with a view, wherever appropriate, to strengthening the permanent child health and child welfare programs of the countries assisted. By 1954 most of these countries had realized the advantages of UNICEF services and instead of matching UNICEF funds, as in previous years, they provided several times as much as the UN appropriations for advancing the welfare of their own children. Thus facilities for manufacturing powdered milk had been developed in the near east, Asia and Latin America where formerly milk and other relief supplies had been imported.

The World Health organization (WHO), created July 22, 1946, from its beginning gave priority to children in much of its work. In addition to the joint programs in which it promoted the mass feeding of children, improved nutrition and more effective methods of food production, the representatives of WHO surveyed the tuberculosis problem in many countries and set up laboratories for the manufacture of Bacillus-Calmette Guérin (BCG) vaccine. Outstanding among its achievements was its campaign against malaria. WHO also issued daily radio warnings of epidemics of smallpox, cholera and other pestilential diseases. Venereal diseases, in some areas affecting nearly half the population, were combated; prenatal and infantile syphilis were treated with penicillin in mass campaigns in several countries. The sanitation program of WHO led to improvement of water supply and sewage disposal systems and destruction of disease-carrying insects. With such improvements the death rate among infants in some areas was cut from 30 to 3 per 100 births in a comparatively short time. WHO and the Food and Agriculture organization (FAO) jointly promoted a "food for health" program, stressing health education of the public.

See also references under "Child Welfare" in the Index volume.

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CHILE, a republic on the Pacific coast of South America that occupies the western slope of the continent south of Peru and west of Bolivia and Argentina. In the south, Chile borders the Strait of Magellan all the way to the Atlantic ocean. It is a narrow, ribbonlike country, averaging only 110 mi. in width, but extending about 2,650 mi. in length, from 17° 30′ S. to 55° 59′ S. In the northern hemisphere this distance would be equivalent to the stretch from southern Mexico to southern Alaska. Although Chile has a greater inhabited latitudinal range than any other country in the world, about 90% of the people live in middle Chile, from 30° S. to 42° S. In this section is the capital city, Santiago (*q.v.*). The total area of the country is 292,256 sq.mi., slightly larger than the state of Texas. Its population (1960) was 7,374,115. In addition to its main area Chile owns the Juan Fernández Islands, Easter Island, and a number of other islands in the South Pacific ocean, and lays claim to a sector of Antarctica from 53° W. to 90° W. In northern and middle Chile the country is composed of three parallel strips: the Andes on the east, the coast range on the west and a series of lowlands between. South of 42° S. there is no central lowland but only a discontinuous island chain standing guard before a fiorded, mountainous coast. Northern Chile is a desert, notable for the production of copper and nitrates; southern Chile is a cold, wet region of little attractiveness and limited economic potential; but middle Chile is climatically most agreeable, and is the centre of agriculture, livestock ranching and industry.

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I. PHYSICAL GEOGRAPHY

The northern coast of Chile conveys the impression of a great land barrier with a remarkably even sky line. This barrier consists of a mountain range with gently rounded upper surfaces that descend eastward only slightly to the floors of the interior basins, or pampas, whereas the seaward face is generally a steep escarpment that drops from an elevation of 2,000 or 3,000 ft. directly into the sea. This coastal bluff is a serious obstacle to transportation and settlement. Only in isolated spots along the coast are there sufficiently wide benches or alluvial fans for townsites. South of Valparaíso the coastal escarpment is more broken and the elevations assume the characteristics of a mountain chain. From Chiloé south, subsidence has taken place, and only the higher parts of the coastal range reach above sea level as a series of islands.

The great barrier ranges of the Andes, which make up fully a third of the country, may be divided about 27° S. into a shorter northern and a longer southern section. The southern part is composed of a single rather narrow range, whereas the northern is made up of two or more roughly parallel ranges enclosing a series of plateau surfaces whose major development, because of the narrow shape of Chile, is to be found in Bolivia and Argentina. The Andes increase progressively in height from an elevation of 6,000 or 7,000 ft. at the southern end until they culminate at 32° 39′ S. in Aconcagua (elevation 22,831 ft.), which is the highest peak in the western hemisphere. The peak is located just across the border in Argentina. Bermejo (Uspallata) pass (elevation 12,917 ft.) lies immediately south of Aconcagua, and is the most important international pass in South America. Below it at 10,469 ft. is the tunnel of the transcontinental railway that connects Valparaíso with Buenos Aires. Farther south the lower average elevation of the mountain ranges results also in lower passes. In the lake district south of 39° S. most of the passes are under 5,000 ft., a circumstance that greatly facilitates trans-Andean communication in that area. The Strait of Magellan in the extreme south is a sea level pass through the Andes. The southern Andes are intensively glaciated, U-shaped valleys and glacially-sculptured peaks being the rule. Large glaciers are still to be found in many places, and extensive moraines are in evidence, many of them acting as dams for lakes. A series of young volcanic cones are superimposed on the Andes between 34° and 43° S., some of them of striking beauty and symmetry.

North of 27° S. the Andes are divided into several chains, of which the western forms the major eastern boundary of northern Chile. Two railroads lead across it into Bolivia, the one from Arica at 13,956 ft. and the other from Antofagasta at 12,972 ft. In 1948 the Trans-Andean railroad of the north was opened through Socompa pass (elevation 12,657 ft.), connecting Antofagasta with Salta, Arg. The extreme ruggedness, the aridity and the cold of this section limit crop raising and grazing, but it is a rich storehouse of minerals. One of the largest copper deposits known is located at Chuquicamata at an elevation of 9,300 ft. It has been worked since 1915 by U.S. interests and is by far the most important economic activity in northern Chile.

Between the coast range and the Andes lies the so-called longitudinal valley. This is not a true valley but an irregular depression, in some places reaching a width of 25 to 50 mi. and altitudes of 3,000 to 4,000 ft. In some sections it is broken by isolated groups of mountains or by spurs from the main range, which divide the valley into a series of basins, locally known as pampas. The most northern of these is the Tamarugal, extending north from the Loa river. This differs from the others in that the ground water in places lies within four or five feet of the surface. Although on the whole this pampa is barren of vegetation there are remnants of what once must have been extensive thorn woods. The desert of Tarapacá lies in the western part of the Tamarugal pampa and furnishes a portion of Chile's nitrate. South of Coquimbo the desert pampas end and spurs of the Andes extend westward to the coastal ranges. Only inland from Valparaíso does the longitudinal valley again appear. The central valley extends, with interruptions, as far as Puerto Montt.

1. Geology.—Along the coast of Chile lies a belt of rocks formed mainly of old granite and schist and overlying Cretaceous and Tertiary deposits; farther inland is the western cordillera of the Andes, which is composed chiefly of intrusive masses, volcanic rocks and folded Mesozoic beds. The deposit in the great longitudinal valley of Chile, which lies between these two zones, is formed of debris that is in places more than 300 ft. thick. In northern Chile the rocks of the coastal zone, which disappear northward beneath the Pacific, consist mainly of isolated masses that stand close to the shore or that project into the sea. South of Antofagasta these old rocks, which there begin to rise to higher levels, form a nearly continuous belt along the coast, extending southward to Cape Horn and occupying the greater part of the islands of southern Chile. They are greatly folded and are doubtless Paleozoic. In northern Chile the Cretaceous and Tertiary beds of the coastal zone are of small extent, but in southern Chile the Mesozoic beds, which are at least in part Cretaceous, form a rather wide band. The Tertiary coastal beds include both marine and terrestrial deposits, and most of them appear to be of Miocene or Pliocene Age. The whole of the northern part of Tierra del Fuego consists of plateaus formed of horizontal Tertiary beds. The northern part of the Chilean Andes, which is the western cordillera of Bolivia, consists almost entirely of Jurassic and Cretaceous sediments and Tertiary eruptive rocks. The Mesozoic beds are thrown into a series of parallel folds, which run in the direction of the mountain chain. Into these folded beds are intruded granitic and other igneous rocks of Tertiary age, and upon this foundation rise the cones of Tertiary and later volcanoes. Triassic rocks are found in northern Chile near Copiapó, where coal seams containing Upper Triassic (Rhaetic) plants have been found but the entire Mesozoic series appear to be represented at different places. The Mesozoic rocks are chiefly marine sandstone and limestone, but they include also tuff and conglomerate of porphyry and porphyrite. These porphyritic rocks, which form a characteristic element of the southern Andes, are volcanic, and as they contain marine fossils they must have been laid down beneath the sea. They are not confined to any one geologic horizon but occur at different levels in the Jurassic beds and at some places in the Cretaceous. Here and there they may be traced laterally into the more normal marine deposits of the same age. Much of the Andes is covered by the products of the great volcanoes that still form the highest summits. The volcanic rocks are liparite, dacite, hornblende andesite and pyroxene andesite. The recent lavas of the volcanoes in southern Chile are olivine-bearing hypersthene andesite and basalt.

Chile has suffered over the centuries from earthquakes as well as from volcanic eruptions. It is located on the boundary between the great heights of the Andes mountains and the equally great depths of the sea, an environment often associated with seismic activity. Over 100 serious earthquakes have been recorded in Chile since 1575. In the 20th century destructive earthquakes occurred in 1906, 1928, 1939 and 1960.

2. Relief and Drainage.—Because of the surface configuration of the country, the rivers are short and unimportant except for the life-giving waters they bring, and have little or no significance in directing the settlement or trade of the country. In the north they are few, and for a distance of approximately 600 mi. the waters of only one, the Loa, reach the sea throughout the year. This stream is the longest in Chile (273 mi.). The Copiapó, 112 mi. long, once discharged its waters into the sea, but rarely does so now, as the needs for irrigation are greater than the supply. The rivers to the south are better fed at their heads and flow through much less arid regions. Some of them become raging torrents at certain times of the year, and a number have been harnessed for the production of electricity. The electrification of the railroad in the Chilean section of the transcontinental line is complete, together with the main line from Valparaíso to the capital. With the increased demand for electric current has come also the storage of water for irrigation.

The lakes of Chile are among the most beautiful in the world. In southern Chile, south of the Bío-Bío river, there is a series of glacial lakes in the provinces of Cautín and Llanquihue. The largest of these lakes are Ranco and Llanquihue, the former with an area of 157 sq.mi., the latter 329 sq.mi. Because of its natural beauty, this lake region has become a resort place for Chileans and tourists at all seasons of the year.

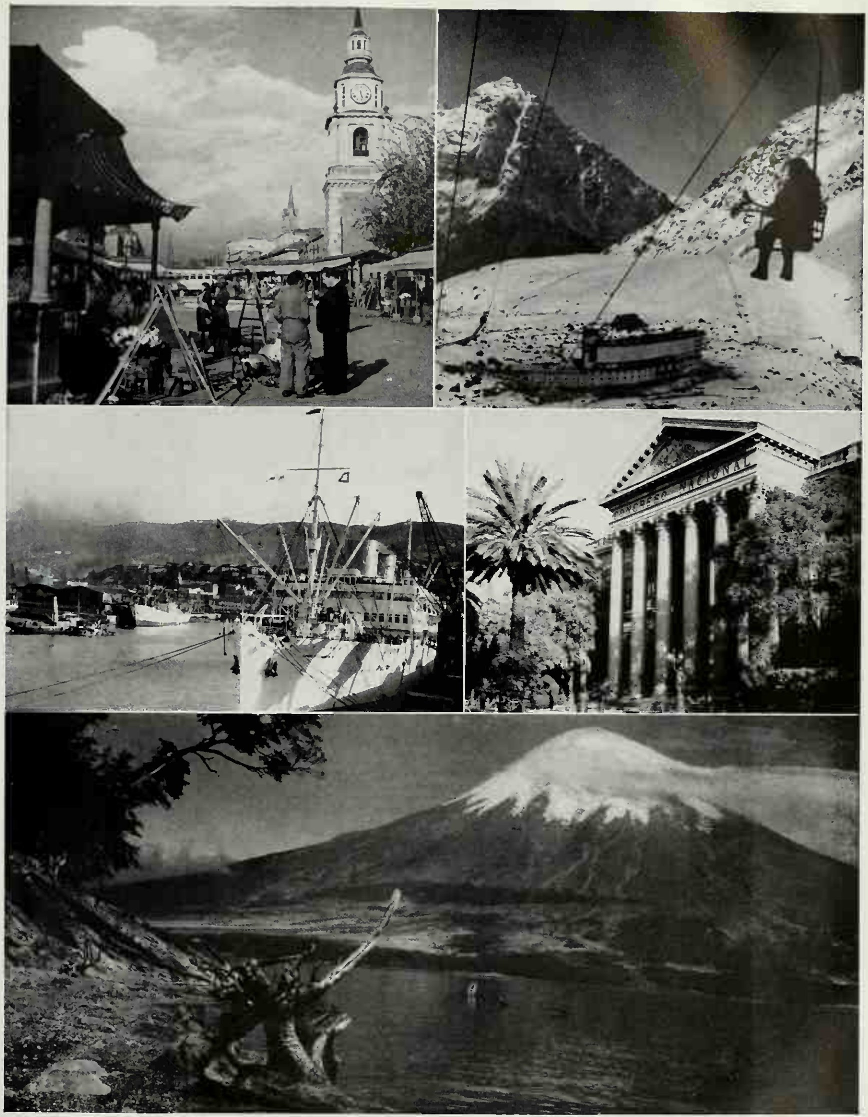
3. Climate.—Not many countries have as great climatic extremes as Chile. The north is an absolute desert, but there is a gradual increase in precipitation through middle Chile until it reaches a total in south Chile not surpassed by any extratropical region. The strong, permanent high-pressure area formed over the Pacific at about latitude 30° S. dominates the climatic conditions of northern Chile, accounting for its northward flowing winds and consequently for the great aridity of the region. South of this high-pressure area is a region of variable winds that accompany the passage of cyclones moving from west to east across the South Pacific ocean. The cyclonic belt moves north in the winter and south in summer, at times causing violent winds to sweep the Andean passes between Chile and Argentina. In middle Chile it makes its influence felt as far north as the region of Coquimbo, where it produces winter rains. In certain years or series of years this migration does not take place or goes on beyond the normal and the result is either great droughts or heavy rains.

South of the southern tip of Chile is a belt made up of numerous low-pressure areas, with unusually high barometric gradients, which produce very strong winds averaging over 30 m.p.h. and reaching peak velocities three or even four times that high. These moving low-pressure areas give a constant succession of storms for which the passage around Cape Horn has been renowned ever since its discovery, and farther northward give the southern part of Chile its westerly winds and heavy rainfall.

North Chile is the driest region of which there is any record. During a 21-year period Iquique had an average rainfall of 1.5 mm. (0.06 in.) and Arica for a 19-year period had less than one-half as much. On the Andean slopes of this region, periodic summer rains fall as low as 8,000 ft. with occasional heavy snows. Such precipitation may produce floods that spread mud and gravel over the valley and give rise to temporary salt lakes. Needless to say, such floods are calamitous; nitrates are destroyed, the nitrate works paralyzed, and the homes of the people, because of the poor mud roofs, practically ruined. Desert conditions extend southward to the latitude (27° S.) of Caldera or Copiapó, where a mean annual rainfall of about 15 mm. (0.6 in.) prevails.

The rainfall increases rapidly to the south, being 141 mm. (5.6 in.) at La Serena (30° S.) and 500 mm. (19.7 in.) at Valparaíso (33° S.). The increase southward is still fairly regular, reaching 2,707 mm. (107 in.) at Valdivia (39° 50′ S.). From there south, the rainfall is more or less uniform except for local modifications with the striking maximum of 5,379 mm. (216 in.) for south Chile at Bahía Félix (53° S.).

The rain-bearing winds come from the southwest. The western Andean slopes are wetter than the valley areas in all latitudes, and this is very noticeable even on the Andean slope of the northern desert region. This dry area thrusts a finger southward through the central valley nearly as far south as Santiago. The 10 to 20 in. rainfall area, whose southern coastal limit is at Valparaíso, extends southward through the valley nearly as far as Concepción, with a rain belt on either side of 20–40 in. and with a belt along the western slope of the Andes, overlooking the beautiful agricultural valley, of 40 to 80 in. This belted arrangement is still more marked in the southern rainy section. The various islands and embayments show a rainfall of 80–200 in.; the mountainous area directly to the east has a precipitation of over 200 in.; in Argentina the rainfall gradually decreases again



PHOTOGRAPHS, (TOP LEFT) FENNO JACOBS FROM THREE LIONS, (TOP RIGHT) PIX FROM PUBLIX, (CENTRE LEFT) PHILIP GENDREAU, (CENTRE RIGHT, BOTTOM) RAYS FROM MONKMEYER

VIEWS OF CHILEAN CITIES AND MOUNTAINS

Top left: Market place of Santiago
Top right: Ski lift and view of Grand Hotel Portillo in the Andes
Centre left: Ships in the harbour at Valparaiso
Centre right: Portico of the national congress building, Santiago
Bottom: Osorno volcano as seen from across Lake Todos los Santos

PLATE II

CHILE

BY COURTESY OF (BOTTOM LEFT) PAN AMERICAN UNION, (BOTTOM RIGHT) UNITED NATIONS; PHOTOGRAPHS (TOP LEFT, CENTRE RIGHT) PIX FROM PUBLIX, (TOP RIGHT) STOPPELMAN—PIX FROM PUBLIX

CHILEAN AGRICULTURE AND INDUSTRY

Top left: Vineyard workers carrying baskets of grapes to carts. Chile exports several millions of gallons of wine annually

Top right: View of the open-pit copper mines near Chuquicamata, Antofagasta province

Centre right: Whaler preparing to unload its catch of blue whales at processing plant

Bottom left: Natural nitrate being loaded on railway cars

Bottom right: Steers arriving in the livestock pens at Santiago to less than 20 in. Irrigation is needed throughout the central valley, not only because of the low rainfall but more especially because the greater part occurs in the winter. This discrepancy becomes less marked from north to south.

At La Serena over 98% of the rain comes in the six winter months and 82% in the three colder months. The percentages at Santiago for the same periods are respectively 90 and 73; for Concepción 83 and 61. Even at Punta Arenas 61% of the precipitation occurs during the six winter months, but south of the Bio-Bio the summers are not dry. The true Mediterranean climate is found from a little north of Valparaíso to just south of the Bio-Bío.

In general, for its latitude, the temperature is low. The cold Peru current, which strikes Chile in the vicinity of 40° S., flows northward along the entire coast, and keeps the temperatures low and uniform. The average summer temperature, even at Arica, does not rise above 75° F. Similarly the mean at Iquique is only 66° F., and at Antofagasta 65° F., although southward the temperature is somewhat lower as at Valparaiso, where it is only 58° F. At the latter place, the mean monthly temperature varies from 63.5° F. in summer to 52° F. in winter, and the thermometer seldom rises to 85° or falls below 38°. Santiago, at an altitude of 1,740 ft., has recorded extremes of 96° F. and 25° F., and on rare occasions snow falls in the city. At Valdivia, in the southern part of the central valley, January is the warmest month with 61.5° F. and July the coldest with 45° F. Because of the winter rainfall and the attendant cloudiness, the sensible winter temperatures are somewhat lower than the records indicate. But there is no doubt that the main inhabited parts of Chile enjoy some of the most pleasant climates of South America. (P. E. J.)

4. Vegetation.—With more than 70% of Chile mountainous, with altitudes from sea level to more than 20,000 ft., with rainfall from practically nothing to more than 200 in. annually, and temperatures from warm to cold, it is readily understandable that the flora is remarkably diverse. Three main plant zones, correlated chiefly with changes of altitude and climate, are evident.

The Chilean coast from the Peruvian border to latitude 20° S. is nearly barren, more nearly approaching an absolute desert than any other part of the world. South of 20° the heavy winter fogs of the coastal hills account for a seasonal flora, prominent in Antofagasta and Atacama provinces. Between 24° and 26° 50′ there are four main types of vegetation in the coast range, varying from drought-resisting desert shrubs, above and below the fog belt, to a more varied plant formation within the fog belt, containing among other species various cacti.

Between 20° 50′ and 37° S. is the Mediterranean zone, which has dry, cool summers and mild, rainy winters. This zone is diversified, and the flora varies with the altitude. Near sea level *Solanum maritimum*, a relative of the potato, is common. Up to 2,500 ft., characteristic plants are a treelike lily, *Crinodendron patagua*, and *Bellota miersii*. Over large areas in these lower altitudes species of low trees, such as *Acacia*, are common. On certain favoured slopes the soapbark tree (*Quillaja saponaria*) and *Lithraea*, among others, are found. Up to 4,500 ft. *Valenzuelia* and other shrubs grow. Below the snow line (about 14,000 ft. in central Chile) are the conspicuous cushion or mound plants, chiefly *Azorella* and *Laretia acaulis*. Many spring-flowering (October and November) plants, belonging to such genera as *Valeriana*, *Anemone*, *Cardamine*, *Libertia*, and *Oxalis*, are found in this zone.

Farther south is a humid area from 37° to 56°, between Concepción and Tierra del Fuego, with rain the year round in some places exceeding 200 in. This region is characteristically a dense, mid-latitude rain forest extending from slightly south of Valdivia to the Strait of Magellan. Several species of false beech (*Nothofagus*) and nine kinds of conifers constitute some of the principal trees in these forests. A motley variety of vines, shrubs, ferns and mosses abound, while in more open parts of the rain forest are found solid thickets of the wild bamboo, *Chusquea*.

Many distinct genera and species of plants are found only in Chile. Many of the Chilean plants are Andean in origin and relationship, and others are subantarctic. Examples of relict and isolated assemblages of plants occur in the flora, suggesting correlation with past climatic and geological changes and events. (J. A. Sk.)

5. Animal Life.—Except at the extreme south, where low passes lead to Patagonia, and at the north, where the deserts of both coast and highland merge with those of Peru and Bolivia, Chile is cut off from the rich life of South America by the barrier of the Andes, which extends north and south for hundreds of miles with scarcely a pass below the snow line. The larger Chilean mammals are the puma and guanaco, the Andean wolf and the huemul (a large deer), the foxlike chilla, and two kinds of wild cats. The mountain rodents include the almost extinct wild chinchilla. The south Chilean forest has distinct types of marsupials (especially *Rhyncholestes*), Darwin's fox, and the little spike-horned pudu, smallest of deer. Though rich in small birds, Chile does not have many of the more conspicuous South American bird types.

The Chilean bullfrog, *Calyptocephalella*, with a bony casque, is regularly eaten. The tiny Darwin's frog, *Rhinoderma*, is remarkable in that the male takes the developing eggs into his enlarged vocal pouch, where they transform into tiny froglets. The native fresh-water fishes are extremely few. The successful introduction of North American trout into the lakes of southern Chile has made them attractive resorts for fishermen.

(K. P. S.)

II. GEOGRAPHICAL REGIONS

It is customary to divide Chile into three major geographical regions. Middle Chile (or central Chile) extends roughly from near Coquimbo to the Bio-Bío river at the latitude of Concepción. Southern Chile, south of the Bío-Bío, is divided into a densely populated northern section and a southern section (south of Puerto Montt) that is very thinly populated. Northern Chile extends northward from Coquimbo to the Peruvian border.

1. Middle Chile.—The Chilean nation is formed around a single nucleus of concentrated settlement. About 73% of the total population lives in middle Chile, and if to this area is added the population of the northern part of southern Chile (between the Bio-Bio and Puerto Montt) the area would include 90% of the Chilean people. All the activities of Chilean life are concentrated in middle Chile, where the city of Santiago is the political, economic, social and artistic centre of the nation. The division of the country into provinces is for administrative purposes only. To a much greater extent than in other countries of Latin America, Chilean institutions are organized around a single geographic area.

As noted above, this middle part of Chile is the section that enjoys a Mediterranean type of climate. It has cool, dry summers and mild, rainy winters, similar to the conditions on the west coasts of all the continents between 30° and 40° of latitude. In many ways the landscape of this part of Chile reminds one of the central valley of California.

Soon after the Spanish conquest the land in middle Chile was marked off into private estates of vast size, known in Chile as haciendas or *fundos*. The system of large private estates owned by a small minority of the people and operated by tenant workers persisted almost unchanged and unchallenged until the 1920s. The census of 1925 showed that in that year middle Chile was divided into 82,084 rural properties. Of these properties, 76,588 were less than 200 hectares (ha.; about 500 ac.) in size. Only 5,396 properties, or about 7% of the total, were classified as haciendas because they were larger than 200 ha. But this small proportion of the properties included almost 90% of all the land in farms in middle Chile. In the valley of the Aconcagua river, which lies just inland from Valparaíso, 98% of all the land in farms was included in 3% of all the properties. Some of the haciendas were huge, covering more than 5,000 ha. (12,350 ac.) each. More than half of all the farmland in middle Chile was included in these large haciendas. The largest single property was the Hacienda Río Colorado, near Santiago, which had an area of 160,000 ha., or about 618 sq.mi.

Most of these huge properties, however, were not arable. On the Hacienda Rio Colorado, for example, only 250 ha. were capable of being irrigated; the rest of the property was too steep or too dry for the cultivation of crops. In the part of middle Chile that lies between Santiago and Concepción, only about 10% of the area can be cultivated; the remainder is useful only for pasture, or is not useful at all.

After 1925, and especially after 1945, some of the large private properties were broken up. The large haciendas have by no means disappeared, but large properties are intermingled with small farms. This process of change has not been brought about by revolution, as in Mexico, nor by government decree, as in some other countries, but by economic pressure. It has proved to be so profitable for the large landowners to subdivide their lands and sell them to small buyers that many of the hacienda owners have disposed of their lands and have retained only small farms for their own use. This process is possible only because the landowning class in Chile has been willing to convert land into cash and then to invest cash in manufacturing or commercial establishments. This willingness to engage in business pursuits distinguishes the Chilean landowners from their counterparts in most other countries of Spanish America.

As long as the large landowners maintained their rural estates, they chose to use them chiefly for grazing high-grade cattle and horses. Traditionally the hacienda owner was interested in stock-raising, not in farming. The tenants who lived on the haciendas (*inquilinos*) and worked for the owners were, of course, permitted to use some parts of the hacienda to raise their own food crops, chiefly wheat, potatoes, beans, peas, lentils, onions, artichokes and peppers. Unlike most other parts of Latin America, wheat occupies more land in Chile than does maize. Yet most of the land, and almost all the better land, has traditionally been used for irrigated alfalfa and other feed crops for the animals. Chile, as a result, does not raise enough wheat and other foods for its own people, but must import these supplies. The herds of fine cattle in middle Chile are driven up into the Andes to feed on the rich high-altitude meadows in the summer and are driven back to the central valley in the winter and fed on alfalfa.

The development of a typical Mediterranean agriculture in middle Chile has been retarded by this interest of the large owners in pastoral activities. Nevertheless, some of the hacienda owners had turned their attention, even before 1925, to the production of characteristic Mediterranean crops. This is the kind of climate that is especially well suited for the production of grapes and wines. Chilean wines are generally acknowledged to be the best produced in Latin America, and of a quality that permits them to compete with wines from the Mediterranean countries of the old world. There are also small areas devoted to the growing of olives and other fruits. The total area used for these characteristically Mediterranean crops, however, is not nearly so large as the area that is physically suitable for this more intensive kind of agriculture.

The breakup of the large properties has increased the area used for Mediterranean crops, including the food crops for domestic consumption. The small property of less than 200 ha. in size is not large enough to use for pasture. Former hacienda lands, subdivided and sold in small units, are now used for orchards, vineyards and wheat. These changes in landholdings and in land use are transforming the character of middle Chile.

Along with the transformation of the rural areas of middle Chile there has been a great increase in the size of the cities and in the variety of urban manufacturing. Three of Chile's four major industrial cities are in middle Chile: Santiago, Valparaíso and Concepción. The fourth, Valdivia, is in the northern part of southern Chile. The first three have all grown rapidly since the 1920s: Valparaíso and Concepción have populations well over 100,000, and Santiago over 600,000 people. The original rectangular city of Santiago has been surrounded by industrial suburbs and slums.

2. Southern Chile.—For a long time after the first Spanish colonization of middle Chile, the Bío-Bío river remained a frontier. South of this river the open landscape of middle Chile originally gave way to the dense forests of the rainy south. Until 1850 the southern forests were left to the Indians, except for a few coastal towns. But in 1850 the first pioneer settlements of Germans entered this region and began to demonstrate how the forested lands could be successfully occupied. After the War of the Pacific (1879–84; *q.v.*) a flood of new pioneer settlers moved southward into the forests south of the Bío-Bío. The province of Valdivia, for example, had only 8,860 inhabitants in 1835, but by 1907 it had 133,443. The original German colonies had been north of Puerto Montt near Lake Llanquihue. But when the Chilean pioneers entered the region the forest was rapidly cleared and the whole area was settled wherever the land was level enough and dry enough to make settlement possible.

In contrast to the form of settlement in middle Chile, this southern frontier was occupied by small farmers, each doing the work on his own property. There were few large estates and no class of large hacienda owners. On the new clearings in the forest the settlers raised wheat and pastured cattle. Of the total area of southern Chile only about 20% is used for food crops; yet on this area is produced the greater part of Chile's wheat. Because of the wet climate only a kind of soft wheat is grown. The production of wheat is concentrated in the territory immediately to the north of Temuco. In addition to wheat the farmers of this region grow potatoes, oats, apples and hay, and use their fields in rotation for the grazing of beef and dairy cattle. However, because of the lack of a market for dairy products, this ideal dairy country is by no means used to capacity. Most of the cattle, here as in middle Chile, are raised for beef.

There is a considerable industrial development in the northern part of southern Chile. On the peninsula of Lebu there are coal mines, some of which extend out under the ocean. The coal is of poor quality, but after processing it can be used in the steel plant near Concepción. Lumber is used for the manufacture of furniture in Valdivia, and there is a boatbuilding industry on the island of Chiloé.

The northern part of southern Chile is famous for its scenery and opportunities for recreation. The lake district, with its magnificent lakes held behind glacial moraines, its background of rugged mountains and its spectacular cone-shaped volcanoes, reminds one strongly of the western borders of the Cascade mountains in Oregon and Washington. The lakes, stocked with North American trout, attract many fishermen in the summer season; in the winter this part of Chile has become one of the world's major ski centres.

All these activities, however, are concentrated in the northern part of southern Chile, between the Bío-Bío and Puerto Montt. The latter town, like Tacoma, Wash., faces the beginning of the embayed section stretching on toward the poles. The similarity of the island of Chiloé to Vancouver Island is striking. To the south, steep rocky islands rise abruptly from the water's edge. Exposed to the open ocean, the cliffed shores are pounded by terrific surf, and only in the sheltered bays and fiords can landings be made. Immediately above the rocky cliffs at the shore the wet tangle of forest covers the land—as far up as the lower limit of permanent snow, which, in Tierra del Fuego, is only 2,500 ft. above sea level. The far south of Chile has one of the world's most unpleasant climates: never very cold, never warm, always cloudy, blustery and wet with sleet or cold rain. The southern coasts are sparsely inhabited by some of the world's most primitive tribes.

Settlement by Chileans in the south is limited to a few areas. Puerto Aysén, at the head of a deep fiord, gives access to sheep pastures in Patagonia across the mountains. On the Strait of Magellan, Punta Arenas is a very old settlement that also serves a sheep-raising area in Chilean territory on the eastern side of the Andes where the climate is relatively dry. In late 1945 oil was discovered in Tierra del Fuego. Since then oil and gas have been produced in these fields, and settlements appeared where only a short time before the land had been entirely unoccupied.

3. Northern Chile.—Northern Chile lies to the north of Coquimbo at about 30° S. and includes the Atacama desert (*q.v.*). In contrast to the rest of Chile this area is very dry and offers few spots suitable for agricultural settlement. Along the western piedmont of the Andes small Indian settlements were established long before the arrival of the Spaniards. With water taken from wells, small areas could be irrigated and used for the growth of maize. But for both Indians and Spaniards the Atacama remained for a long time only a region to be crossed as quickly as possible. When the Spaniards found silver in the mountains of what is now Bolivia, some of it was brought to ports along the harbourless coast—such as Antofagasta. There were only a few oases where rivers from the mountains provided reasonably certain supplies of water. In the north there was the oasis of Tacna (in Peru) and its port Arica (in Chile). Far to the south, where the Loa river emerges from the Andes, there was the oasis of Calama, served by the port of Antofagasta. And far to the south, again, the oasis of Copiapó was served by the port of Caldera.

In the colonial period Tacna was recognized as a part of Peru, Calama belonged to Bolivia, and Copiapó was in Chile. But the boundary between these territories remained undefined. During the 19th century methods were invented for making use of nitrate, the unique natural resource of the Atacama. It was first used for fertilizer early in the century and by the middle of the century its use for the manufacture of gunpowder had been started. By 1860 a thriving mining industry had been established, and for the first time the location of the boundaries became important. After many difficulties, Chile declared war on Peru and Bolivia and by 1883 had occupied and established ownership of all the desert country as far north as Arica. Several new nitrate shipping ports were established, such as Iquique, connected with the mining communities to the east by steep railroads over the coastal scarp. As long as nitrate provides economic support, mining towns can be supported in places where even water must be shipped in from outside. The part of Chile north of Copiapó has proved to contain a wealth of resources on which the Chilean economy is all too dependent.

In the 20th century copper has become even more important than nitrate. The copper comes from three large mining areas: Chuquicamata, near Calama in the Andes; Potrerillos, in the Andes a little to the north of Copiapó; and El Teniente, in the Andes east of Santiago. Northern Chile has proved to be a most valuable national asset, even though only a small proportion of the Chilean people live there. (P. E. J.)

III. THE PEOPLE

1. Racial Types.—The population of Chile is predominantly white, although intermarriage with the Araucanian and other Indian groups has taken place over the centuries and continues at a slow pace. By this process the Indians have been gradually assimilated into the white group. According to estimates made by the Chilean census bureau there are fewer than 150,000 persons, or about 2% of the total population, who could be considered predominantly Indian (largely Araucanian).

A strict and relatively efficient program for controlling immigration from Europe and from the other American republics has obviously influenced the physical structure of the population. The policy was established during the colonial period when only Spanish citizens could enter the colony. Colonists during this period came largely from the regions of the Basque provinces, Castile and Andalusia. About the middle of the 19th century a movement to bring in German immigrants was initiated and continued until the end of the century. The influence of this movement is evident throughout Chile, especially in the south around Valdivia, Llanquihue and Osorno, where many of the people still retain German customs.

Other European countries that have made important contributions to Chilean immigration include Italy, the British Isles, France, Switzerland and Yugoslavia. Small contingents of refugees from northern and central Europe were admitted after World War II. As a result of these movements family names such as O'Higgins, O'Brien, Ramsey, Edwards, Walker, Eastman, Ward and Sauer are common.

2. Languages.—Spanish is the dominant language of the country, although several Indian dialects are still spoken in relatively isolated areas. Many of the people of southern Chile still speak German but Spanish is slowly replacing it.

3. Religion.—As in all Latin-American countries, Roman Catholicism is the predominant religion. Chile, however, traditionally has maintained a policy of religious tolerance that has resulted in the development of major groups of Protestants throughout the country, especially in the cities of Santiago, Concepción, Valdivia and Antofagasta. Many of these religious groups sponsor and operate extensive programs for community development and rural welfare with emphasis upon health and education. The Roman Catholic religion was maintained by the state until 1925, when the church was disestablished.

4. Customs and Culture.—There is a traditional two-class social structure in Chile (*see* below), but the people have embraced various democratic institutions. Democratic government is evident in a wide variety of forms in village and community life, including freedom of speech and of the press. Chilean women, who obtained the right to vote in local elections in 1934 (and in national elections in 1949), were among the first in western countries to assert social and political independence by participating in public affairs and by directing their own personal lives with a minimum of interference from parents and other relatives.

Chilean family life is woven tightly into a pattern of social and economic interdependence strongly fortified by a deep sense of loyalty and mutual responsibility. So complete may be the pattern that many members limit their personal contacts outside their homes almost exclusively to relatives and a few close friends. Although there has been some loosening of family ties, particularly in cities, most social life goes on within the boundaries of kinship, in large part controlled by the much respected elders of the group.

Chile has been a pioneer among American nations in many fields of social welfare, labour laws, low-cost housing and accident insurance. Broad social legislation in these fields has relieved the family of some of its economic and social responsibilities, although most members still recognize obligations for family and individual misfortune when the state fails to do so.

For upper- and middle-class families meals are often social affairs of some importance, where many formalities are observed and where time is not a factor of major importance. A light breakfast and heavy lunch and dinner are supplemented by snacks (*meriendas*) of sandwiches and sweets at midmorning and midafternoon. Excellent wines are produced in quantity and liberal use is made of both red and white varieties at mealtime. Chilean cuisine is considered among the best of the Americas. Beef and fowl are prepared in a multitude of ways, as are the fish and shellfish that abound along the entire coast. Seafood specialties include *Cochayuyo*, or seaweed; *Erizos*, or sea urchins; and *Locos*, a type of scallop. Some of the more common native dishes are *empanadas*, meat-filled cakes; *pastel de choclo*, a combination of corn, meat, chicken and vegetable; *cazuela*, a stew containing chicken, corn, vegetables and rice; and *humitas*, a mass of ground sweet corn wrapped in the corn husk and boiled.

In addition to the cosmopolitan activities characteristic of the large cities, there are many dances, fiestas and other social activities throughout the nation. The folk and popular music is largely Spanish in origin, with the exception of that of the Araucanian Indians, who have preserved some of their ancient songs and instruments. Some of the native dances are strikingly gay and colourful. The *cueca* is perhaps the most widely popular at all occasions. It has been called the dance of love or of conquest. The music for the *cueca* is rapid and rhythmic with the guitar the dominating instrument. Male and female partners dance with handkerchiefs twirling about their heads and shoulders while the audience applauds the more dextrous couples. Men frequently dance in high, hard-heeled boots with which they beat out staccato notes with considerable skill. Other popular dances include the *zapateo*, a tap dance common in South America, the Spanish fandango and the *cuando*. Semiprofessional bands may be found in most rural villages and towns.

A popular form of amusement is the rodeo, where Chilean cowboys or *huasos* compete in horsemanship and in the ability to turn a steer or other animal at full gallop in a round corral. So difficult is the feat that specially-bred horses are trained for the task from the day they are broken to the saddle. The costume of the Chilean *huaso* is elegant and picturesque, consisting of a broad-brimmed black hat, short and colourful poncho, short-cut jacket adorned with many buttons, and tight-fitting, high-waisted trousers pulled over low-cut boots from which hang spurs that often are of delicately-worked silver. A good rodeo with *huasos* of recognized skill will draw audiences from miles around.

5. Class Structure.—A very definite division of the population into two social and economic classes, generally referred to as upper and lower, and the influence of this division in every phase of life has been noted by many students of Chilean life. Prior to 1890 hardly any individual fell outside the limits of these two classes: the upper class, largely a landholding aristocracy, wealthy, well-traveled and cultured; and the numerous lower class group referred to popularly as the *rotos* or "broken ones." The historical basis of this classification is rural, growing out of the tremendous importance attached, during both colonial and early republican periods, to the possession of land. From the rural scene its influence spread out to affect national life at every turn. One's class conferred a practically indelible life stamp that could be erased only by special circumstance. The accumulation of wealth by one from the lower class was by no means a guarantee of admission into the upper stratum of society. Even in the case of a decline of wealth, some respectable form of government employment usually could be found for the less fortunate of the elite, sufficiently remunerative to enable them to maintain appearances. Members of the upper class dominated politics as well as professions such as law and medicine. They were in general control of banks and other financial institutions. The lower class was composed mostly of city labourers and rural tenants and wage labourers. Limited educational facilities for children of the lower classes effectively blocked their entering the professions.

By mid-20th century there was considerable evidence of change in the traditional two-class system. A large group of families and individuals exhibited many middle-class characteristics, including both an improved economic status and a set of values based upon a relatively advanced program of human rights. This was the result, in large part, of the growing strength of labour (trade) unions in the cities and mining areas, where they were obtaining higher wages and better working conditions for skilled and unskilled workers. Another important factor in this development was the improvement of a school system that formerly not only barred many poor children from participation but also offered those who attended only the fundamentals of the three R's. Upper-class Chileans were quick to note that the new group no longer identified itself with the lower-class working group, over which it felt it had achieved something, and made no effort to identify with the aristocratic upper class, from which it had to establish its independence.

Additional material on the archaeology, settlement and ethnology of Chile will be found under INDIAN, LATIN-AMERICAN; and SOUTH AMERICA. *See* also ALACALUF; ARAUCANIAN; ONA; TEHUELCHE; YAHGAN. (O. E. L.)

IV. HISTORY

At the time of the Spanish conquest of Chile in the mid-16th century the region was inhabited by about 500,000 Indians. Nearly all the natives were closely related in race and language, but the culture of those tribes north of the Maule river was more advanced than that of the others, for they had been influenced first by the Chinchas of Peru and second by the Quechuas, who formed part of the extensive empire of the Incas.

The conquest of Chile began in 1536–37, when forces under Diego de Almagro (*q.v.*), associate and subsequent rival of Francisco Pizarro (*q.v.*), invaded the region as far south as the Maule river in search of an "Otro Perú" (another Peru). The discouraging reports brought back by Almagro's men forestalled further attempts at conquest until 1540–41 when Pizarro, after the death of Almagro, granted Pedro de Valdivia license to conquer and colonize the area. Valdivia, with about 150 companions, including his mistress, Inés Suárez, the only Spanish woman in the company, entered Chile in late 1540 and founded Santiago (Feb. 12, 1541). For the next two decades the settlers lived a precarious existence and were constantly threatened by the Indians, who resisted enslavement. Before the safety of the colony was guaranteed, land was apportioned to the conquerors, and thus was begun the system of large estates mentioned above. The estates were later institutionalized through the *mayorazgo*, a practice of transmitting estates by entail.

Valdivia did not undertake the conquest of the region south of the Bío-Bío river until 1550. In that year Concepción was founded and preparations were made to move southward. During the next two years settlements and forts were established in La Frontera, but the Indians rose in a revolt that led to the capture and death of Valdivia and to the beginning of a costly struggle. The Araucanians, often referred to as the Apaches of South America, kept the struggle alive until the 1880s by successfully adapting their way of life and military tactics to changing conditions. Although Concepción was destroyed on several occasions it remained as the Spanish outpost in the south as did La Serena, founded in 1544, in the north. The province of Cuyo held the same position east of the Andes until 1776 when it was made a part of the newly created viceroyalty of La Plata. Before the end of the 16th century English pirates and freebooters, including Sir Francis Drake and Thomas Cavendish, and later Dutch adventurers harassed the coast in search of sudden wealth and as part of a prolonged effort to force Spain to permit trade with its new world colonies.

1. Colonial Period.—As little precious metal was found in Chile the settlers early turned their attention to agriculture. They grew a wide variety of cereals, vegetables, and fruits, raised livestock, and consumed nearly all of their production locally. Largely because of the poverty of the colony, there were never more than a few thousand Negro slaves, and since the Indians proved to be an unreliable source of labour the settlers often had to work the fields themselves. The lack of mineral wealth made the area unattractive to Spaniards, and at the end of the 16th century there were no more than 5,000 Spanish settlers in the entire colony. In this regard it should be pointed out that, beginning in 1600 and continuing until trade restrictions were relaxed in the late colonial period, Chile was a "deficit area" in the empire, and the Spanish crown had to provide an annual subsidy to meet the expense of maintaining officials in Santiago and an army on the Araucanian frontier.

Chile lived under the same administrative and religious systems as its neighbours, but because the colony was poor there was, until the 18th century, a tendency to send mediocre officials to preside over its destinies. The Spanish crown and the Roman Catholic Church combined to deprive the colonists of any democratic experience. The influence of the Catholic Church in secular affairs was always significant and frequently decisive.

The most apparent social development after 1600 was the rapid growth of a mestizo (mixed Indian and European) group. By the end of the colonial period, when the population of the colony reached an estimated 500,000 (not including unsubjugated Indians), approximately 300,000 were mestizos and about 150,000 were Creoles (native-born persons of European descent). About 20,000 were peninsulars (recently arrived Spaniards), perhaps 10,000 were Negroes and a handful were recently emancipated Indians. At the end of the colonial period, the vast majority of the population was concentrated in the Aconcagua valley and the central valley (extending from Santiago to Concepción) which together form "the cradle of Chilean nationality."

Education in colonial Chile was almost a complete monopoly of the Catholic clergy. However, in 1758, courses were opened in the Royal University of San Felipe at Santiago and attracted students from the Spanish colonies across the Andes. Nonetheless, Chile was an intellectually backward area at the beginning of the 19th century. The colony did not have a printing press until shortly before it won independence from Spain in 1818, and the paucity of contacts with the outside world prevented even the elite group from having informed opinions on developments in Europe and the United States.

2. Struggle for Independence.—Despite the colony's isolation, its inhabitants at the start of the 19th century were feeling the effects of developments elsewhere. The most significant of those developments were the winning of independence by the 13

Anglo-American colonies and by Haiti, the French Revolution, and the inability of Spain to defend its system in America, as indicated by the British invasion of the La Plata region and increased contraband trade on the part of British and U.S. citizens. Finally and decisively came the intervention of Napoleon in Spain, an act that in 1808 threw Chile and the other colonies on their own resources and led them to take the first steps toward greater autonomy and self-government. In Chile the initial step toward independence was taken on Sept. 18, 1810, when a *cabildo abierto* (open town meeting) in Santiago, attended by representatives of privileged groups whose vaguely defined objectives included a change in administration, accepted the resignation of the president-governor and in his place elected a junta.

From 1810 to 1813 the course of the patriots was relatively peaceful. Trade restrictions were relaxed; steps were taken toward the eventual abolition of slavery; a newspaper was established to publicize the beliefs of the patriots; and education was promoted, including the founding of the Instituto Nacional. However, the embers of civil strife were also fanned. The Creoles were divided over how far the colony should go toward self-government. José Miguel Carrera (*q.v.*) and his brothers, whose desire for complete independence was equalled if not surpassed by their personal ambition, inflamed the issues. Meanwhile, Spain had taken steps to reassert its control over the colony. At the battle of Rancagua on Oct. 1 and 2, 1814, it re-established its military supremacy and ended what has been called *la patria vieja* (the old fatherland).

Following the defeat at Rancagua, patriot leaders, among them the Carrera brothers and Bernardo O'Higgins (*q.v.*), future director-dictator of Chile, migrated to Argentina. There O'Higgins won the support of José de San Martín (*q.v.*), who was raising an army to free the southern portion of the continent by first liberating Chile and then attacking Peru from the sea. The Carreras continued their spirited agitation for independence in Buenos Aires and the United States. Meanwhile, many of those who remained in Chile suffered from the harsh rule of Spain's inept representatives and became convinced that absolute independence was necessary. In Jan. 1817, San Martín's well-drilled army, with O'Higgins as one of its commanders, began its march across the Andes; and on Feb. 12, 1817, the patriot forces defeated the royalists on the hill of Chacabuco, which opened the way to Santiago. O'Higgins was proclaimed supreme director of Chile, although the act of declaring Chile's independence was not taken until a year later (Feb. 12, 1818), on the first anniversary of Chacabuco; and the decisive defeat of Spain on the Chilean mainland (Spain held the island of Chiloé until 1826) did not come until the battle of Maipo, April 5, 1818. Before emancipation was assured, O'Higgins began the creation of a Chilean navy, which by late 1818 was in the process of clearing the Chilean coast of Spanish vessels.

Chile was free, but its inherent weaknesses were everywhere manifest. The Creoles remained bitterly divided between O'Higgins and the Carreras. Two of the Carrera brothers had been executed in Mendoza, Arg., in 1818 and José Miguel Carrera suffered the same fate in the same city in 1821. The elite groups were dedicated to the retention of those institutions on which such things as law, property, family and religion were founded. The masses, who had been little more than spectators in the conflicts between 1810 and 1818, were not invited to participate in government. In any event they had few permanent values or interests to defend. As the war of independence had gone on year after year the financial hardships of the new state had increased alarmingly, force had been increasingly substituted for reason, and personalism had been raised to the level of a political ideology.

3. Dictatorship and Anarchy, 1817–30.—Personalism and force predominated between 1817 and 1830 as Chile passed through an era of political turbulence and dictatorship. O'Higgins controlled the new republic until 1823 when widespread discontent brought about his resignation and exile to Peru. He tempered the radicalism born of the independence movement with a conservatism that guaranteed the gains achieved in the struggle against Spain and made possible the utilization of basic institutions inherited from Chile's colonial past. Many of the failures attributed to O'Higgins were beyond his control to prevent, for the republic was impoverished and its leadership had a minimum of experience in self-government. O'Higgins was not a politician. He alienated the Catholic Church by his insistence upon the nation's right of patronage over ecclesiastical appointments and his opening of a cemetery for non-Catholics. His decision to abolish titles of nobility and his approval of a move to suppress the *mayorazgos* cost him support among the landed elite. He permitted the salaries of soldiers to remain in arrears.

Ramón Freire, militarist, anticlericalist, and sectionalist (he represented the forces of the south that resented the monopoly over the government enjoyed by Santiago), seized the power surrendered by O'Higgins. Freire continued the attacks upon the church initiated by O'Higgins and brought about the abolition of Negro slavery. An ill-advised attempt at federalism made in the constitution of 1826 was a major factor in Freire's temporary eclipse in 1827; but an election brought to power a congress and president friendly to him.

In 1828 an unworkable liberal constitution was promulgated. This constitution had the effect of sharply dividing the responsible elements of society into two parties—*pelucones* ("bigwigs") who were conservative and Catholic; and the *pipiolos* ("novices") who were liberal and anticlerical. Matters reached a crisis in 1829 with the outbreak of civil strife between Freire, spokesman for the liberals, and Joaquín Prieto, a military chief acceptable to the conservative elements. The issue was decided by force of arms at Lircay, April 17, 1830, with the utter defeat of the liberal forces.

4. Autocratic Republic, 1831–61.—The victory of Lircay ushered in an era of political stability and peace under conservative domination that lasted until 1861. The period has been commonly referred to as the "autocratic republic." Joaquín Prieto was president during the 1830s, but the strong man of the regime was the haughty and overbearing Diego Portales. Either as cabinet member or private citizen he ruled as a virtual dictator until he was assassinated in 1837. Before becoming the guiding genius of the nation's destiny, Portales had been a businessman and had developed an abiding contempt for the popular masses who, he asserted, "must be given both bread and blows," and for "the shibboleths of democracy, republicanism, and freedom."

As leader of the nation, Portales, the Alexander Hamilton of Chile, spoke for the rich landowners and traders. In their interests he imposed order and unity upon a previously anarchic people. The opposition press was ruthlessly silenced. The army was cleared of dissenters and made responsible to the presidential will. Portales was a skeptic but esteemed the church as an instrument to restrain the masses. He restored to the church the influence it had lost during the struggle for independence and gave it full partnership with the state. Attempts to end the entailed estates were dropped. As part of a determined effort to promote trade, the port of Valparaíso was developed, foreign businessmen and capital were invited in, and the public debt was refunded. Mineral production rose sharply as the decade drew to a close.

Rule by the class and under the system that Portales represented was legalized by the constitution of 1833, which, with a few amendments to alter its aristocratic character somewhat, remained the national charter until 1925. It combined aristocratic supervision with autocratic administration. The president was given almost unlimited power over a highly centralized government. Property qualifications for suffrage left control of the nation in the hands of no more than 10% of the population.

Although Portales was indifferent to popular education, he stimulated intellectual activity by providing a favourable working climate for emigrants to Chile and by inviting scholars from abroad. The Venezuelan-born man of letters Andrés Bello (*q.v.*) and the French naturalist Claudio Gay headed a distinguished list of learned men who made Chile the intellectual centre of Latin America before 1850.

Economic competition between Chile and Peru and a move on the part of Bolivian dictator Andrés Santa Cruz to federate his nation with Peru, a measure interpreted by Portales as a threat to

Chile, brought a three-year war with the confederation (1836–39). Portales mercilessly crushed those who opposed the war. His assassination by mutinous soldiers in June 1837 helped to unite the nation and to popularize the war, which was carried to a successful conclusion. The victory assured the predominance of Chile on the west coast.

After the death of Portales, Chile began to enjoy its material prosperity and cultural activities, both of which had made rapid progress following the return to political stability in 1830. Chile became an enclave surrounded by republics in various stages of political anarchy, economic deterioration and cultural darkness. It was in this atmosphere that Manuel Bulnes (*q.v.*) assumed the presidency, which he held from 1841–51.

Bulnes' term of office was marked by rising nationalism, material and technological advances, and cultural progress. Under the impulse of a new-found nationalism, the country began to expand its settled area and to strengthen its claims to unmarked frontiers. German immigrants were brought in and settled in the Araucanian stronghold below the Bío-Bío. Chile pushed its claims to territories around the Strait of Magellan, in Tierra del Fuego and in Patagonia. When Argentina challenged Chile's actions, diplomatic controversies were opened that were not resolved until the 20th century. The public debt was liquidated and the customs were better regulated. Steamship lines were established, flour mills were constructed, coal mines were opened, and the output of precious and semiprecious metals was increased. A flourishing but short-lived trade with California, after gold was discovered there in 1849, added to the nation's prosperity.

Peace and progress made Chile a mecca for intellectuals—among them Domingo Faustino Sarmiento, Bartolomé Mitre, Vicente Fidel López, exiles from the Rosas tyranny in Argentina, and Juan García del Río of Colombia, who added their talents to those of intellectuals who had arrived earlier. A normal school was founded in 1842. The University of Chile with Andrés Bello as its rector opened in 1843. Within the decade, a school of agriculture, a technical school, a conservatory of music, and a school of architecture and painting were founded. Newspapers and literary journals provided forums from which Chilean intellectuals such as José Lastarria, a liberal, and Francisco Bilbao, strident anticlerical, strongly influenced by the European revolutions of 1848, launched attacks upon the established order. The achievements of Manuel Montt (*q.v.*) as minister of education did much to promote his claims to the presidency of the nation, a post he held for ten years beginning in 1851.

An armed uprising aimed at preventing Montt from assuming the presidency was ruthlessly suppressed by the Conservatives. The new president displayed a keen appreciation of the need to develop the nation's natural resources, an enlightened conservatism and a pedantic devotion to law. He outlawed the *mayorazgo*, which laid the basis for a sounder agricultural economy by encouraging the division of estates among the children of landowners. Railroads, telegraph lines and water systems were built, and schools charged with providing skilled craftsmen and trained technicians were publicly financed. At the same time, Montt as president denied intellectuals the freedom he had guaranteed them as minister of education. With encouragement from the president, Andrés Bello completed the codification of Chilean laws, a project he had begun many years earlier.

Emerging elements in society who economically favoured industrial capitalism over agrarian feudalism and who politically insisted on greater congressional power at the expense of the executive branch were becoming increasingly vocal at a time when Montt split his own party and took the first step toward anticlericalism when he eliminated the compulsory ecclesiastical tithe. The division within conservative ranks enabled the rising elements to force personnel changes in Montt's administration. Montt later suppressed an armed revolt but realized he could not impose his own choice of a successor, so he agreed to a candidate acceptable to the new groups—José Joaquín Pérez, a man admired by the liberals and trusted by the church. The acceptance of the compromise candidate ended 30 years of absolute rule by the *pelucones*.

5. Liberal Republic, 1861–91.—Supported by a fusion of Liberals and Conservatives, the presidency of José Joaquín Pérez, from 1861 to 1871, initiated a 30-year-long era known as the "liberal republic." During those three decades conservative aristocratic governments were succeeded by liberal administrations; the political elite, however, still came from the traditional families and had little taste for bringing the masses into the nation's political life. Politics became confused to the point where labels meant little as new parties emerged and old ones splintered. Anticlericals consistently won victories over the Catholic Church. Largely as a result of a military victory over Peru and Bolivia that gave Chile control of the rich nitrate zone of the Atacama desert, the nonagricultural sectors of the national economy spurted. New entrepreneurs stood on common ground with the old political liberals against the remnants of feudal control. The Liberal doctrine was made the philosophic justification for a new capitalism. Economic diversification, an enlarged bureaucracy, the expansion of public education, the professionalization of the army—all these contributed to a notable expansion of the middle classes.

The ability of the Liberals to win the approval of the middle groups, and those members of the emerging industrial proletariat who could qualify for the vote under relaxed suffrage requirements, encouraged the Conservatives, who were losing strength, to support measures designed to weaken presidential authority.

The forces that in 1860–61 broke the political monopoly of the Conservative party almost immediately set out to exploit their newly won advantage. Before the Pérez regime ended they had given added impetus to technological development and reformed the secondary curriculum. They had amended the constitution (1865) to guarantee non-Catholics the right to educate their children in their own faith and to worship within buildings belonging to private individuals or associations. They had also weakened the executive branch of the government in 1868 by an amendment to the constitution that prohibited the chief executive from succeeding himself. An unwarranted bombardment of Valparaíso by Spain in 1866 was one of the chief episodes in a brief war that only momentarily halted the march of progress in Chile.

Under Pres. Federico Errázuriz Zañartu (1871–76) the reform movement was accelerated. The power of the president was further restricted and a measure was adopted providing for minority representation in the house of deputies. The power of the church was further reduced when a law was passed stipulating that decent burials should be provided for Protestants in sections set apart in public cemeteries, and the Catholic clergy were made accountable to the lay courts for all civil and criminal offenses. Security and well-being encouraged learning. Benjamín Vicuña Mackenna and Diego Barros Arana (*q.v.*), responding to the vigour of the period and to the still rising sense of nationalism, lifted the historian's craft in Chile to unprecedented levels. The University of Chile was expanded, and Santiago was modernized and beautified.

Errázuriz was succeeded in the presidency by Aníbal Pinto, who was confronted with a world-wide economic depression, aggravated in Chile by crop failures and a serious decline in the price of copper. In the face of a treasury deficit the government began to issue inconvertible paper money, one result of which was a rapid rise in the cost of living. Before Chile was able to recover from the economic crisis, disputes with Bolivia and Peru over the nitrate area led to war. The conflict, known as the War of the Pacific, ended victoriously for Chile in 1883; the nitrate area passed to Chilean control, thereby greatly increasing the national territory and providing the government with an easy source of revenue. Chile acquired temporary control of the Peruvian provinces of Tacna and Arica with the understanding that their final disposition would be determined by a plebiscite. The final decision was postponed repeatedly and the issue became known as the Tacna-Arica dispute (*q.v.*).

In 1881, before the War of the Pacific ended, Domingo Santa María, a strong Liberal, became president. Under him troops raised originally to fight Peru and Bolivia were sent to the south and finally subdued the Araucanian Indians. The peso depreciated to about half its former value, and prices rose accordingly. Santa María gave fervent support to liberal measures. Congress assumed the power to override the president's veto by a two-thirds vote, curtailed the powers of local officials (ordinarily tools of the president), and relaxed the suffrage requirements by abolishing economic qualifications. Cemeteries were secularized, and civil marriage and civil registry were recognized.

The liberal reformer José Manuel Balmaceda (*q.v.*) was inducted as president in 1886 under seemingly auspicious circumstances. The Chilean people were confident of their destiny. They had just won a major war and had expanded their national boundaries. Revenues from nitrates made it possible to keep to a minimum the tax burden on the wealthy class and at the same time to institute a large public works program and to promote education. In 1888 Chile formally annexed Easter Island (*q.v.*) in the Pacific ocean about 2,300 mi. W. of the port of Caldera. But there were countervailing influences. The government made no attempt to abandon the system of paper money that had brought misery to the popular groups. The Liberals were split into a number of factions. The Conservatives fought the president because of his anticlericalism and indicated their objection to the increasing influence of the new professional and economic elements in education by founding Catholic University of Chile (Santiago) in 1888. Finally, the president failed to rally congress behind him. By 1890 his congressional support had melted away to the point where he could not gain approval of his budget. He countered by announcing that he would proceed without congressional sanction, thereby assuming dictatorial powers. A week later congress, supported by the navy and with widespread popular approval, voted to remove him from office, and the country was plunged into civil war. The navy promptly seized the nitrate ports, thus assuring the congressional forces a ready source of revenue. Eight months later and at the cost of thousands of lives and many millions of pesos the congressional forces were victorious. After they entered Santiago, Balmaceda took his own life, thereby terminating the long era of presidential autocracy.

6. Harvest of Parliamentarism.—The triumph of the congressional elements and the solidification of their victory marked the beginning of a period during which Chile continued to cut the ties that bound it to its feudal agricultural past and to associate itself more closely with industrial capitalism. But before the republic had time to examine its fortunes following the civil war it was confronted with a series of international problems that claimed much of its attention during the next two decades. Chile's success in resolving a number of thorny issues without resort to force reflected credit upon the republic.

Resentment was aroused against the United States over its sympathy for Balmaceda as indicated in 1891 by U.S. seizure (and later release) of the "Itata," a vessel sent by the Chilean rebels to obtain arms at San Diego, Calif. Still more serious was the "Baltimore" incident the same year. U.S. sailors on shore leave at Valparaíso from the "Baltimore" were attacked by a mob, and two sailors were killed. The incident was settled by Chile's offer of compensation, but only after the United States had sent an ultimatum demanding an apology and Chile had left no doubt that it considered the warlike attitude of the United States a national affront.

The "Baltimore" incident had hardly been resolved when serious friction developed with Argentina over portions of the boundaries separating the two nations. The issue involving the Puna de Atacama, in the north, was settled in 1899 by arbitration of the U.S. minister in Buenos Aires. In May 1902, the two countries signed treaties providing for the arbitration of the disputed southeastern boundary (Patagonia), which had been in contention since the 1840's. The dispute was arbitrated by King Edward VII of England, who recommended division of the contested territory. In commemoration of the settlement the two nations joined in erecting on their common boundary the famous statue known as the "Christ of the Andes." In 1904 Chile signed with Bolivia the pact of Santiago by which Chile gained full sovereignty in the Atacama region but under terms which left in doubt many issues that were not resolved until the 1920s. Through Chile's understanding with Brazil and Argentina and through the participation of the three in controversies between the United States and Mexico, the country gained prestige in the hemisphere. The republic remained officially neutral during World War I, but favoured the Allied powers.

Politically the period from 1891–1918 was characterized by parliamentary rule. The omnipotence of executive rule that had produced 60 years of "praetorian peace" before 1891 gave way to the omnipotence of the legislative branch, which did hardly more than spawn national confusion. There was little room for strong presidents during the era and none appeared. On the contrary, weak executives—Jorge Montt, 1891–96; Federico Errázuriz Echaurren, 1896–1901; Germán Riesco, 1901–06; Pedro Montt, 1906–10; Ramón Barros Luco, 1910–15; and Juan Luis Sanfuentes Adonaegui, 1915–20—followed one another in a monotonous procession of mediocrities. Meanwhile, the rise and fall of cabinets became chronic—there were approximately 120 major shifts between 1891 and 1924.

The transfer of power from the executive to the legislative branch did not result, however, in any significant change in the country's power structure. Rather the landholding and financial elements that had disputed political predominance since the Montt regime of the 1850s finally found a basis for alliance in their mutual desire to prevent emerging social and economic groups from asserting themselves. The religious issue subsided once the landholding and financial elements united, so that no real differences separated the contending forces.

The lack of issues had a profound influence on political values. Moral discipline and public responsibility degenerated as parties and politicians, becoming more money-conscious, resorted freely to fraud and bribery to win power, which was then used for the advantage of the victors. While the political leaders interpreted electoral liberty as freedom to indulge in fraud and bribery, the working classes viewed being paid for one's vote as a right of citizenship. The middle classes, in order to share more fully in the spoils of office, made politics their chief pursuit. But there was at least one favourable aspect to this otherwise sordid political climate. Chile, in sharp contrast with a vast majority of its Latin-American neighbours, gave every evidence of having matured to the point where personalism was on its way out and parties could look forward to deriving their force from the doctrines they propounded rather than from the candidates they offered the electorate.

In the economic sphere a growing dependence on mining, exaggerated individualism, and unbridled capitalism characterized the transformation era. Mining rapidly supplanted agriculture as the first factor of progress. Nitrate production, which in 1892 was slightly over 300,000 tons, reached 1,000,000 tons in 1896, averaged 1,720,000 tons annually between 1901 and 1910, and 2,500,000 tons annually between 1911 to 1920. Meanwhile the price of nitrates in world markets increased about 75% between 1910 and 1918. Copper mining, important in the economy since the 1830s, attained an average annual production of 33,000 tons between 1901 and 1910; it increased to 68,000 tons annually between 1911 and 1920. Mining prosperity caused commerce and industry to expand. Foreign trade, which amounted to 140,000,000 pesos in 1896, rose to approximately 580,000,000 pesos in 1906. Revenues from mines were used to beautify cities, to which the rural population flocked in search of a better life. In 1907, 43.2% of the population lived in urban centres; by 1920 the figure had risen to 46.4%. Santiago, the national capital, in 1920 contained 14% of the total population of the nation.

Expanded activity in mining, commerce and industry, each of which received added impulse from World War I, gave rise to a new and aggressive capitalist element that fought for economic privileges. A demand that economic life be free from state intervention became a fundamental postulate of this new *bourgeoisie*, which invited foreign capital to develop the nation's resources. During this era foreign capital greatly increased its share in Chilean mining, but approximately 50% of the investment in extractive industries continued to be of domestic origin. Politically aligned with the old landed aristocracy, the new urban capitalists supported systematic depreciation of the currency, a measure that weakened the position of wage earners and those with fixed incomes.

An abrupt decline in the world demand for Chilean nitrates and copper following the armistice of 1918 served to emphasize the fact that the social problems arising from the economic transformation had been left to multiply. Chile's infant mortality rate had become the highest among the nations of the western world. Alcoholism had become a widespread social illness. The *conventillos* or slums of Santiago, where workers lived in cramped and unsanitary quarters, had become a symbol of national failure without arousing the indignation of those who controlled the government. Real wages declined by 10% between 1913 and 1923 as the industrial labourer and white collar worker were caught in a spiraling inflation.

In 1912 the Socialist Labor party was formed in a bid for labour support. But the new party was no more effective in easing the plight of the worker than had been the mutual aid societies and anarchist-dominated syndicates that the working man turned to increasingly after 1900. The strike was the only means the workers possessed to call attention to their plight and they struck 293 times between 1911 and 1920. In the face of such conditions the founding of a university at Concepción (1919), more public schools, better qualified teachers, a free press, and greater availability of printed matter did little to alleviate popular discontent.

The discontent of the working class was, in fact, increased by developments in Europe, where new ideas had wrought havoc with the social fabric. The new social consciousness found expression in Chile in 1918, an election year. Control of the lower house of congress was at stake. Many different elements of the population—wage-earners suffering from inflation, small businessmen pinched by both inflation and high interest rates, and discontented intellectuals—joined forces in the Liberal Alliance, comprising approximately 15 political factions, to unseat the vested interests. Arturo Alessandri Palma (*q.v.*), lawyer, politician, demagogue and "Lion of Tarapacá," served as the cohesive force that held the discontented groups and the social romantics together during the campaign. Directing his appeals to the newly articulate elements of society, Alessandri hammered home his argument that the economic problem had become the fundamental political problem.

The Liberal Alliance won a striking victory at the polls and captured control of the lower house. Politics had been forced out of the "smoke-filled room" and into the street, where the voices of the depressed elements could be heard, however faintly.

7. Reorientation of a System.—Politically ambitious middle groups and working elements had come to the surface in 1918. For the next two decades a bitter political war waxed and waned between the new elements and the entrenched privileged groups. In the process the national welfare was sacrificed to the interests of political parties. The use of force as a means of settling political differences was revived. There was a pronounced trend toward state intervention in the economy. Collectivism as a social philosophy assumed greater stature. Nationalism was lifted to new heights as a political ideology. The church-state pact was broken. These developments threatened rather than destroyed established institutions and values. Democratic-republicanism continued to be the objective of all but a narrow fringe of extremists. There remained a wide area within which the free enterprise system had full rein and the private ownership of property was strongly defended—land monopolists went almost untouched. The Catholic Church continued to be the interpreter of social values for an influential sector of the population.

Discontented voters elected Alessandri to the presidency in 1920 in a close election that was finally decided by a "court of honour." Alessandri's election temporarily pacified the masses. The old ruling element, however, remained predominant in the senate. From there it offered tenacious opposition to Alessandri's social and economic reform recommendations. Economic distress, caused largely by a depressed world demand for Chilean nitrates and copper, served the interests of the opposition, as did the president's failure to resolve the Tacna-Arica dispute with Peru.

Stalemated at nearly every turn, Alessandri made a determined effort to win a working majority in the legislature, and used questionable methods in intervening in the elections of 1924. He carried both houses and won approval of an advanced labour code, but the legislature soon fell to bickering and failed to act on his other recommendations. At this juncture, unrest in the army over salaries that were in arrears and the general instability of society culminated on Sept. 5, 1924, in the institution of a military junta to direct national affairs. By decree-laws the junta enacted some of Alessandri's social program. The junta's interest in reform was short-lived, however, and its members had turned to the right before they were removed early in 1925 by a group of young officers headed by Maj. Carlos Ibáñez del Campo.

The new junta invited Alessandri to return to the presidency, and he did so on March 20, 1925, but only on condition that the executive branch of government would be strengthened in relation to the legislative. This issue and others raised by the constitution, which many considered outmoded, led to the writing of a new constitution that was approved by a plebiscite in Sept. 1925.

The constitution of 1925 provided for the popular election of presidents who would have decisive power in government. Congress, the stronghold of the reactionaries, was deprived of power to oust ministers by censure. Members of congress could not serve in the cabinet. The constitution also separated church and state, but thanks both to religious and to secular authorities, this was done in a manner that did not leave angry resentments. In providing for greater state participation in the labour and welfare fields the constitution gave recognition to the recent reorientation of the nation's thinking away from its former *laissez faire* position and toward the collectivist aspirations of the lower middle-income groups and the working elements, who were becoming increasingly articulate.

Under fire from both conservatives and reformers and unable to relieve the economic depression that blanketed the republic, Alessandri was forced from office in Oct. 1925. The *coup d'état* was engineered by Ibáñez, minister of war in the Alessandri cabinet and dictator-president from 1925 to 1931. When Ibáñez had a presidential election called, Emiliano Figueroa Larraín emerged the victor and replaced acting president Luis Barros Borgoño in Dec. 1925. But Ibáñez ruled Chile arbitrarily until he forced Figueroa Larraín to resign and had his own power legalized in an election held in May 1927.

Ibáñez was aware of the transformation that the republic was experiencing, and under him progress was made in welfare and labour legislation. The nation maintained an economic climate that invited foreign loans and investments needed to speed industrial production. Meanwhile, Ibáñez was careful not to arouse the rural aristocracy by tampering with the nation's landholding system. Creation in 1930 of the Compañía de Salitre de Chile (Chilean Nitrate company, known as COSACH), a nitrate monopoly whose control was shared by foreign and domestic capitalists and the Chilean nation, was one of the most daring moves in the direction of state intervention in business in Latin America up to that time.

A steady flow of foreign capital into the republic made for a spurious prosperity. Public works projects kept the working groups occupied and provided a market for local manufactures. Growth of public and private bureaucracies and a significant expansion in the field of education offered new opportunities for the intellectual element. By supporting laws directed against the employment of foreigners and offering protection to domestic commerce and industry the dictator gave his stamp of approval to an intensification of economic nationalism. Meanwhile, the final settlement of the Tacna-Arica dispute in 1929 served to silence the agitators who had kept Chile and Peru on the brink of war throughout the decade.

The world depression that struck in 1929 emphasized basic weaknesses in the Chilean economy and aggravated latent social discontent. The nation's sources of foreign exchange dried up. It was forced off the gold standard and defaulted on its external debt. By Dec. 1931 mining output, having dropped steadily after early 1929, was down to 52% of the 1927–29 average. Deprived of foreign exchange, the republic's international trade nearly ground to a halt. Unemployment and underemployment were widespread. Of 91,000 men employed in mining at the end of 1929 only 31,000 continued in employment at the end of 1931. A third of the population lived in substandard quarters. When Ibáñez discharged public employees and tried to raise taxes, dissatisfaction over his dictatorial methods burst forth. Students at the University of Chile revolted. They were joined by medical doctors and other professional men. Restless mobs added their disapproval. On July 26, 1931, Ibáñez tendered his resignation and left for Buenos Aires, plunging Chile into a violent 18-month-long civil conflict, made worse by the misery and suffering which accompanied economic stagnation.

During the period of civil strife, Chile was led first by Conservative Juan Estéban Montero, who unsuccessfully sought to restore constitutional government. He was forced from office by a military clique; Socialist Carlos Dávila was placed in the presidency in June 1932 and congress was suspended. Dávila's 100-day rule was too short to implement a program, but he advanced ideas of social welfare and state intervention that had lasting influence. "Responsible" elements, frightened by the "excesses" that Dávila tolerated from the working groups, demanded a return to order and stability. He was ousted by the military group in September and after an election Arturo Alessandri returned to the presidency in Dec. 1932 for a second term.

Alessandri, who had more or less stood still as social and economic thinking in Chile moved to his left, won the election with support from the right and centre of Chile's political spectrum—especially important was his acceptance by the Radical party. Under him, Chile began its slow recovery from the depression as mineral and industrial output rose from their 1931–32 low points and tax concessions gave rise to a notable expansion in the construction industries. The budget was balanced, COSACH was reorganized, and payments on the interest of the foreign debt were resumed.

When it became apparent that Alessandri was more devoted to constitutionality than to reform, the Radical party withdrew its support (1934). This party, dating from the 1860s, had been the personification of individualism until 1918 when it associated itself with the emerging urban groups. By the 1930s, although its leadership had remained tightly in the hands of southern landholders and the new wealthy class in commerce and industry, it had become the champion of democratic government, social reform, and economic diversification through industrialization.

8. The New Order.—The Radical party, torn by internal dissension, vacillated for approximately two years after withdrawing its support from the Alessandri government. Then in 1936 it gained control of the alliance of parties of the centre and left known as the Popular Front. The origins of the Popular Front have not been definitively established, but the consensus of scholars seems to be that it was formed at the urgings of the Chilean Communist party, which had been founded in 1921. The Popular Front temporarily provided a common ground for most segments of society whose objectives were becoming steadily more difficult to reconcile with traditional values. It also proved to be a springboard from which the Radical party was propelled to national leadership under three presidents whose terms extended from 1938 to 1952.

Pedro Aguirre Cerda, educator, member of the Radical party and standard-bearer of the Popular Front, won the presidency in 1938. His narrow margin of victory, only about 4,000 out of a total of 440,000 votes, probably was provided by Nazi elements who threw their support to the Popular Front when, following an unsuccessful armed uprising organized by former dictator Ibáñez and Nazi leader Jorge González von Marées, 62 of the revolutionaries were shot by government troops after they had surrendered.

In office Aguirre Cerda, a conscious imitator of Franklin D. Roosevelt, devoted himself to implementing the Popular Front program. He aided and protected organized labour. The popular masses were urged to become more politically conscious. Educational facilities and health and welfare programs were expanded significantly. By 1941 Chile had the most comprehensive social welfare program in Latin America. Industry was given strong state support. The Corporación de Fomento de la Producción (C.O.R.F.O.), or Development corporation, was chartered to funnel public capital into basic areas of the economy that were not attractive to private investors and to provide private enterprise with relatively low interest-bearing loans. Funds from the Export-Import bank helped to capitalize C.O.R.F.O.

Before Aguirre Cerda died in office in 1941 the Popular Front had disintegrated as a result of strife between leftist liberals and the Communists, who were supporting the Axis in World War II.

Juan Antonio Ríos succeeded to the presidency (1942–46). Ríos in effect traded the extreme left support that Aguirre Cerda had courted for backing from the Catholic-oriented Social Christian element. A wealthy businessman from Concepción, Ríos was not a strong leader. He did not need to be, as the course of World War II largely dictated his decisions. Fearing that Chile could not protect its long coast line against a possible Axis attack, Ríos associated his nation with the Allies but did not break relations with the Axis until Jan. 1943, and did not declare a state of belligerency until Feb. 1945. In the face of the foreign threat he had little trouble rallying the nation behind him, especially in view of the fact that Communist agitation against the United States and its allies had been stilled by Hitler's invasion of Russia in June 1941. A strong demand at favourable prices for Chilean copper, a high level of employment, and lend-lease aid from the United States further eased Ríos' efforts at "moderation." In this atmosphere the president was able, with a minimum of friction, to shift the ideological base of his government to favour industrialization.

When Ríos died in office in 1946 it was evident that by putting a lower priority on social reform he had satisfied only the industrial element among those to whom the Radical party looked for electoral support. The party's choice of Gabriel González Videla as its presidential candidate was an obvious effort to improve its standing with the low-income groups that Ríos had alienated. González Videla, a self-made man from La Serena and a prominent lawyer, had early associated himself with the left wing of the party. During the campaign he openly sought Communist backing, and the Communist party responded by instructing its members and followers to vote for him. This, in effect, constituted a revival of the Popular Front.

As president, González Videla proved a disappointment to his popular following. He began his term with Communists in his cabinet but within a few months he removed them. In 1948 the Law for the Defense of Democracy made the Communist party illegal, and so it remained until 1958, when it was again given legal status. González Videla's break with the Communists was apparently prompted by two considerations. He seemingly became convinced that Chile had to industrialize at all costs and apparently also became satisfied that Chilean national welfare depended upon close and friendly relations with the United States.

The president's decision to throw the weight of his office behind industrialization involved a calculated political risk. There were three major political considerations: (1) faster industrialization would require an increasing share of new investment capital at a time when the agricultural sector was lagging and the purchase of foodstuffs from abroad was requiring more and more of the nation's foreign exchange; (2) industry would have to assume primary responsibility for providing employment for the approximately 50,000 persons who were entering the labour pool each year; and (3) industrialization would have to be financed in large part by inflation, thereby placing added burdens on the already hard-pressed working elements. González Videla's political gamble did not pay off. Industry failed to respond as expected; industrial employment in 1949 was actually below the 1947 level, and the workers revolted against what they considered their undue exploitation by the wealthy.

The administration succeeded in maintaining republican institutions and a free press, and in expanding educational opportunities. Chile's literacy rate was exceeded only by Argentina's and

Uruguay's, and perbaps Costa Rica's, among the Latin-American republics. But these successes paled before the failure of the administration's economic policies. The president's successes in promoting Chile's international interests and prestige were also probably undervalued. He perhaps assumed the role of a demagogue in his efforts to strengthen Chile's claims in Antarctica, but he showed considerable restraint before breaking relations with the U.S.S.R. and its satellite, Czechoslovakia (Oct. 1948). He was circumspect in dealing with the meddling Perón regime across the Andes. The representatives he sent to the United Nations, the Pan American Union and international congresses in general reflected credit upon Chile. His relations with the United States served the purposes of the Chilean people, at least to some extent. His government obtained loans and other forms of assistance, including funds and technological aid without which the integrated iron and steel plant at Huachipato, near Concepción, formally opened in 1950, probably would not have become a reality.

Carlos Ibáñez, erstwhile dictator and plotter, succeeded González Videla as president in 1952. Ibáñez, who ran as an independent without the organizational support of any major party, personalized in the eyes of many voters the repudiation of discredited political machines. He made "Larger Loaves of Bread" the symbol of the need for a more equitable distribution of the national income. To the propertied groups he proposed a reexamination of the economy with a view toward integration of agriculture, mining and industry. He crossed socioeconomic lines by appealing to national pride and national sovereignty. One of the significant results of his campaign was that he aroused the agrarian workers. That group served notice that it was about to enter the already confused political picture as an independent force.

The president's erratic conduct and a continuing deterioration of the economy brought on by a serious decline in the price of copper were major considerations which prevented Ibáñez from successfully resolving any of the problems that he pointed out before his election. Like his Radical predecessors, he resisted the methods advocated by extremist supporters. He left the land redistribution problem to some future administration with the result that 75% of the arable land remained in the hands of 5% of the landed proprietors. He continued state intervention in the economy but also invited private capital to supplant the state in certain industrial and commercial ventures. His attitude toward foreign capital did not discourage U.S. companies from expanding their investment in mineral enterprises. Political freedoms were generally respected.

When Ibáñez ended his term in 1958, Chile's record in the defense of democratic institutions was unsurpassed in Latin America. The military group remained discreet in its concern over political and economic developments. Public morale, however, was low. A bitter political campaign had kept open old and angry wounds. The republic teetered on the edge of economic disaster. It had no untapped sectors of its economy capable of providing further immediate basic development. Rampant inflation caused hardship on those with fixed incomes, but many wealthy people profited from the constant cheapening of the peso. Economic instability invited political instability and made short-term solutions attractive.

On Nov. 3, 1958, Ibáñez' successor, Jorge Alessandri, was inaugurated president for a six-year term. The son of twice-president Arturo Alessandri, the new chief executive had won office as the candidate of the "traditional" elements that occupied the right wing of the political spectrum in Chile. In a five-way race, he received 32% of the popular vote, narrowly defeating Salvador Allende, candidate of the socialist-communist Popular Action Front (FRAP). Allende's strong showing called attention once again to the fact that since the mid-1930s the Chilean voter had been tending more and more to support the "reform" groups.

Himself a businessman, President Alessandri ran a businessman's administration, the creation of a viable economy being his primary objective. One of his most important assets was the faith that the United States and international lending agencies had in him, a faith that was strengthened when he instituted an austerity program soon after taking office. Throughout his term Chile was, on per capita basis, a primary recipient of public and private loans and developmental aid from abroad. But the austerity plan called upon the long-neglected and exploited workers to make the first and greatest sacrifice. Labour resented this policy and called strikes, but gained little more than wage increases which were immediately eroded by cost of living rises resulting from food shortages and inflation. The escudo, which replaced the peso as Chile's monetary unit in 1960, valued at approximately one to the U.S. dollar when issued, had dropped to about 3.3 per U.S. dollar by the mid-1960s. The nation's economy continued to be tied to copper which provided 70% of Chile's foreign exchange earnings and 50% of its fiscal revenues. However, despite labour unrest and a shaky economy, the republic maintained a degree of democracy seldom equaled in Latin America. President Alessandri's decision in Aug. 1964 to break relations with Cuba dealt Fidel Castro's prestige one of its hardest blows.

The Chilean voters' trend toward the reforms advocated by the left wing was clearly reflected in the presidential campaign of 1964. For the first time in the nation's history, no rightist contender entered the race and the one candidate from the centre had no chance of victory. Both major contenders were left of centre, but there was a marked difference in their orientation. Sen. Eduardo Frei represented the moderately leftist Christian Democratic party, while Socialist Sen. Salvador Allende was the candidate of the far left Popular Action Front. Both Frei and Allende promised sweeping social and economic reforms so as to effect a basic restructuring of the country's economy and its power structure. Frei emphasized, however, that the changes must be made "with freedom."

Economic nationalism, specifically as it related to the U.S.-owned copper companies, was also an electoral issue. Allende called for outright nationalization of the companies, a position favoured both by nationalists and by the far left. At the risk of losing votes, however, Frei maintained that Chile would profit far more by a policy of encouraging the companies to expand production greatly and refine all copper in Chile. Frei's emphasis on reforms with freedom won for him the largest majority obtained by any Chilean president (56% of the 2.5 million votes cast) in approximately 50 years.

Frei was inaugurated in Nov. 1964. His popular mandate made his position a strong one, and he gained additional strength when the congressional elections held in March 1965 gave the Christian Democratic party an amazing vote of confidence, increasing the party's seats in the lower house from 23 to 82; this vote gave the party an eight-seat majority in the lower house of congress. Meanwhile, the Liberals and Conservatives, which may be classed as the traditional parties, suffered serious defeat, their representation in the chamber dropping from 45 to 21.

In terms of domestic politics the congressional elections were significant in two respects. They completely undermined the charges of the extreme left that President Frei had won office only with the aid of votes from the reactionary right, and also the overwhelming victory of Christian Democratic candidates immediately following Frei's personal triumph was a warning to the opposition that its already weak position could be further endangered should it stand firm against the president's reform program. Outside Chile the results of the two elections were hailed as reaffirmations by a politically sophisticated people that progressive reform could best be achieved within a democracy.

In the social and economic areas, President Frei's position was not so favourable as it was in the political sphere. Chile faced numerous problems that seemed to challenge solution within the structure of established institutions. The nation was struggling to maintain a growth rate that had for years hovered near 4.5%. Inflation continued at a threatening pace. The real income of workers was only slightly above 1945 levels. The lower 60% of the population received only 20% of the national income. Literacy rates were probably lower when President Frei took office than they had been 25 years earlier. Undernourishment was chronic, and at least a third of the population lived in homes that the government considered substandard. In the agriculturally rich and heavily populated provinces of Aconcagua and Santiago, 7% of the landholders controlled more than 90% of the land. As a group the large landholders showed little interest in modernizing their operations. The total effect was that those within the rural and urban working classes who aspired to improve their status were cramped in every direction they turned. (J. J. J.)

V. POPULATION

The racial composition of the Chilean population is predominantly white. This is the result of heavy mortality among the Indians during the colonial period—from both disease and warfare—and of extensive migration from Europe in the 18th and 19th centuries. The 18th-century migration came chiefly from Spain and was mostly Basque. The 19th-century immigrants came from Germany, Italy and England. Such Indian groups as remained at the end of the 19th century were small and were limited to specific areas of northern and central Chile.

The 1952 census classified 127,151 Chileans as Araucanian Indian. (*See* ARAUCANIAN.) Most of these were concentrated in the provinces of Cautin, Malleco, Arauco, Valdivia and Bío-Bío.

In the extreme south there are remnants of the Fuegians, an indigenous people of extremely primitive culture. In the coastal region of the north there are some Changos, who may represent survivors of an original, indigenous racial stock. Throughout most of the territory there is a generous sprinkling of English, Irish, Scottish, German, Italian, Yugoslav and French settlers who still carry the names of their immigrant forefathers. The immigration of these groups has never been of major proportions but the process has been a relatively stable one.

Provinces and Population

Province and capital	Area in sq. mi. 1952	Population 1952 Census	Area in sq. mi. 1960	Population 1960 Census
Aconcagua (San Felipe) .	3,940	128,378	3,812	140,543
Antofagasta (Antofagasta)	47,515	184,824	48,381	215,219
Arauco (Lebu) . . .	2,222	72,289	2,023	89,460
Atacama (Copiapó) . .	30,843	80,113	30,219	116,235
Aysén (Aysén) . . .	34,357	26,262	39,993	37,770
Bío-Bío (Los Angeles) .	4,343	138,292	4,299	168,718
Cautin (Temuco) . .	6,707	365,072	7,095	394,654
Chiloé (Ancud) . . .	9,052	100,687	10,430	99,211
Colchagua (San Fernando)	3,255	139,531	3,215	158,509
Concepcion (Concepcion) .	2,201	411,566	2,194	539,521
Coquimbo (La Serena) .	15,401	262,169	15,306	308,991
Curicó (Curicó) . . .	2,215	89,432	2,033	105,802
Linares (Linares) . .	3,791	146,257	3,635	171,350
Llanquihue (Puerto Montt)	7,107	139,986	7,029	167,671
Magallanes (Magallanes) .	52,285	55,119	50,978	73,156
Malleco (Angol) . . .	5,512	159,419	5,442	174,300
Maule (Cauquenes) . .	2,172	72,181	2,200	79,736
Ñuble (Chillán) . . .	5,487	251,342	5,387	285,639
O'Higgins (Rancagua) .	2,746	224,593	2,743	259,470
Osorno (Osorno) . .	3,507	123,059	3,566	144,005
Santiago (Santiago) . .	6,727	1,754,954	6,829	2,437,425
Talca (Talca) . . .	3,722	173,693	3,915	206,154
Tarapacá (Iquique) . .	21,346	102,789	22,422	123,070
Valdivia (Valdivia) . .	8,083	232,647	7,132	259,794
Valparaíso (Valparaíso) .	1,860	498,254	1,976	617,510
Antarctica territory . .	. .	87	. .	202
Total	286,396	5,932,995	292,256	7,374,115

The 1960 census showed a population of 7,374,115 as compared with 5,932,995 in 1952; 5,023,539 in 1940; 4,287,445 in 1930 and 3,731,573 in 1920. The density of population per square mile in the whole country was 25.2 in 1960 and 20.7 in 1952 but there was a wide range of density between regions. In 1952 the northern desert region, with more than one-third of the total area, had 6½% of the population and a density of less than 4 per square mile. The central region, with only 18% of the national area, had 65% of the total population and a density of 76 per square mile. The mainland forest region, with 13% of the area, had 26% of the population and a density of 38 per square mile. The archipelagic zone of the forest area, with 27% of the total area, had only 2% of the population and a density of little more than 1 per square mile. Atlantic Chile, with 7% of the area, had only 1% of total population. Most of its inhabitants were in the city of Punta Arenas.

Chile has one of the highest birth rates in the world. Just before 1930 the annual rate was about 40 births per 1,000 population. Although the rate decreased somewhat after 1930 it was 35.4 in 1960. Approximately one-third of all births were recorded as illegitimate in 1917; this percentage had declined to 17.1% in 1960.

The death rate in Chile progressively declined after 1900, due largely to improvements in child care practices, but remained high in the cities. It was at a low of 11.9 deaths per 1,000 population in 1960. This gave a survival rate (births minus deaths) of 23.5 for 1960, a rate sufficiently large to double the population in slightly more than one generation.

Like most other Latin-American populations, that of Chile has shown strong tendencies toward urbanization. The 1960 census classified 66% of the population as urban as compared with 52% in 1940.

Major cities (1960 municipal pop.) were: Santiago (646,731); Valparaíso (259,241); Concepción (167,468); Viña del Mar (126,441); and Antofagasta (89,114). (O. E. L.)

VI. ADMINISTRATION AND SOCIAL CONDITIONS

1. Government.—Chile is a unitary or centralized republic and has always had this type of government except for a brief and unhappy experiment with federalism in the mid-1820s. Responsibility is centred in the president, who is elected by direct vote of the people for six years and cannot immediately succeed himself. Beginning in the early 1890s Chile had a semiparliamentary form of government but this led to serious political difficulties. The new constitution of 1925 reverted to the presidential type.

The constitution provides for direct elections, suffrage for both men and women, citizenship without class distinction, separation of church and state, and a strong executive branch. The legislative and judicial branches have considerably more independence of the executive than in most Latin-American governments.

If no presidential candidate receives a majority of the popular vote a choice between the top two candidates is made by the congress, which normally follows the practice of electing the one receiving the plurality of the popular vote. The Belgian system of proportional representation is used for legislative elections. The electorate in the 1960s included over 1,500,000 persons, of whom approximately one-third were women; full woman suffrage was adopted in 1949. A literacy qualification for voting prevails.

The president, who must be native-born and at least 30 years of age, freely appoints and removes cabinet members, although party pressure sometimes exerts an indirect but considerable influence on appointments to and resignations from the cabinet. Presidential appointments of diplomatic, high military and some administrative officials must be approved by the senate. The cabinet normally includes 14 positions although at times two or more portfolios are in the hands of one minister. In case of a vacancy in the presidency the office is temporarily filled by the minister of the interior, who is required to call a new election within 60 days; the president chosen at this election fills a full six-year term. The president can propose legislation and can veto bills passed by congress, but the congress by a two-thirds vote can override a veto. The president has broad appointing power, directly or indirectly, in the administrative subdivisions of Chile; he names the *intendentes* (chief administrative officials) of the provinces, the governors of departments, and the *alcaldes* (chief local administrative officials) in municipalities of more than 100,000 inhabitants.

The national congress consists of a senate and a chamber of deputies. The former is composed of 45 members, five from each of the nine groups of provinces into which the republic is divided for such purpose. Each senator holds office for eight years, and half the seats are renewable each four years. Senators must be at least 35 years of age. The chamber of deputies numbers 147 members, one for each 45,000 persons. The members are elected for 4-year terms. No alternate senators or deputies are elected, as is done in several Latin-American countries; in case of vacancies special elections are held. Ordinary sessions of the congress last from May 21 to Sept. 18. It passes on the budget but the president may alter items within the limits therein prescribed. The senate has 12 standing committees and the chamber of deputies 13. Members in each chamber are seated in a semicircular arrangement according to the political complexion of their parties, as in France. The system of proportional representation results in the election of representatives from many parties. Members of the cabinet may not hold seats in the congress but may speak in its sessions.

The judiciary is headed by a supreme court of justice of 13 members appointed by the president from panels proposed by the court itself. Members must be at least 36 years of age and must have had at least 15 years' experience as attorneys or judges. Lower levels of the judiciary include nine courts of appeal and 139 *jueces letrados*, or certified judges (of first instance). The president cannot remove judges but is empowered to transfer them, when necessary, within the jurisdictions to which they belong. Judges are removable by a two-thirds vote of the supreme court.

The largest unit of local government is the province, of which Chile has 25. Provinces exist for administrative rather than political purposes, and the *intendente*, who heads each province, is primarily an administrative agent and a political representative of the president. Each province has a provincial assembly, the members of which are chosen by municipal councils; powers of the assemblies are narrowly restricted, however, both in law and in practice. The next largest subdivision is the department, each province having from one (in Aysén in southern Chile) to six (in Santiago) departments; the usual number is three or four per province. The chief departmental officer is the governor, who is appointed by the president. Departments are divided into subdelegations and the latter into districts. The president has broad power of removal of lower administrative officials and the administration is both hierarchical and highly centralized.

Political parties in Chile are more important than in most Latin-American countries. This has been true since the late decades of the 19th century; during the time of the semiparliamentary regime beginning in the early 1890s governing was largely on the basis of agreements made among the party groups in the national legislature. Since the restoration of presidential government in 1925 the chief executive's power has been relatively greater than before but it is still true that a political figure's allegiance to his party may sometimes be greater than to the president, even if the former happens to be a cabinet member.

The party picture in Chile bears many similarities to that in France. Proportional representation makes a multiparty system almost inevitable and at times more than 30 parties have been registered for an election. There is necessarily a good deal of flux in the number, composition and alignment of parties, although the Radical, Liberal and Conservative parties are all some decades old; the "Liberal" party is, in fact, a conservative grouping and the "Radical" party is moderate. A more recent party that has become significant in Chilean politics is the Christian Democratic party. It was organized in 1957 by a union of the National Falange (not similar to the Spanish Falange) and the Social Christian Conservative party. The Christian Democrats succeeded in electing Eduardo Frei as president on Sept. 4, 1964, with 56% of the popular vote. Their hold was consolidated by congressional elections March 7, 1965, which gave them a clear majority in the chamber of deputies and substantial gains in the senate.

Party coalitions have sometimes been organized. Thus, in the 1930s the Popular Front was an influential grouping composed of leftist and left-of-centre parties. By the late 1950s the Popular Action Front (commonly referred to by its initials as FRAP) had become an active and influential coalition; it did not include the Radical party. Communists were theoretically banned from action as a party by the Law for the Defense of Democracy (1948). It ineffectively suppressed them for a decade but was repealed late in the administration of President Ibáñez. Communists have claimed a hard core of about 50,000 voters in Chile. The often frenetic activity of Chilean political parties, especially during electoral campaigns, has resulted in a relatively high degree of urban political participation. In rural areas, however, apathy has usually prevailed.

2. Taxation.—The Chilean tax structure responds in part, but only in part, to social organization and pressures. Thus, in the mid-1950s, consumption taxes that bore proportionately more heavily on low-income groups accounted for only about one-eighth of all tax revenues in Chile; this was one of the lower ratios of the kind in Latin-American countries. Indirect taxes in general are significantly lower in Chile than are direct taxes. All taxes are levied by the national congress. The three most important types are the income taxes, sales taxes and taxes on imports and exports.

3. Labour.—Chile is marked by great disparity in personal incomes. For large numbers of people wages are low, employment is uncertain and housing is inadequate. The importance in the national economy of copper and nitrate production means that when production declines—whether because of insufficient markets, low prices or for other reasons—workers are released in the producing areas and quickly drift back to Santiago. As unemployed *rotos*, they constitute a socially and politically volatile and potentially explosive element.

Labour organizations before the 20th century, beginning with the Typographical union established in 1853, were of the mutualist type that emphasized insurance features and educational, cultural and social activities. The mining and shipping industries gave impetus to the formation of a formal labour movement late in the 19th century, and by 1903 *sindicatos* (workmen's associations or trade unions) had about 63,000 members centred in the province of Valparaíso; membership grew to 92,000 by 1910. The Labour Federation of Chile was organized in 1909 and adhered to the third international in 1921. It thereafter sponsored a frankly Communistic program, much of which was embodied in the social legislation of the mid-1920s.

The depression of the early 1930s, which, so far as the nitrate industry was concerned, had begun years earlier, stimulated the conversion of the labour movement into a popular mass activity. Rival labour organizations in Jan. 1937 created the Confederación de Trabajadores de Chile (C.T.Ch.), which included about half of all Chilean industrial workers and a larger proportion of miners. It was controlled by Marxist ideology and adopted a lengthy program of action. After World War II a rift occurred between Communist and other elements in the organization, with the coal-mining unions supporting the Communist element, nitrate and railway workers being more or less divided, and copper-mining unions and most of the important manufacturing unions of Santiago backing the Socialists. The confederation withdrew from the Confederación de Trabajadores de América Latina (C.T.A.L.; Confederation of Latin-American Workers) in June 1947 on the ground that that organization had succumbed to Communist influence. Important agricultural and other semiautonomous unions also exist in Chile. By the 1960s the chief labour organizations were the Central Única de Trabajadores Chilenos (C.U.T.Ch.; Single Centre of Chilean Workers) and the Confederación Nacional de Trabajadores (C.N.T.; National Labour confederation), both of which engaged actively in politics as rivals. About 500,000 in 1960 were members of labour organizations.

The development of the Chilean labour movement, one of Latin America's most important, was accompanied by much violence and many strikes. A bitter general strike occurred at Santiago and Valparaíso early in the 20th century and in 1907 a strike at Iquique resulted in the death of 1,000 persons. Strikes were prevalent in the 1920s and 1930s and the severe post-World War II inflation caused many crises. Beginning in 1945 the operations of a number of foreign interests, including copper and nitrate companies, were seriously hampered by protracted labour disputes, work stoppages and strikes. The Labour code provided that no work stoppage could occur in any establishment employing ten or more workmen or employees until the code's provisions for conciliation had been exhausted.

Inflation continued to be a major factor in causing labour unrest and strikes up to the end of the Ibáñez administration in 1958, despite strenuous but sporadic attempts to introduce an austerity program and hold down the price level. The cost-of-living index increased 2,200% between 1945 and 1958. In the decade ending with 1958 money in circulation increased 3,000% but production only 50%; it therefore proved necessary for President Ibáñez to borrow heavily from social welfare funds. During the late 1950s and early 1960s Pres. Jorge Alessandri achieved some success in checking inflation but encountered strong protests from labour groups.

4. Welfare Services.—Chilean labour and social legislation is among the most extensive and complex in Latin America. Although there were some earlier enactments, labour legislation had its formal beginnings in the decree-law of Sept. 8, 1924, which, with supplemental legislation, was codified as the Labour code of 1931, the first such code to be promulgated in Latin America. The Chilean code, in contradistinction to the Mexican (with which it shares a position of international influence), distinguishes between workers and white-collar employees and contains separate provisions for each category. The code regulates in detail employer-employee contracts, hours and wages, vacations and holidays, and workmen's compensation; it also provides for compulsory profit sharing by labour and places on the employer basic responsibility for work accidents and diseases.

The Chilean system of social insurance, begun in 1926, covers almost the whole working population under a number of social welfare organizations. The basis of the system is a compulsory *caja*, or guild structure, related to the type of employment. The system is financed by employer, employee and government contributions. The law applicable to manual workers provides family allowances and sickness, invalidism, old-age and elements of unemployment insurance; that applicable to salaried employees also provides for other benefits, including dismissal wages, medical benefits and borrowing privileges.

As a result of progress made after 1925 in public health and sanitation the death rate dropped sharply. Birth and death rates (unofficial) in the early 1960s were respectively about 35 and 12 per thousand of population. The infant death rate was approximately 116. The number of Chileans per physician was approximately 1,600 in 1960, the second most favourable ratio in South America. Just under half of all Chilean dwellings in 1960 had one or two rooms, 34% had three or four rooms, and 19% had five or more rooms; 54.5% had a piped indoor water supply, 35.7% had baths, and 54.5% had electricity.

5. Education.—Chilean education in the colonial period was limited and was conducted by the church. The first public educational system was organized about the middle of the 19th century. A program of school building was inaugurated during the prosperous years of the 1880s and was continued into the 20th century, but it was not until 1920 that primary education between the ages of 7 and 15 was made compulsory. The principal stimulus to education in the 19th century was given by Andrés Bello, the eminent Venezuelan teacher, who spent most of his adult career in Chile and was primarily responsible for organizing the educational system.

The educational system is organized on three levels—primary, secondary and university. Agricultural, commercial, technical and evening school education was considerably expanded in the 1950s. Public expenditure for education as a percentage of national income ranks among the highest in Latin America. The University of Chile (the official university, founded at Santiago in 1842) in the 1960s reported more than 8,000 students; the Catholic University of Chile at Santiago 2,700; the University of Concepción 1,800; and the University of Valparaíso 1,200; there are four other small universities. Literacy of those over ten years of age rose from an estimated 50% in 1920 to more than 80% at mid-century.

6. Defense.—The armed forces were reported in the early 1960s to have a total strength of about 46,500 officers and men—21,500 in the army (including conscripts and a labour force), 17,000 in the navy and 8,000 in the air force. The navy included 2 cruisers and about 40 other vessels, and the air force operated approximately 50 jets and about 190 conventional aircraft. The army and navy differed considerably in tradition, the former having been trained, beginning in the 1880s, by German military missions, and the latter inheriting an English naval influence. These differences were reflected in a politically important way in the fact that during the civil war of 1891 most army elements supported the president while the navy aligned itself with the congress. By the 1950s, however, Chile had become one of a minority of Latin-American countries in which the armed forces were relatively apolitical. On April 9, 1952, Chile signed a military assistance pact with the United States, pledging free access to raw materials and armed support in defense of the western hemisphere. (R. H. Fi.)

VII. THE ECONOMY

Before World War I the Chilean economy was based primarily on agriculture and mining. There was little manufacturing although the food and beverage industries were active. For finished products Chile relied heavily on imports, but during World War I shortages of goods and of shipping forced Chile to produce more for itself. This trend continued after the war and added breadth to the Chilean economy. Agriculture was also encouraged to provide for an expanding population and to improve the diet of those who were insufficiently fed.

A. Production

1. Agriculture.—The Spanish brought to Chile the traditional Spanish attitude that land was valuable in and of itself and that its ownership carried social and political prestige. Hence, during the colonial period the productive land in central Chile was divided into large estates, whether by grant, seizure, fraud, purchase or marriage. After independence, there were frequent attacks on the concentration of agricultural land in the hands of the few. Despite criticisms, the system persisted so that about 10% of the farms in modern Chile include about 86% of all the agricultural land in the nation. As of the mid-1960s there was little evidence that the situation would be altered. There is in operation, however, a plan to settle farmers on land owned by the government.

The bulk of the farmland is located in the central valley, an area about 30 mi. wide that lies between the coastal range and the Andes mountains and reaches from La Serena to Puerto Montt. The largest properties are near Santiago. The southern part, settled by Germans after the 1840s, has smaller units. A landed aristocracy occupies the large estates. Labour is supplied by *inquilinos*, who reside permanently on the land, and by *afuerinos*, migratory workers who are employed during busy seasons. The latter are a miserable lot, poorly paid, illiterate, diseased and often alcoholic. About one-third of the people in Chile are engaged in agriculture.

Chilean agriculture has failed to provide enough food for the nation. The acreage is limited, but there are nevertheless about two and one-half productive acres per capita, more than many European states possess. One reason for inadequate production is that the land is not farmed by the most modern methods. Fertility is restored by rotating the fields, a practice that restricts cultivation. Cheap labour is used instead of machines, and modern techniques are ignored. Inadequate rainfall, especially in the north, makes irrigation imperative. During the colonial period, private associations were formed to canalize the rivers. These associations continued during the 19th and 20th centuries, and the government has given assistance to irrigation projects. Even so, irrigation has not kept pace with the growth of the population. Projected agricultural colonies on unoccupied lands have yielded barren results. Potentially, Chile could feed a population four times as large as its present total.

The major crops are wheat, barley, oats, rye, corn, potatoes, peas, lentils, beans and a wide variety of fruits, for which Chile is justly famous. Rice, previously a major import, became a significant crop after 1937. Near the cities, the artichoke, strawberry, radish, asparagus, lettuce, tomato, onion and other truck crops are cultivated in abundance. Chile imports wheat, sugar, coffee, tea, bananas and cotton.

Some horses, goats and hogs are raised, but cattle and sheep are most important. The cattle industry is inadequate, for about 35% of the nation's beef requirement must be imported from Argentina. The dairy industry supplies butter and cheese, but not nearly enough milk. South of Puerto Montt, sheep provide wool and mutton for domestic consumption and for export, mainly to the British Isles.

Wine has been produced since the time of the conquest, but until 1850 quality was ignored. Vines and expert wine makers were then brought in from France and Spain, and Chile began to produce wines of better quality. Beginning in 1875 Chilean wines appeared at international expositions, and by 1900 enjoyed a wide reputation. Vineyards are found throughout the central valley but are most numerous in the Santiago area. The fact that Chileans are accustomed to drinking wine with meals assures a stable domestic market. In addition, exports range from 5,000,000 to 8,000,000 l. annually.

Beginning in 1939, the government adopted a policy of encouraging the production of more food and borrowed funds from abroad for the purpose. Pedigreed stock were imported. New irrigation systems were built and old ones improved. A general plan for the development of agriculture and transportation was adopted in 1954. Agreements were signed with the United States to import U.S. surpluses with the provision that funds from their sale should be loaned to the government to promote agriculture.

2. Forestry.—In 1946 a team of U.S. forestry experts estimated that about 10% of the total area of Chile was covered with commercial timber. This amounted to about 2.5 ac. of commercial timber per capita as compared with 1.4 ac. in the United States. Unfortunately, a great part of this rich resource lies in the inaccessible southern third of the country and economic exploitation is difficult because of the profusion of varieties. There are both hard- and softwoods adequate to meet national needs but a plentiful supply of heavy structural timber is lacking.

Before World War I Chile's lumber industry was both inefficient and wasteful. The mills were small; exact dimensions and proper seasoning were ignored. Imported woods from the United States dominated the market, especially in northern Chile where the mines created a large demand. After 1914, the domestic lumber industry began to grow. Tariff protection and propaganda in favour of the national product helped. Eventually an industry embracing between 600 and 700 sawmills emerged. These were small, portable mills that cut from 5,000 to 7,000 bd.ft. per day. As a result, the importation of lumber has virtually ended. Chile also manufactures veneer, plywood and wood pulp. The forestry experts mentioned above recommended a plan to preserve this rich resource and part of the plan has been put into effect. Reforestation, proper cutting and fire prevention have been emphasized, along with efforts to produce briquettes, prefabricated houses, wood alcohol, protein feed and other by-products. This industry has yet to attain its full potential. Essential to that end is improved transportation to the southern reserves.

3. Mining.—Mining, especially of nitrates and copper, has been of major importance to Chile since the first half of the 19th century. Without nitrates and copper, the northern third of the country would have little economic importance. It was the struggle for nitrates that provoked the War of the Pacific and gave to Chile a world monopoly of natural nitrate production. Copper and silver mining began on a small scale during the colonial period, but copper production became of real economic importance only with the entrance of U.S. capital and technical skill on a large scale in the 19th century. Despite its importance to the national economy, mining employs only 10% of the population.

There are various theories to account for the deposits in Chile of *caliche*, the grey, rocklike substance containing sodium chloride, sodium nitrate and iodine salts. *Caliche* is found in a narrow strip about 10 to 50 mi. wide between latitudes 19° and 25° S., along the eastern slope of the coast range. The deposits vary in thickness from a few inches to several feet. It is uncertain who first realized that nitrate had commercial value, whether the Jesuit priests or Thaddeus Haenke, the German explorer. With recognition of its value as a fertilizer and in the manufacture of explosives, exportation began in the 1830s; by 1860 a flourishing business had been established. The industry, developed mainly by foreign capital, prospered until 1920, and taxes on exports supplied about 60% of the Chilean budget. After 1920 the Haber-Bosch process for the manufacture of synthetic nitrate presented serious competition. The depression curtailed the market even more. The price of nitrate in 1932 was less than 40% of the price before 1920. Employment and tax revenues both declined.

To meet this competition the Guggenheim process was developed to replace the old Shanks refining technique. The new system, highly mechanized, reduced labour costs, increased efficiency and processed ores of lower grade. Each of two new plants erected at María Elena and Pedro de Valdivia in 1926 and 1930 was capable of producing more than 500,000 tons annually. These two plants, along with a third built at Victoria in 1944 with Chilean and some foreign capital, account for about 90% of all Chilean nitrate production. The industry is directed by a government agency, the Nitrate and Iodine Sales corporation, established in 1933 to succeed the unsuccessful Chilean Nitrate company. This bureau was permitted to allot quotas and market the product. The export tax was revoked. It was agreed that the industry should be reimbursed for the cost of production plus $1.50 per metric ton. The difference between this amount and the market price was defined as profit, of which the operators were to receive 75% and the government 25%.

Iodine, a by-product of nitrate refining, was once a virtual Chilean monopoly. This monopoly, too, has been challenged. Chile now produces about 2,000,000 lb. per year, about 75% of the world's needs.

Production of copper increased slowly after independence until Chile became the world's leading producer in the latter half of the 19th century only to fall behind as deposits in the United States were exploited. After World War I, production increased again so that an annual average of about 200,000 tons was maintained from 1920–30. With the depression, production fell to 103,173 tons in 1932. World War II stimulated production to about 500,000 tons per year.

Foreign competition alone was not responsible for the decline toward the end of the 19th century. Part of the trouble stemmed from failure to adopt improved techniques. There were also heavy freight charges. It was the foreigner, principally the North American, who invested the capital, restored the industry, and won control of 90% of it. The Braden Copper company was the first; it acquired El Teniente near Rancagua in 1904 and began production in 1911. In 1915 control passed to the Kennecott Copper company. This mine produced about one-third of the national total. The Guggenheim company purchased Chuquicamata, northeast of Antofagasta, in 1912 and then in 1915 sold it to the Anaconda company, which began production that year. Chuquicamata produces about half the national supply. A smaller mine, Potrerillos, inland from Chañaral, was acquired by Anaconda in 1927 and produced about one-sixth of the national output. The deposit at Potrerillos has been exhausted but another in that vicinity is now being exploited by Anaconda. At the mid-20th century rate of exploitation it was estimated that copper production could be sustained for at least another 50 years.

Chile produces more coal than any other South American country, but the product is of poor quality, either semibituminous or lignite. Coal mining began in 1840 at Lota on the Bay of Arauco and has been carried on at that point since. The original development was due to the need to find coal for the first steamship brought to the Pacific. Other mines in the same area are at Coronel and Lebu. These produce about 2,000,000 tons per year. The mines are adjacent to the coast and some reach out under the sea. Before the construction of the Panama canal, Chile did a profitable business in bunker coal. With completion of the canal in 1914 and conversion of ships to oil that business was lost. The outlook for the future is not bright as the reserves are limited and operation is costly.

Iron deposits in Chile are rich and abundant. The best ore contains as much as 70% iron and is virtually free of impurities that are difficult to remove. The first property to be developed, El Tofo, about 40 mi. N. of La Serena, was owned by a French company until 1913 when it was leased to the Bethlehem Steel company. Bethlehem then invested about $40,000,000 to modernize the operations, both at the mine and the port, Cruz Grande, where modern loading facilities were installed. In 1930, 1,500,000 tons were exported. By 1960 the high-grade ores at El Tofo practically had been exhausted, although low-grade ores remained. A second premium deposit, El Romeral, near Coquimbo, was producing in quantity; this also is a Bethlehem operation. Ores were exported to the United States and were also shipped to the Chilean steel mill near Concepción. There were additional important iron deposits in Atacama province.

Small mines, widely scattered but mostly in the north, yield gold and silver; these metals are also obtained as by-products in copper refining. In addition, Chile has deposits of lead, mercury, zinc, borax, sulfur and manganese. The sulfur and manganese deposits have commercial potential. Some molybdenum results from the processing of copper at El Teniente. Native limestone supports a cement industry.

Beginning about 1910 there were halfhearted attempts to locate oil and a few dry wells were drilled. Interest then lagged until 1940 when a geologist from the United States reported indications of oil in the southernmost regions. A successful well was drilled in 1945 and production increased phenomenally until in 1960 it was exceeding 70,000 metric tons monthly—still not enough, however, to meet national requirements. The nation's oil reserves and oil industry are controlled by the government.

4. Fisheries.—Even during the Spanish period it was known that the coastal waters abounded in edible fish and crustaceans. There are also marlin and swordfish to attract the sportsman. Despite knowledge of this rich resource there was no systematic effort to develop a fishing industry before 1930. Chile even imported fish. But after 1930, with government encouragement, a gradual change was made so that the tuna, congrio, corvina, sardine, hake and sierra came to be marketed. Cheaper fish, especially the anchovy, are made into meal for use as fertilizer and livestock food. A whaling industry was founded before 1900, and oysters, crabs, clams, *locos* (scallops) and *erizos* (sea urchins) are caught.

In view of the shortage of food it would be desirable to introduce much more fish into the Chilean diet. The problems to be overcome are many, including refrigeration, transportation and expense. The biggest problem, however, will be to teach the Chileans to substitute fish for meat as a main course, attempting to change a centuries-old custom.

5. Industries.—Handicraft industries such as weaving, leather work, food production and shipbuilding were established before independence. During the 19th century the food industry expanded; flour was exported; gas lighting was introduced; breweries, foundries, textile mills and shoe factories appeared; and wine was produced on a commercial basis. Notable among the industrial pioneers were people of Basque, English, German and Italian origin. These early factories were often little more than workshops. The Sociedad de Fomento Fabril was founded in 1883 by leading manufacturers to encourage industrial growth, and there were fairs or expositions as early as 1894 to emphasize the quality of domestic goods. Agitation for a protective tariff failed until 1928 when the moderate prevailing rates were increased.

When World War I interrupted imports, the development of industry was stimulated. The depression encouraged industry again to provide jobs and also materials that could not be imported because of the lack of foreign exchange. Exchange control, adopted in 1931, favoured domestic goods over imported commodities. A further stimulant came in 1938 with the election of Pres. Pedro Aguirre Cerda whose government was committed to a policy of industrial and agricultural self-sufficiency. Largely because of Aguirre Cerda's insistence, La Corporación de Fomento de la Producción (Chilean Development corporation) was organized in 1939. This government agency was directed to formulate plans to expand the national economy and raise the standard of living, and was authorized to contract foreign loans. The basic law stipulated that the corporation should be directed by a council drawn from the executive and legislative branches of the government, the various professional societies, financial institutions and the national federation of labour. It could undertake projects alone or assist private agencies. About five years were required to formulate a basic plan and to catalogue the national resources. The corporation's chief projects were the development of power, especially hydroelectric power, and the development of basic industries such as iron, steel and paper to reduce imports.

The bulk of Chilean industry is located in and about Santiago and Valparaíso. A third major area is Concepción with the nearby Pacific Steel company plant that has virtually freed Chile from dependence on iron and steel imports. Near Concepción are the fresh water, coal, labour force, access to water and land transportation, and room for expansion which the steel industry demands. Iron ore arrives by sea from northern Chile, and the coal for smelting comes from the region just south of Concepción. Because oil resources were limited, coal of poor quality and imported fuel expensive, the planning officials gave high priority to hydroelectric projects. The country was divided into seven districts to be developed separately and then integrated. Investigation disclosed that from Arica to Puerto Montt there was a 6,000,000 kw. potential.

From foundations laid in the early national period or developed since, modern Chile manufactures most of its metal goods, including tin plate and copper products that were formerly processed abroad. From timber milled domestically comes furniture, cartons, veneer, plywood and paper products. Brick, ceramics, tile and glass are manufactured at home. Little processed food is imported. A relatively new industry is the manufacture of edible oil from sunflower and other seeds. Textile requirements are met domestically. Few shoes are imported. A chemical industry supplies most of the dyes, paints, insecticides and drugs required by the national market.

Economic overtones were abundant in the presidential election of Sept. 1964. Eduardo Frei, the successful candidate of the Christian Democratic party, took a moderate position, stressing control of inflation, agrarian reform, industrial expansion, expansion of exports, increased production of copper, together with further development of the paper, wood and fishing industries. The basic problem for Chile is to increase its production so as to care for the rapidly expanding population. Substantial economic progress is apparent; however, it can not be demonstrated statistically that economic progress has done more than keep pace with the growth of the population. To raise the mass of the Chileans to a decent standard of living, the rate of economic growth must be vastly increased.

B. TRADE AND FINANCE

1. Trade.—The movement of goods within Chile is marked especially by the shipment of foods from the central area to the north and the shipment of oil, coal, mutton and wool from the south to the central region. Manufactured goods move from the centre to all parts of the country.

Minerals dominate the export trade. Before 1932 nitrates headed the list, but copper later became the undisputed leader, followed by nitrates, iron, iodine and other minerals. Agricultural exports consist mainly of dried and canned fruit, wine, wool, hides and mutton. Some metallurgical products are exported. Leading imports are petroleum, machinery, railroad and maritime equipment, automobiles, sugar, cotton, coffee and tea, beef and some long-fibre wool.

Before World War I most Chilean exports went to Great Britain and other European countries. The two world wars and the change in the character of mineral exports diverted European commerce to the western hemisphere. The United States became Chile's foremost trading partner. The neighbouring states of Argentina, Bolivia, Peru and Brazil also exchange goods with Chile. The nation's trade balance is usually favourable, but because of the large foreign investment in Chile the favourable balance is needed in part to meet interest payments.

2. Currency and Banking.—For many years Chile's national monetary unit was the peso, which was divided into 100 centavos. In 1931 the peso was established at 12.17 cents U.S. currency. After 1931 its value greatly depreciated. When exchange control was abandoned in 1956, the peso on the free market was sold at over 1,000 to the dollar.

In Jan. 1960 a new monetary unit, the escudo, equal to 1,000 pesos or about 95 cents, was introduced, but inflation continued during the 1960s. The central Bank of Chile, established in 1925, resembles the U.S. federal reserve system and supervises the nations's other banks.

C. Transport and Communications

1. Railways and Roads.—Because of its location, topography and latitudinal expanse, Chile is at a disadvantage in creating an efficient land transportation system, but it has one of the best railway systems in South America. The first rail line in South America, reaching 50 km. inland to Copiapó from Caldera, was completed in April 1851. It was built by William Wheelwright (*q.v.*), a U.S. engineer. From that modest beginning, a national railway network of about 9,000 km. has been built, about two-thirds of it controlled by the national government. The national lines include the longitudinal line from Pisagua to Puerto Montt (a distance of about 1,500 mi.), the Arica-La Paz line that gives Bolivia access to a seaport, the Trans-Andean line from Los Andes to Mendoza, Arg., the Valparaíso-Santiago line and the Antofagasta-Salta (Arg.) line, completed in 1948. The state also operates a small fleet of ships from Puerto Montt to southern ports. There are numerous short feeder lines that connect the longitudinal lines with the various ports. A short line from Arica to Tacna (Peru) is controlled by British capital. The Antofagasta-Bolivia railway, formerly controlled by British capital, is operated by the Bolivian government. Serious problems result from the multiplicity of gauges and the maintenance of obsolete equipment. To overcome the fuel problem, considerable sections of the state railways in the central zone have been electrified. The relatively good railroad network, mostly state-owned, is often blamed for Chile's failure to develop better highways. Modern hard-surfaced roads form only a small percentage of all highways. Country roads are often rough, dusty in the summer and almost impassable during the rainy season. The few good roads in the north are maintained by the mining companies.

2. Shipping.—There is virtually no freight or passenger traffic on the rivers of Chile, for the streams are shallow and reach but a short distance inland. The long coast line provides few natural harbours. Only a few ports such as Arica, Antofagasta, Coquimbo, Valparaíso, San Antonio and Puerto Montt have modern dockside facilities. Antofagasta and San Antonio with copper and Tocopilla and Iquique with nitrates lead in exports. Valparaíso leads in imports.

Coastwise shipping became a national monopoly in 1917 although the law was relaxed in 1939. By the early 1960s Chile had about 100 ocean-going vessels, about 85 of which were engaged in the coastwise traffic. All of these vessels were small and most of them were old. Foreign ships carried most of Chile's export trade. The Grace Line (U.S.) was most important, followed by ships from Great Britain and the Netherlands.

3. Air Transport.—The development of air transport has been of outstanding importance to Chile because of its geographical situation. Between the late 1930s and the mid-1950s there were enormous increases in traffic on both domestic and international routes. Santiago was the terminus of several international routes, and the number of passengers entering and leaving Chile by air exceeded that of all other means of transport combined. Routes of the National Air Line (L.A.N.) covered the whole length of the country and extended to Buenos Aires and to the United States. Airfields were numerous but the number suitable for large four-engined aircraft was limited.

4. Telecommunications.—The internal telegraphic service was largely government-controlled; international telecommunications service was provided largely by All America Cables and Radio, Inc. and an affiliate of Cable and Wireless, Ltd. The internal telephone service, under control of private companies, was not highly developed, only a small percentage of Chileans having telephones. Commercial radio broadcasting was highly developed, and the country also has two television stations. *See* also references under "Chile" in the Index. (W. D. Be.)

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Current history and statistics are summarized annually in *Britannica Book of the Year*. (J. J. J.)

CHILI (Chile), the pods of several kinds of peppers, notably the capsicum, used as a condiment. A dish of meat and beans, called chili con carne, highly flavoured with chili, is popular in the United States; it is generally, though erroneously, believed to have originated in Mexico. In tropical countries chilies are used in many ways to flavour foods.

CH'I-LIN (Ki-lin), one of the four symbolic creatures that in Chinese mythology is believed to keep watch and ward over the celestial empire. It is a unicorn, portrayed in Chinese art as having the body and legs of a deer and the tail of an ox. Its advent on earth heralds an age of enlightened government and civic prosperity. It is regarded as the noblest of the animal creation and as the incarnation of fire, water, wood, metal and earth. It lives for a thousand years, and is believed to step so softly as to leave no footprints and to crush no living thing.

CHILL HARDENING, the process of hardening the surface of a metal by rapidly cooling it while it is molten or at a very high temperature. Usually the chilling is done by plunging the object in a bath of water or oil. In the case of railway and other wagon and car wheels, a "chill mold" is used, consisting of a sand mold with the outer part (which forms the rim) made of cast iron. Chill hardening is sometimes combined with case hardening. *See* Founding; Heat-Treatment; Iron and Steel Industry; Surface Hardening.

CHILOÉ, province of southern Chile bisected approximately by lat. 43° S., was reduced to its present size in 1937 when Llanquihue province (*q.v.*) was created. Its 10,430 sq.mi. area embraces the insular components of Chiloé, Chauques and Guafo islands, and the Guaitecas islands (northern part of the Chonos archipelago) which are structurally part of the coastal range, and a rugged Andean continental segment which extends from Estero Comau to the Palena river. Volcanoes (Huequén, Minchimávida, Corcovado) arise on the mainland. In both segments evidence of glaciation is general. Summers and winters are cool and humid. Temperate forests of broadleaf evergreens cloak much of the land, but for centuries subsistence farmers, and lumbermen since the early 19th century, have deforested large areas. The predominantly agricultural population (99,211 in 1960) is concentrated on eastern Chiloé and adjacent islands. Most families own small tracts on which potatoes, wheat and a few head of livestock are raised. Fishing and shellfish gathering are important. There are a number of small lumber mills. Economic opportunity is limited so emigration is common; *chilotes* predominate in the labour forces in southern Chile and southern Argentina.

Castro, founded in 1567 and capital until 1834, is centrally located in the province. Ancud, the capital, formerly San Carlos de Ancud (pop. [1960] 18,207 mun.), founded in 1769, is to the north. A narrow-gauge railway and a road join them; both have airfields. Castro (pop. 18,262 mun.) has steamer service to Puerto Montt (*q.v.*), but most of the intercourse with the mainland is by nonscheduled launch or ship. The area suffered from a severe earthquake in 1960. (J. T.)

CHILON (6th century B.C.), Spartan statesman, listed by Plato as the seventh of the Seven Wise Men of ancient Greece, was the son of a certain Damagetus. Either in 560 or 556 B.C. he was ephor (an office which he is sometimes even said to have founded). The sayings traditionally attributed to him, which include "Nothing in excess" and "Know thyself" (though he is not the only claimant to these), are sometimes truly laconic; *e.g.*, "Give no trouble" and "Do not hope for the impossible."

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CHILPERIC, the name of two Frankish kings, of the Merovingian dynasty.

CHILPERIC I (539–584) was the son of Clotaire I by Aregund, sister of his queen Ingund. On his father's death (561), fearing that his half brothers would set him aside as a bastard, he seized the royal treasure and tried to set himself up in Paris, but was ejected by the brothers, who allowed him only the kingdom of Tournai, the poorest share in the inheritance. After his half-brother Charibert's death (567), however, he received the country later known as Normandy, Maine and Anjou, together with Rennes, as well as Limousin, Quercy, Toulouse and much territory south of the Garonne.

Already in 562 Chilperic had tried unsuccessfully to take Reims from his half-brother Sigebert of Austrasia, who was then fighting the Avars in the east. Next, in 568, Chilperic had his wife Galswintha, sister of Sigebert's wife Brunhilda (*q.v.*), murdered so that he could marry his mistress Fredegund (*q.v.*). Sigebert then exacted Galswintha's marriage settlement (Bordeaux, Limoges, Quercy, Bigorre and Béarn) from Chilperic as compensation. Resenting this, Chilperic in 573 sent two of his sons, Theudebert and Clovis, to attack Sigebert's southwestern territories. Sigebert then sought help from the Germanic tribes beyond the Rhine, and Chilperic, though his half brother Guntram of Burgundy was now supporting him, was driven back to the Seine and had to restore all his conquests (574). When he advanced as far as Reims in 575 he was again defeated and would have lost his kingdom to Sigebert but for the timely assassination of the latter. In 581, however, when all his own sons were dead, Chilperic adopted Sigebert's son Childebert II. He then turned against Guntram, but this attack came to nothing (583). Shortly after the birth of a last son (the future Clotaire II), Chilperic was assassinated at Chelles in Sept. or Oct. 584.

Gregory of Tours called Chilperic the Nero and the Herod of his age. He was indeed a typical Merovingian despot, unbridled in his rapacity and ambition. He sold bishoprics, levied crippling taxes and seized the property of the rich. Dissolute, sadistic and superstitious, he was stirred by echoes of classical learning and of Roman splendour. He composed Latin verse, ordered the addition of four Greek letters to the Latin alphabet and constructed amphitheatres at Soissons and in Paris. He also dabbled in theology, forbidding orthodox trinitarian belief. He attempted to extend to women the right of inheritance denied them by Salic law.

CHILPERIC II (*c.* 675–721), king of Neustria. As the alleged son of Childeric II he was taken from a monastery (where he was living under the religious name of Daniel) and made king in 715. Utterly subservient to Ragenfrid, mayor of the palace, he accompanied him on a campaign against Austrasia which took them as far as Cologne. Returning, they were defeated by Charles Martel, the Austrasian mayor of the palace, at Amblève, near Liège, in 716. They then sought help from Eudes, duke of Aquitaine, but were again defeated, near Soissons, and Chilperic fled to Aquitaine in 719. Within that year, however, the weakling king of Austrasia, Clotaire IV, died, and Charles Martel, needing a Merovingian to lend legality to his power, restored Chilperic, who now became king of the entire *regnum Francorum*. He died at Soissons in 721.

See F. Lot, *et al.*, *Les Destinées de l'empire en occident de 395 à 888* (1928), in G. Glotz (ed.), *Histoire générale* (*Histoire du moyen âge*, vol. i). (JE. H.)

CHILTERN HILLS, a range of chalk hills in England extending from southwest to northeast through parts of Oxfordshire, Buckinghamshire, Hertfordshire and Bedfordshire. Considerable areas are cared for by the National trust. The Chilterns form a well-marked escarpment facing northwestward, with a long southeastern slope, and run from the Thames in the neighbourhood of Goring to the headwaters of its tributary the Lea between Dunstable and Hitchin, the crest line between these two points being about 55 mi. These hills are part of a larger chalk system, continuing the line of the White Horse hills from Berkshire, and themselves continued eastward by the East Anglian ridge, a series which represents the edge of the chalk rising from beneath the Eocene deposits of the London basin. The greatest elevation in the Chilterns is Coombe hill (852 ft.) in the vicinity of Wendover. Toward the Thames gap to the west the elevation falls away only a little, but eastward the East Anglian ridge seldom exceeds 500 ft. Several passes through the Chilterns are used by roads and railways converging on London. The hills were formerly covered with beech, which is still the characteristic growth and the main raw material of the chair and furniture manufactures of High Wycombe.

CHILTERN HUNDREDS, an abbreviation of "the stewardship of the Chiltern Hundreds," an ancient office in the gift of the crown. An old principle of English parliamentary law declared that a member of the house of commons, once duly chosen, could not resign his seat. This rule was a relic of the days when the local gentry had to be compelled to serve in parliament. The only method, therefore, of avoiding the rule came to be by accepting an office of profit from the crown. The Succession to the Crown act of 1707 provided that every member accepting an office of profit from the crown should thereby vacate his seat, but should be capable of re-election, unless the office in question had been created since 1705, in which case the holder was disqualified from membership failing express statutory provision to the contrary. Before this time the only course open to a member desiring to resign was to petition the house for its leave, but except in cases of incurable ill-health the house always refused it. Among the posts of profit held by members of the house of commons in the first half of the 18th century are to be found the names of several crown stewardships, which apparently were not regarded as places of profit under the crown within the meaning of the act of 1707, for no seats were vacated by appointment to them. The first instance of the acceptance of such a stewardship vacating a seat was in 1740, when the house decided that Sir W. W. Wynn, on inheriting from his father, in virtue of a royal grant, the stewardship of the lordship and manor of Bromfield and Yale, had *ipso facto* vacated his seat. On the passing of the House of Commons (Disqualification) act of 1741, the idea (possibly suggested by Sir W. W. Wynn's case) of utilizing the appointment to certain crown stewardships as a pretext for enabling a member to resign his seat was carried into practice. These nominal stewardships were eight in number, but only two survived to be used in this way in contemporary practice —namely, the offices of steward or bailiff of the three Chiltern hundreds of Stoke, Desborough and Burnham, and of the manor of Northstead. These were carefully preserved by the House of Commons (Disqualification) act of 1957 which clarified the extremely confused state of the law relating to offices of profit and repealed much previous legislation. A stewardship was first used for parliamentary purposes in 1750, the appointment being made by the chancellor of the exchequer. It was laid down in 1846 that the Chilterns could not be granted to more than one person on the same day, but this rule has not been strictly adhered to. Modern practice is to grant the Chiltern hundreds and the manor of Northstead alternately, so that two members may vacate their seats at the same moment. Each new warrant expressly revokes the grant to the last holder, the new steward retaining it in his turn until another is appointed. A member who vacates his seat in order to test electoral support at a by-election or to contest another constituency may take his seat if re-elected even though he still holds a stewardship.

See parliamentary paper, *Report From the Select Committee of House of Commons on the Vacating of Seats* (1894). (Jk. W. G.)

CHI-LUNG (Keelung; Japanese, Kiirun), leading port and city of northern Formosa (Taiwan), located 18 mi. N.E. of T'ai-pei (*q.v.*) at the mouth of the Chi-lung river. The otherwise excellent deep-water harbour is exposed to the northeast winds of winter, which bring heavy rains. Chi-lung (pop. [1956] 194,006) was developed by Chinese settlers during the 18th century following previous efforts by the Spanish and Dutch to establish a trading post there. Partly because of its proximity to T'ai-pei and partly because of Formosa's unbalanced international trade, Chi-lung's foreign and domestic imports are much greater than exports. It is a major fishing centre, with freezing factories, a marine products school and a meteorological station. Closely associated with coal and power, Chi-lung's industries include fertilizer factories, several shipbuilding yards, a grain elevator, a flour mill and a bicycle plant. (N. S. G.)

CHIMAERA, in zoology, the common name for any cartilaginous fish (Chondrichthyes) of the small order Chimaerae (sometimes given family rank as the Chimaeridae). "Chimaera" or "chimera" (although the latter spelling usually indicates a genetic mosaic animal or plant; *see* Chimera), from the Latin meaning "monster," refers to the grotesque form of these, for the most part, deep-sea species. *See* Chondrichthyes.

CHIMALTENANGO, a department in the highlands of Guatemala; area 764 sq.mi.; pop. (1962 est.) 165,432. The capital of the department is also named Chimaltenango (pop. [1960 est.] 9,065). The higher part, along the Pan-American highway, is occupied by Maya Indians who grow maize, beans and wheat. The lower areas (below 5,000 ft.) are divided into private estates that grow coffee and sugar cane and pasture cattle and hogs. Access to Chimaltenango is by the highway from Guatemala City about 20 mi. to the east. (P. E. J.)

CHIMBORAZO, a province in highland Ecuador, bounded west by Bolivar, north by Tungurahua, east by the Oriente and south by Cañar province. Area 2,379 sq.mi.; pop. (1962) 279,607. The province includes Mt. Chimborazo in its northwest corner, the highest mountain (20,702 ft.) in Ecuador. A large part of its area is in the zone of the paramos, or high mountain grasslands. Chimborazo includes parts of two intermontane basins in which the people are concentrated: the basin of Riobamba and the basin of Alausí. The capital is Riobamba (*q.v.*). At the higher altitudes the land is used mainly for grazing sheep; in the basins much land is used for the pasture of dairy cattle. The crops include maize, wheat, barley, potatoes, fruit and fibre plants. In the towns of Riobamba and Alausi there are textile mills that produce woolen goods and clothing.

The province is served by the railroad that connects Guayaquil and Quito and by the Pan-American highway, which passes close to Riobamba and through Alausí. (P. E. J.)

CHIMERA. In Greek mythology the Chimera was a fire-breathing female monster resembling a lion in the fore part, a goat in the middle and a dragon behind. She devastated Caria and Lycia until finally she was slain by Bellerophon (*q.v.*). In art the Chimera is usually represented as a lion with a goat's head in the middle of the back, as in the bronze Chimera of Arezzo (5th century). The word is now used generally to denote a fantastic idea or fiction of the imagination. Chimera, or *chimère*, in architecture, is a term loosely used for any grotesque, fantastic or imaginary beast used in decoration.

CHIMERA. Biologically, chimera is defined as a mixture of tissues of different genetic constitution in the same part of an organism.

In ichthyology the term chimera, or chimeroid, is commonly applied to primitive sharklike fishes of a group typified by the genus *Chimaera*. *See* Chondrichthyes.

In botany certain types of plants were formerly regarded as "graft hybrids." Graft hybrid suggests a plant produced by the fusion of vegetative cells derived respectively from two plants grafted together. It is true that plants composite in nature and having some of the characteristics of the two plants employed may result from an operation of grafting, but these arise without the fusion of cells that would justify the appellation of hybrid. The term graft hybrid has been replaced in general by "plant chimera" or simply "chimera." (*See* also Grafting [in Plants].)

Many of these plants have been long known in gardens, being grown as curiosities rather than for their decorative value. The earliest to be described in scientific literature was the Bizzaria orange which appeared in a garden in Florence in 1644, arising as an adventitious bud from the region where a scion of sour orange (*Citrus aurantium*) had been grafted on a stock of citron (*Citrus medica*). Others are the so-called *Crataego-mespilus* forms, arising in a similar way following the grafting of medlar (*Mespilus germanica*) on hawthorn (*Crataegus monogyna*); the *Pyrocydonias* from the grafting of pear (*Pyrus communis*) on quince (*Cydonia vulgaris*); and, best known of all, *Laburnum adami* (or *Cytisus adami*) from the grafting of the small purple-flowered broom (*Cytisus purpureus*) on the common laburnum (*Laburnum vulgare*). In all these instances the history of origin is the same; the plants at present in existence have been derived by vegetative propagation from an adventitious shoot that arose at the junction of scion and stock.

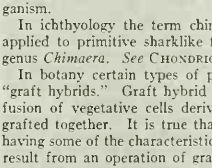

FIG 1

Stages in the production of a chimeral branch: Winkler's method. Dotted line indicates position of cut. n, nightshade; t, tomato; sc, sectorial chimera

While all the examples mentioned above originated as the result of a horticultural operation, their production was unintentional. Knowledge of the subject passed into a new phase with Hans Winkler's experiments in 1907, deliberately designed to produce graft hybrids. In these experiments black nightshade (*Solanum nigrum*) was grafted on tomato (*Salanum lycopersicum*) (*see* fig. 1).

After the graft had taken, a transverse cut was made through it at the junction of the stems. From the exposed surface, numerous buds developed which grew into new shoots, all of which were shoots either of nightshade or of tomato except one; this, arising at the junction of the two tissues, had the characters of nightshade on one side and tomato on the other. Winkler called this shoot a chimera, since it was partly of one species and partly of another. In the following two years large-scale experiments were carried out resulting in the production of many thousands of shoots from decapitated grafts. Most of these were either pure nightshade or pure tomato, some were chimeras of the kind already described but in addition there were a few shoots showing characters intermediate between the scion and stock. These differed among themselves as to the extent to which they resembled scion or stock and

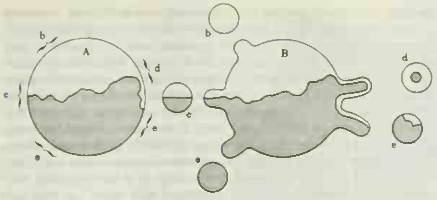

FIG 2

(A) Diagram of a cross section of the stem of a sectorial chimera consisting of green and colourless tissue; the line of junction between the two tissues is often very irregular. (B) Illustrating how there may arise from such a stem pure green (a), pure white (b), sectorial (c), periclinal (d) or mericlinal (e) branches, depending on the position of lateral bud formation

Winkler gave them special names, believing them to be true graft hybrids.

In 1909 Erwin Baur published observations on variegated plants, in particular the garden geranium (*Pelargonium zonale*). In such plants branches sometimes occur in which one side is green and the other colourless, corresponding structurally to the tomato-nightshade branch to which Winkler first applied the term chimera. In the present instance the distribution of the two kinds of tissue constituting the branch is dramatically obvious because of the difference in colour. Such a branch, called by Baur a sectorial chimera, when cut through transversely usually presents an appearance as shown in fig. 2(A). The nature of any lateral shoot arising from it depends on the place of origin; shoots arising at a and b will be pure green and pure white respectively, while one arising at c will possess a sectorial structure like the parent branch. If a shoot arises as at d where, as often occurs, a superficial strip of one component overlaps the other, a periclinal chimera will result in which a "core" of green tissue is invested by a "skin" of colourless tissue, one, two or more cell layers thick, or vice versa.

If the bud arises at the extreme edge of the overlap, as at e, the superficial "skin" may occupy only part of the surface of the shoot, a condition described as mericlinal. Thus, a branch having a sectorial structure gives rise during growth not only to occasional sectorial branches like itself but to branches that are pure for either component, periclinal or mericlinal. In contrast, a branch that has once acquired a periclinal pattern shows very great stability of structure during growth, producing lateral branches that are all periclinal chimeras like the parent branch.

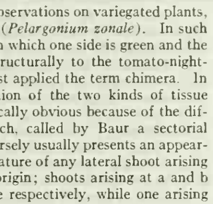

FIG. 3

(A) Longitudinal section through the growing point of a periclinal chimera in which the cells of the central core possess potentially green plastids while in the two outer cell layers the plastids lack the capacity to become green; (B) transverse section near the edge of a leaf derived from such a growing point. Because the whole of the marginal tissue, apart from the epidermis, is derived from the second layer of the growing point, the leaf has a white margin. (C) Superficial appearance of a leaf from such a periclinal chimera. The central part of the leaf, as well as the stem, appears green since the green core tissue shows through the two enveloping layers of colourless cells

Baur's experiment with these chimeras of *Pelargonium* composed of green and colourless tissue led him to suggest that Winkler's "graft hybrids" between nightshade and tomato were really periclinal chimeras, and he provided evidence that two plants to which Winkler had given special names were built up of a core of tomato with a skin of nightshade one and two cell layers thick respectively, and two others of a core of nightshade with skins of tomato one and two cell layers thick. After some hesitation Winkler concurred.

Attention was then turned to *Laburnum adami* and the other long-known "graft hybrids." Opinion became general that these also are periclinal chimeras: *Laburnum adami,* for example, consisting of a core of laburnum invested with a one-layered skin of *Cytisus purpureus,* the *Crataegomespili* having a core of hawthorn covered with skins of medlar differing in thickness in the different forms, and so on.

Because reproductive cells in flowering plants arise from the layer second from the surface of the growing point, seedlings from periclinal chimeras are pure core if the skin is but one cell layer thick, and pure skin tissue if the skin consists of more than one layer; they are never periclinal chimeras like the parent plant. Also, while stem branches or cuttings reproduce the periclinal condition, root cuttings yield plants of core tissue only, because of the endogenous manner in which lateral roots are formed.

Apart from being an occasional product of grafting, chimeras also arise in nature, most frequently, no doubt, as the result of a sudden mutation in some cell or cells of a growing region. The new kind of tissue may be conspicuously different from the old as when it is colourless instead of being green, but far more commonly the difference is evident only on special investigation as when the number of chromosomes is altered.

In contrast to the graft-hybrid interpretation which predicates a blending of the two components, the chimera hypothesis regards the components as maintaining their identity, but arranged in a definite pattern at the growing point; the manner in which vegetative growth occurs in flowering plants is responsible for the way this pattern is transferred from the growing point to the mature tissues. The whole behaviour of these plants in reproduction and vegetative growth, as well as in the nature and arrangement of their mature tissues, accords well with the supposition that they are chimeras.

The alternative graft-hybrid hypothesis cannot be said to be theoretically impossible, but it may be regarded as improbable in view of what is known of plant behaviour and as lacking positive supporting evidence. Nevertheless, it still has a few supporters, as exemplified by T. D. Lysenko and his followers.

While in no sense conclusive, it is at least significant that variegated foliage as described above for *Pelargonium zonale* is commonly met with in flowering plants of all kinds, but never occurs in groups such as the ferns with a single-celled growing point. This is what would be expected if such variegation is correctly interpreted as a consequence of the possession of a growing point having a chimerical structure, for which a multicellular growing point is a necessity. *See* also GENETICS: *Soviet Genetics.*

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CHIMERE, a garment worn as part of the ceremonial dress of Anglican bishops. *See* VESTMENTS, ECCLESIASTICAL.

CHIMKENT, an *oblast* in the Kazakh Soviet Socialist Republic, U.S.S.R. Formerly the South Kazakhstan *oblast*, formed in 1932, it was given its present name in May 1962 when it became part of the newly formed South Kazakhstan *krai.* It borders on the Kirgiz S.S.R. in the southeast and on the Uzbek S.S.R. in the southwest. The area is 58,000 sq.mi.

The *oblast* lies to the southeast of the Aral sea, on both sides of the Syr-Darya river which flows through its central and southern parts. Most of its territory is flat, hills being confined to the southeast and centre where peaks rise to more than 6,500 ft. The climate is continental with a short spring and winter and a long hot summer. Annual rainfall varies from less than 5 in. in the desert to about 40 in. in the hills. In the north the Chu river flows only from April to June. The population, nearly two-thirds rural, was 648,161 (1959) representing 11.2 per square mile; about 50% are Kazakh, 33% Russian, and minority groups include Uzbeks and Koreans. The *oblast* is divided into 15 *raions* and has five towns (Chimkent, the *oblast* centre, Lenger, Kentau, Turkestan and Arys) and eight "settlements of town type."

The economy centres on nonferrous metallurgy, textiles, food production, cotton production and livestock breeding (chiefly sheep). Coal is mined at Lenger and there is an important metallurgical works at Achisai producing lead and zinc concentrates. Chimkent has a lead foundry and cotton ginning factories. Of the whole area 55% is devoted to food grains, 18% to crops, including cotton (mainly in the irrigated Bet-Pak-Dala or Golodnaya steppe), and the remainder to fodder and vegetables. The *oblast* is traversed by the Tashkent–Orenburg railway for 370 mi. Arys is the junction with the Turkestan–Siberian (Turksib) railway. There are branch lines from Chimkent to Lenger and from Turkestan to Achisai. The main roads are Chimkent–Tashkent, Chimkent–Dzhambul and Chimkent–Turkestan. (G. E. Wr.)

CHIMKENT, the capital city of the Chimkent *oblast* in the Kazakh Soviet Socialist Republic, U.S.S.R., lies 380 mi. W. of Alma-Ata. It was formerly a caravan centre, Isfijab, captured from the Arabs by the Russians in 1864. The population was 153,-241 in 1959, having increased more than sevenfold since 1926. Before 1917 Chimkent was a centre of the santonin industry and it now possesses a large chemical and pharmaceutical works. In addition it has an important lead works, cotton gins, flour mills and fruit canneries. Chimkent, an important railway centre, is the junction of the Arys, Dzhambul and Lenger lines. A cultural centre, with more than 30 schools and 70 libraries, Chimkent has a pedagogical and a building industry institute. (G. E. Wr.)

CHIMNEY, a structure or portion of a building constructed to carry away smoke and gas from fires. It is intended to induce and maintain a draft providing air to the fire. It will also act as a ventilator facilitating the change of air in a room. Chimneys range in height to over 300 ft. for some industrial stacks.

HISTORY

The Romans developed elaborate vent and chimney systems in connection with furnaces and hot-air heating chambers under the floors and in the walls of villas, baths and libraries. The brazier, which they used for domestic purposes, was adopted by southern Europeans for heating. Only in northern Europe, where the wood fire was the usual heat source, was the chimney given architectural emphasis in building exteriors. The custom of maintaining the hearth at the centre of the communal room and allowing the smoke to escape through vents or louvers in the roof or gable ends goes back to prehistoric huts of the northern peoples.

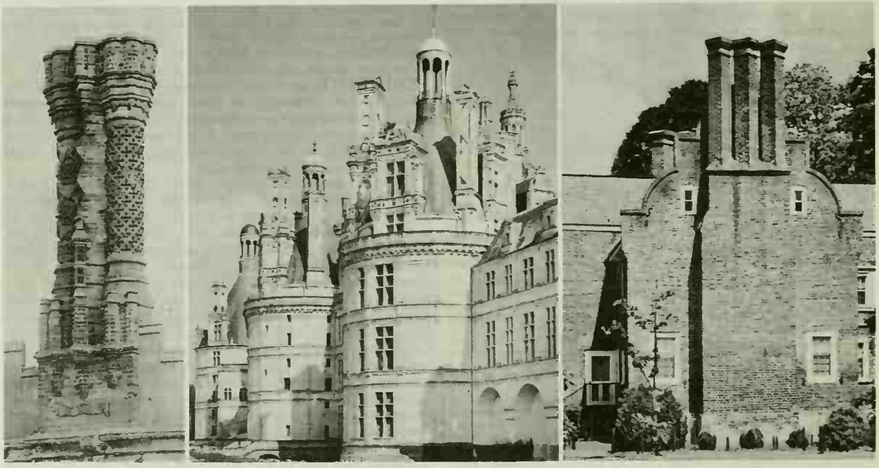
Characteristic chimney forms appeared in medieval times, when the development of masonry techniques allowed the construction of a hearth with a fireproof backstop and flue. Some of the oldest chimneys extant (12th century) are tubular, the shape considered most efficient. Some have ingenious conical caps with hooded side vents. Where masonry materials or techniques were lacking, expedients ranged from a barrel with both ends removed to carry smoke through a thatched roof, to the rectangular wooden chimney constructed of notched branches and lined with a coat of clay plaster. This type was used on the American frontier. As rooms became numerous, fireplaces did also, and rectangular flues were grouped to carry them through the roof in a rectangular mass of masonry. Steep-roofed French châteaux required tall chimneys, the late Gothic and early Renaissance examples being elaborately decorated with carvings, pilasters, niches and inlays to form an important part of the architectural ensemble. In English chimneys of the time each flue emerging at the roof line was treated as a separate columnar structure with base, cap and polygonal or twisted shaft, generally of elaborately shaped bricks.

Chimneys of the 17th and 18th centuries were rectangular. Generally the top courses were projected to form protective caps. The more massive early chimneys were often decorated with bevels or pilasters. In America this type was used as the central feature of the colonial New England farmhouse; the end position was customary for chimneys in the warmer southern colonies, allowing for better air circulation through the house and less retention of heat by the chimney. In the 18th century end placement of fireplaces, which could easily be combined to form fireproof party walls, became standard for row housing everywhere.

In the later 18th century coal became a readily available fuel and the principles governing the operation of domestic fireplaces and chimneys were investigated. Benjamin Rumford established the definitive forms and proper relationships of the essential parts of the chimney. These included the fireplace, throat, smoke chamber and flue. Benjamin Franklin invented a cast-iron hearth, evolved from the traditional fireback, used to protect the wall behind the fire and increase heat reflection from it. The Franklin stove could be inserted in overscaled fireplaces or used freestanding when connected by a stovepipe to a chimney flue. In the 20th century new models of this type, intended to supplant the traditional masonry fireplace, were prefabricated in steel.

FIREPLACE AND CHIMNEY CONSTRUCTION

The chimney is generally the heaviest part of a construction and must have ample footing to prevent uneven settlement. It should be built independently and not support other parts of the structure. In North America the masonry substructure of a fireplace is



BY COURTESY OF (LEFT) THE MANSELL COLLECTION, LONDON; PHOTOGRAPHS (CENTRE AND RIGHT) WAYNE ANDREWS

CHIMNEYS OF THE 16TH AND 17TH CENTURIES: (LEFT) ENGLISH TUDOR, THORNBURY CASTLE, GLOUCESTERSHIRE; (CENTRE) FRENCH RENAISSANCE, CHAMBORD; (RIGHT) U.S. COLONIAL, "BACON'S CASTLE," SURRY COUNTY, VA.

generally built hollow and encloses an ash pit. Ashes are swept through a pivoted cast-iron dump plate at the back of the hearth, drop into the pit and are removed through a small airproof cast-iron clean-out door. In Europe a raised fire grate is more commonly used with some form of shallow tray for ashes beneath. The fireplace has a back hearth of firebrick, while the part extending in front of the chimney is intended as a precaution against sparks and may have a more finished masonry surface. The front hearth is laid on a reinforced concrete slab or brick trimmer arch supported by the chimney and bounded by headers framing and opening in the floor.

BY COURTESY OF (RIGHT) KENTUCKY HISTORICAL SOCIETY, PHOTOGRAPH (LEFT) WAYNE ANDREWS

EARLY AMERICAN CHIMNEYS: (LEFT) 17TH-CENTURY NEW ENGLAND, THE "SCOTCH" HOUSE, SAUGUS, MASS.; (RIGHT) WOODEN CHIMNEY AT THE RECONSTRUCTION OF FT. HARROD, HARRODSBURG, KY.

Dimensions and Shape.—If the fireplace is the only source of heat its size should be proportional to the size of the room, the severity of the climate and the insulating efficiency of the building. Fireplaces have become smaller as design has improved and fuel costs have increased. More heat can be obtained from the open fireplace if it is modified to heat the air entering the room or if a supplementary air-circulation system is added. Most fireplaces depend in part for combustion on cold air drawn through cracks in floors and around door and window casings. They will not operate satisfactorily if the room is too well sealed or if too much air flows through it.

If air coming from the outside can be drawn through a series of pipes or ducts in the rear wall of the fireplace and heated before it is discharged into the room above the fireplace opening, a more even and economical heating of the room will result. Where a circulator is used, a double-walled metal heating chamber forms the back and sides of the fireplace. Cool air is drawn from the room at floor level, is warmed in the chamber and delivered to the same or adjoining rooms or to the floor above by means of ducts and registers. Baffles in the chamber may increase efficiency, and if a fan is added, the heating capacity of the system will be further increased. Masonry fireplace walls should be of firebrick laid in fire-clay mortar. The side walls should splay in plan, so that the back wall is narrower than the opening, and the upper part of the back wall should slope to reflect heat into the room. A depth of 16 or 18 in. is usual, although fireplaces as shallow as 12 in. work well when the throat is properly constructed. The opening into the room should be wider than it is high. Its area will govern the flue size required, being approximately ten times the area of the effective cross section (discounting the corners) of the flue.

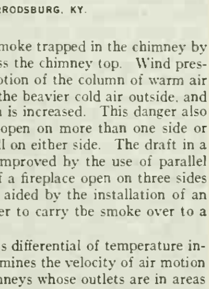
The Throat.—The throat is placed toward the front of the chimney and centred over the fire. The internal surfaces of the throat—especially the entrance to it under the front lintel or arch—should be rounded and smooth to provide a streamlined passage. The throat usually narrows to about four inches deep, and should extend six or eight inches above the top of the fireplace opening to the level of the smoke shelf at the bottom of the smoke chamber, where a damper, or valve plate, should be installed. The damper, which must be adjustable to regulate the air flow, should hinge at the back and extend the full width of the throat.

The smoke shelf is the horizontal surface formed by setting back the masonry at the top of the throat to the line of the back wall of the flue. It serves to deflect downdrafts which would otherwise force smoke and soot into the room. Where there is no damper it is sometimes built with a slight concavity to direct the cold air upward again before it encounters the rising warm air.

The Smoke Chamber.—The space above the shelf is the smoke chamber. It is constructed by sloping the masonry of the side and front walls uniformly toward the centre to meet the bottom of the flue lining. As it should have smooth surfaces it is convenient to build it around a metal form. The smoke chamber slows down drafts and acts as a reservoir for smoke trapped in the chimney by the pressure of gusts of wind across the chimney top. Wind pressure interferes with the normal motion of the column of warm air in the chimney forced upward by the heavier cold air outside, and the danger of poor chimney action is increased. This danger also arises when the fireplace itself is open on more than one side or when there are openings in the wall on either side. The draft in a fireplace without a back may be improved by the use of parallel dampers, while the construction of a fireplace open on three sides or on two adjoining sides may be aided by the installation of an asymmetrical metal smoke chamber to carry the smoke over to a point under the flue.

Height.—Since height as well as differential of temperature inside and outside the chimney determines the velocity of air motion within it, short chimneys and chimneys whose outlets are in areas of high wind pressure are also likely to be smoky. Nearby obstacles such as a steeply pitched roof, a tree or another building may deflect the wind, producing pressure or suction over the chimney top. Thus a chimney which need only extend two feet above the ridge when it passes through it should probably rise three feet above the ridge when built elsewhere on the roof.

Except in structures with specially designed central flues, each fireplace or appliance will have a separate flue of a height and size appropriate to its heat output and to the volume of air circulation which it requires. As gas appliances burn at relatively low temperatures and do not produce soot, their flues can be smaller and constructed of concrete block or asbestos cement units.

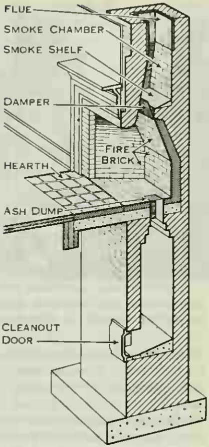


WAYNE ANDREWS

A CHIMNEY DESIGN AS ART. CHIMNEYS OF THE CASA MILÁ, BARCELONA, SPAIN (1905–07), BY ANTONIO GAUDÍ

Lining.—Each flue should have a fire-clay lining. Unless made of dense concrete or specially cast concrete units, an unlined flue will develop leaks from the action of hot gases and weathering. This will increase the disintegration of mortar and spalling of brick caused by moisture in the chimney freezing in cold weather. Linings should be carefully cemented and the space between lining and masonry filled with mortar. Traditional pargeting (plastering with lime cement mortar) of the inside of a brick flue, if clear of debris, will generally provide a satisfactory substitute for the lined chimney.

The pargeted chimney must be constructed with a slightly larger cross section (to take care of the same volume of gas) because of



BY COURTESY OF UNIVERSITY OF ILLINOIS SMALL HOMES COUNCIL "BULLETIN"

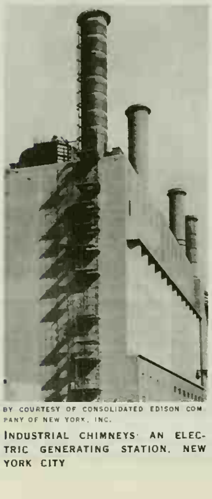
ISOMETRIC DRAWING OF FIREPLACE AND CHIMNEY

greater friction. Where masonry is to be avoided, economical lightweight chimneys of tubular form can be suspended from the framing of the building. A smoke test should be made on each flue before any appliances are connected. (A smudge fire is built and the top of the flue covered tightly. Smoke will be seen escaping through any openings.)

The pipes used to connect appliances with masonry flues should end at the edge of the lining where they discharge into the flue and be sealed in place.

Precautions.—Flues should be vertical except where bends are required to collect them in a stack. Although bends reduce rain splash down the flue, they restrict the flow of gases. Therefore care should be taken that there is no reduction in the cross-sectional area of the flue at the bend and that it slopes at an angle of at least 45°, and preferably more than 60°. Where flues are grouped together they should be separated by at least four inches of masonry to the top of the stack. The danger of warm air siphoning into a neighbouring unused flue, resulting in condensation and damage to interior finish, can be avoided by carrying the partition, or withe, between the flues higher than their outlets or by varying the heights of the flues. Usually the flue lining is carried a few inches above the masonry of the chimney and a cement bevel sloped up to it. Baffles, hoods, cowls, chimney pots or spark arresters may form part of the chimney top to control venting, while a capstone will keep rain out of a seldom used flue.

Usually the flue linings project above the weatherproof chimney cap, which is made slightly larger than the stack to protect the masonry below it. Where condensation from slow-burning materials may deposit acids or tars on the flue, additional air must be allowed to enter to increase the velocity of the gases, or a means of collecting and removing the condensate must be provided at the base of the flue.



BY COURTESY OF CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

INDUSTRIAL CHIMNEYS: AN ELECTRIC GENERATING STATION, NEW YORK CITY

Fire hazard may be reduced by cleaning partially obstructed flues, removing combustible soot by suction or brush. All combustible building materials should be kept away (nine inches) from flues or fireplace openings, and the space left around the chimney where it passes through the framing of a wooden floor should be packed with fireproof insulation. Where the chimney passes through the roof, flashing and possibly dampproof masonry courses will be necessary to avoid staining of the chimney breast.

Larger Chimneys.—Industrial chimneys are usually freestanding single flues with radial firebrick cores and outer jackets of steel, brick or reinforced concrete. Often there is an insulating air space to allow for differential expansion and contraction. Brick chimneys are generally tapered and reinforced with an iron or steel ring at the top, while concrete chimneys may be built with fire-clay linings. Similar freestanding chimneys are built within or alongside multistory office, hotel and apartment buildings, but are anchored laterally at suitable intervals to ensure stability.

See also HEATING AND VENTILATION.

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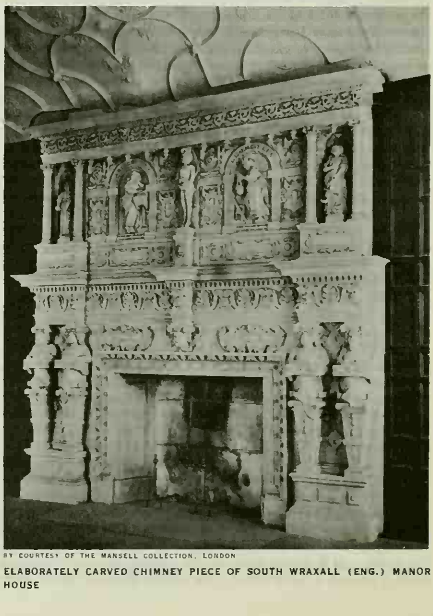
CHIMNEY PIECE, in architecture, was originally a hood, projecting from the wall over a grate, built to catch the smoke and lead it up to the chimney flue. Later, the term was used for any decorative development of the same type or for the same purpose, as a mantel or mantelpiece. Like the chimney (*q.v.*), the chimney piece was essentially a northern medieval development. Its earliest form, a simple hood, sometimes with shafts below, at the wall, is seen in the king's house at Southampton and at Rochester castle, England (12th century). Later, the spaces under the ends of the hood were made solid, so that the fireplace became a rectangular opening, and in some cases the fireplace was recessed into the wall. Late medieval fireplaces were of great size and richness; *e.g.,* the triple fireplace in the great hall of the Palais des Comtes at Poitiers.

During the Renaissance fireplace openings were decorated with columns, pilasters and entablatures, and occasionally the front of the wall or hood above the overmantel was enriched. North Italian palaces have numerous examples of great delicacy. In France the fireplaces at Blois and Chambord are famous. In England the same formula appears in naïve and complex types, with the usual Elizabethan and Jacobean mélange of misunderstood classic and Flemish motifs—strapwork, gaines, etc. In France, after a brief classicism under Henry II and Henry IV, the chimney piece reflected the baroque and rococo design trend. Although the opening



BY COURTESY OF THE MANSELL COLLECTION, LONDON

ELABORATELY CARVED CHIMNEY PIECE OF SOUTH WRAXALL (ENG.) MANOR HOUSE was usually smaller, the decoration was rich, and commonly characterized by elaborate overmantel treatments. The detail assumed the classic extravagance of the Louis XIV style, the swelling curves of the Louis XV and the distinguished restraint of the Louis XVI styles, but almost always retained the same general proportions and overmantel enrichment. German design largely followed that of France; chimney pieces were less numerous there, however, because of the use of porcelain stoves.

In England the Renaissance chimney piece was at first treated, with simple architraves, frieze and cornice, in such as way as to serve as mantelshelf, occasionally with rich paneling above, and much breaking or keying of the moldings. Later, consoles, caryatids and columns were used, although occasionally a bolection molding of sweeping profile replaced the architrave, and the shelf was omitted. In the latter half of the 18th century the characteristic English chimney pieces, in the style of Robert Adam, owed much to Louis XVI influence. In American colonial work there was a close following of English precedent, and occasional examples can be traced to specific plates in English architectural books. (J. G. VanD.)

CHIMPANZEE, one of the anthropoid apes of the family Pongidae. An inhabitant of tropical Africa, it is distinguished from its congener and neighbour the gorilla (*q.v.*) by its smaller size, large outstanding ears and more lively disposition. Males range up to 5 ft. and 150 lb.; females are slightly smaller.

Chimpanzees dwell in small family parties in the rain forest belts of Africa from Gambia to the Congo region; inland the range extends north of the Congo river eastward to Lake Albert and Lake Victoria and thence southward to northwestern Tanganyika.

Although the general colour of the coat is invariably black with some white hairs on the face and around the anus, examples from so wide a range naturally exhibit considerable variation in size, distribution of hair and skin pigmentation. Consequently many varieties have been described; but, in view of the changes shown by captive animals in passing from youth to maturity and the differences due to sex, it is now felt that the majority of them are invalid. In the early 1960s it was not possible to state precisely how many valid forms exist, but those mentioned below are certainly recognizable, though whether as species or subspecies is a moot point.

1. The masked chimpanzee (*Pan satyrus verus*) of upper Guinea has a pale muzzle bearing short, white hairs, while the brows and upper face are blackish from birth. Ears are large, pale and prominent, fingers and toes pale, palms and soles brownish (never black), body skin pale.

2. The choga (*P. s. satyrus*) occurs in the same area as the next form; *i.e.*, in lower Guinea east of the Dahomey gap. Black-faced throughout life, its nose is not swollen; the body skin is black, including that on hands, feet and ears. Ears are rather smaller than in *verus* and placed somewhat higher. The skull in the male shows a sagittal crest.

3. The koolo-kamba of Nigeria and the western Cameroons region is distinguished by its gorillalike swollen nose, resembling a squashed tomato. The face is blotchy and the hair long and coarse.

4. The long-haired or eastern chimpanzee (*P. s. schweinfurthi*) has the face completely pallid at birth, but with age it becomes a dirty brownish-pink; ears, hands and feet are also pink. This form comes typically from the eastern part of the range, *i.e.*, Tanganyika and Uganda, but extends thence westward into the Congo, a few stragglers even reaching into the Cameroons.

5. The pygmy chimpanzee (*P. paniscus*) is a very distinct, dwarfish animal, confined to the south bank of the Congo river. It deserves full specific rank and has even been promoted to a new genus (*Bonobo*) by some authors. Its limb proportions somewhat recall those of the gibbon (*q.v.*).

In contrast to the other great apes, chimpanzees are temperamentally extrovert and endowed with considerable intelligence, involving even a degree of insight. They are consequently educable, though attention is inclined to wander if a particular problem eludes them, whereupon they are liable to tantrums. However, they show great individual variability in personality.

In nature chimpanzees move in small family parties led by an adult male. On the ground they walk on all fours in a semierect attitude, but in the trees they use their arms for swinging from branch to branch. When walking, they lean on the knuckles of their hands. In an erect position, their arms reach just below the knees. Females produce a single offspring after a gestation of 32–34 weeks. There is no special breeding season. Full growth is attained by the 11th year and the life span is around 35 years. The chimpanzee's food includes fruit, plant shoots and occasionally insects and birds' eggs.

See Primates; *see* also references under "Chimpanzee" in the Index volume. (W. C. O. H.)

CHIN, a group of tribes of Mongoloid race occupying the southernmost part of the mountain ranges separating Burma from Assam, numbering some 260,000 in the late 1950s. They are closely related to the Lushai to the west, the Haka and Lakher tribes to the south, and the Kuki to the north. Their history, traceable to about A.D. 1600, is a long sequence of tribal wars and feuds; they also raided the neighbouring areas, such as Chittagong in 1777 and Manipur in 1856. The first British expedition into the Chin hills in 1889 was soon followed by annexation. Previously there had been head-hunting and slave raiding, and much effort had to be devoted to defense. The villages, often of several hundred houses, were self-contained units, some ruled by councils of elders, others by autocratic headmen. There were also hereditary chiefs, exercising political control over large areas and recognized as "lords of the soil," receiving tribute from the cultivators.

Agriculture is the basis of the economy; land is cultivated in rotation, consecutive cultivation for between three and six years being followed by reversion to forest. The land is worked by hand with hoes; rice, millet and maize are the main crops. Hill slopes are cultivated from top to bottom with variations of height between individual fields of up to 6,000 ft. Domestic animals are kept mainly for meat, and are neither milked nor used for traction. The mithan (*Bos frontalis*), the main sacrificial animal, is a symbol of wealth and prestige. Pigs, goats and fowls are also sacrificed as well as eaten. Prowess in hunting has religious significance, and the slayer of much game is believed to enjoy high rank in afterlife. Equally important for the attainment of a desirable fate after death is the giving of lavish "feasts of merit." Social advancement too is achieved by means of feasts, and much of the Chins' material resources is devoted to payments and ritual connected with marriage, birth, death and illness.

Traditional religion comprises a belief in numerous deities and spirits, accessible to propitiation by offerings and sacrifices. Christian missions have made many converts, and in a late cult known as Pauchinhau indigenous and Christian religious concepts have been mingled. The area inhabited by Chins is also claimed by the Kuki, Lushai and Lakher as their original home, and ethnographically these tribes conform to a similar pattern: they speak related Tibeto-Burman languages, and common to all is the rule by chiefs, the division of society into patrilineal, exogamous clans, polygyny and the levirate; a system of patronage amounting to serfdom enables a chief to build up a powerful following. These tribes have retained their identity, and Burmese cultural and linguistic influence has remained limited. *See* Burma.

See B. S. Cary and H. N. Tuck, *The Chin Hills* (1896); J. Shakespear, *The Lushei Kuki Clans* (1912); N. E. Parry, *The Lakhers* (1932); H. N. C. Stevenson, *The Economics of the Central Chin Tribes* (1943). (C. v. F.-H.)

CHINA, a vast country of eastern Asia, bordering the U.S.S.R. and the Mongolian People's Republic for more than 6,000 mi. on the north and west; it is flanked by Korea on the northeast; the Yellow sea, East China sea and South China sea on the east; Vietnam, Laos and Burma on the south; and the Karakoram and Himalaya ranges on the southwest. Including Manchuria, Sinkiang and Tibet and numerous smaller islands, but excluding Formosa (Taiwan), China has a total area of 3,691,502 sq.mi. with a population (1953) of 582,603,417; (1957 est.) 646,530,000. After the victory of the Chinese Communists and the flight of the Nationalist government to Formosa (Dec. 8, 1949), China was divided into two political entities: Communist China on the mainland and the Nationalist government on Formosa.

The People's Republic of China (Chung-hua jen-min kung-ho-kuo), capital at Peking, which was formally inaugurated in Oct. 1949, was founded on the principles of Marx, Lenin and Stalin and of Mao Tse-tung's New Democracy. The Nationalist government in T'ai-pei, Formosa, was based on Sun Yat-sen's Three Principles of the People and the five-power constitutional system; its official name is the Republic of China (Chung-hua-min-kung-ho-kuo).

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    - 3. Shang, or Yin (*c.* 1766–*c.* 1123 B.C.)
    - 4. Chou (*c.* 1122–256 B.C.)
  - C. Middle Period
    - 1. Ch'in (221–207 B.C.)
    - 2. Han (202 B.C.–A.D. 221)
    - 3. Six Dynasties (221–589)
    - 4. Sui (589–618)
    - 5. T'ang (618–906)
    - 6. Five Dynasties and Ten States (907–960)
  - D. Early Modern Period
    - 1. Sung (960–1279)
    - 2. Yüan (1280–1368)
    - 3. Ming (1368–1644)
    - 4. Ch'ing (1644–1912)
  - E. 19th Century and Revolution
    - 1. First War With Great Britain and First Group of Foreign Treaties (1839–44)
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    - 3. T'ai P'ing Rebellion and Other Revolts
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    - 7. Boxer Uprising (1900)
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I. INTRODUCTION

Traditionally, China has been considered as comprising five separate cultural and economic regions: China proper, Manchuria, Mongolia, Sinkiang and Tibet. To these in the second half of the 20th century must be added a sixth, industrial China.

Less than half the country's total area is essentially Chinese. Its civilization has always rested upon agriculture, and Chinese culture has extended as a dominant institution only into those areas where cultivation is possible. The majority of political China is either too dry, too hilly or too cold for farming; these vast spaces, while relatively empty and hence relatively easily incorporated into the Chinese polity, are inhabited for the most part by non-Chinese people whose cultures and economies are markedly distinct from the human patterns of agricultural China.

The interaction between agricultural China and the outer areas of political China is in part a measure of their differences, but equally of the attractive power, wealth and prestige of Chinese civilization. Despite the distinctions outlined below, "greater China" is a living entity, with a degree of unity that belies its regional distinctiveness.

1. China Proper.—"China proper," as the agricultural area commonly is called, consists of 18 provinces—Anhwei, Chekiang, Fukien, Honan, Hopeh, Hunan, Hupeh, Kansu, Kiangsi, Kiangsu, Kwangsi, Kwangtung, Kweichow, Shansi, Shantung, Shensi, Szechwan and Yünnan—bounded by the sea to the east, the mountains to the south and west and the desert to the north. In early Han times only a few areas near the capital were clearly delimited, and the more distant military and civil zones or districts were but loosely designated. Under later dynastic rulers the units changed steadily in number and general area, but slowly the number of closely delimited areas increased, particularly in the north. The final shaping of the 18 provinces occurred during the 15th and 16th centuries, under the Ming rulers, at which time there were 15 provinces. Anhwei had not been separated from Kiangsu, Hupeh and Hunan had not been divided, Kansu still was a part of Shensi, and the limits of several provinces had not yet been settled. By 1760, under the Manchus, only Hupeh and Hunan remained undivided (though recognized), some other lines were still under final adjustment, and the western boundaries of Szechwan and Yünnan still were ill-defined. Detailed adjustments in fully precise boundaries have continued, and the Szechwan-Tibetan border still is subject to repeated change. Despite these late adjustments in details the basic political patterns have been intact for several centuries, and they express a kind of integrated regionalism toward which administration has long been moving, so that political boundaries have been recognized by all as far more than mere administrative lines. Strikingly, the political divisions were developed on land form and drainage criteria in almost all cases, but they have become important historical and cultural boundaries that the Chinese have recognized and compounded in many ways. The historic identification of provincial birthplace, and the banding together of fellow provincials, has been one of the strongest social attributes of the Chinese.

The Great Wall, completed, from earlier walls, as a continuous unit by the emperor Shih Huang Ti in the 3rd century B.C., still serves to mark a line between farming and grazing along the desert border of agricultural China in the north and northwest. Not all of the area of the 18 provinces is arable, however, and in fact mountains, hills and climate, especially in the west and south, combine to keep almost three-quarters of it out of cultivation (*see* below). In many of the areas—for example, the southwest—there still live many non-Chinese people. Agriculture also increasingly spread out beyond the limits of China proper after the middle of the 19th century as population pressure mounted. Manchuria and the moister parts of Inner Mongolia have in particular been increasingly settled by north China farmers. But the 18 provinces of China proper do contain the bulk of the agricultural land, the great majority of the Chinese people and the roots and body of Chinese civilization.

2. Manchuria.—Manchuria was sparsely settled before 1900. Chinese political claims to it were weak but were made effective by the mass immigration of farmers. Southern Manchuria has rich resources of broad, level land, coal, iron, timber and water power, which were largely developed by the Japanese during their period of control from 1931 to 1946. This process continued under Chinese Communist control after 1947 and made Manchuria into a major industrial area. Manchuria's current distinction from China lies to a considerable degree in the commercialized and industrialized nature of its economy, a reflection of accessible resources and of heavy Japanese and Russian investment in railways and manufacturing between 1890 and 1946. The name Manchuria is no longer officially used, and the area is known simply as the Northeast. (*See* also MANCHURIA.)

3. Mongolia.—Mongolia is a vast steppe bordering on the desert of central Asia. The moister southern sections, now the Inner Mongolian autonomous region (formerly Ningsia, Suiyüan, Chahar and Jehol—not part of the 18 provinces), especially since the end of the 19th century have been infiltrated by Chinese farmers and drawn more firmly under Chinese political control. The remaining drier sections, known as Outer Mongolia and sparsely though almost exclusively occupied by Mongols, are oriented to the Soviet Union. Outer Mongolia's independent status as the Mongolian People's Republic was recognized by both the Nationalist and Communist governments of China in agreements with the Soviet Union. (*See* also MONGOLIA.)

4. Sinkiang.—Sinkiang is the westernmost extension of political China, a desert corridor between the two arms of the mountain mass of central Asia, the Tien Shan (Chinese, *shan;* English, "mountain") and Kunlun ranges. Its earlier name of Eastern or Chinese Turkistan reveals its non-Chinese culture, as well as the reason for the repeated assertion of Chinese control: it is the traditional overland connection with the west. Most of Sinkiang's people belong culturally to the Turkish group, and life centres in the scattered string of oases from east to west along the base of the mountain escarpment. These oases, following both the northern and southern margins of the desert basin, nourished the old silk route from China to Europe and the middle east. At Kashgar and Yarkand passes lead out of the desert basin and across the Pamirs into Russian Turkistan and Afghanistan. Another route westward runs north of the basin through the oases of Hami and Urumchi into the steppe of Dzungaria, which is also included in the province of Sinkiang. Chinese authority in Sinkiang tended to be increasingly nominal after 1900, and Russian influence grew. The Chinese Communist government established its control in Sinkiang in late 1949; and in 1956 renamed it the Sinkiang Uighur autonomous region, giving it special status. (*See* also SINKIANG.)

5. Tibet.—Tibet, like Mongolia, has two parts, though it is less usable from a human point of view. The terms "nearer" and "farther" Tibet record this division, the first referring to the borderland areas in the east fronting on agricultural China and low enough or with a series of narrow river valleys to permit farming. About 80% of Tibet's cultivated area and the majority of its population are there. Most of nearer Tibet used to be included in the Chinese provinces of Sikang and Tsinghai (not part of the 18 provinces), reflecting not only the penetration of agriculture but the need for a buffer against nomadic raids from farther Tibet. In late 1955 the province of Sikang was abolished, and the area annexed to Szechwan. Most of farther Tibet is too high, rugged and cold for agriculture. It is extremely thinly occupied by a non-Chinese population whose support comes largely from nomadism based on the yak, from the raising of barley in a few favoured places, and from the trade routes connecting India, China and central Asia which pass through the country, with their most notable focus at Lhasa, the capital.

Chinese sovereignty over all of Tibet usually has accompanied the rise of a strong dynasty in China. As central authority in China weakened during the 19th century the theocratic government at Lhasa became increasingly independent. Though Great Britain and Russia recognized China's suzerainty by treaty in 1907, Tibet remained very loosely attached until the Chinese Communist government carried out a military occupation as far as Lhasa in 1951 and obtained an agreement conferring on Peking all control of foreign affairs, currency and defense.

6. Industrial China.—The growing industrialization of China in the second half of the 20th century significantly alters the limits of the old, agricultural China. Road, rail and air transport is unifying the whole of greater China in a way never before accomplished. Many of the newly located mineral resources lie in areas marginal to the old centres of population and economic power. As the industrial program matures the formerly marginal and nonagricultural sectors of the political state, except for farther Tibet, will become productive areas vital to the economy of the whole. In the expanding economic development of the first and second five-year plans the regional dispersal of Chinese, of industrial processes, industrial plants, internal trade routes and economic forces serves to enlarge the areal economic structure of China more nearly to fit its political limits. Though the process had only begun, by the 1960s it already had altered the regionalism of China.

II. PHYSICAL GEOGRAPHY

The eastern Asian mainland, containing China proper and its outlying segments, possesses tremendous variety and complexity in its physical make-up. There are to be found ancient hard rock surfaces (north China and Manchuria), a zone of recent windblown sediments masking the underlying surface (the loesslands of the middle Yellow [Huang] river system), some of the world's youngest and loftiest mountains (Himalayas, Kunlun and Tien Shan), one of the lowest spots on earth (Turfan depression), a dramatic region of karst land forms (Kwangsi and Kweichow), two of the world's great rivers (Yellow and Yangtze) and two alluvial lowlands subject to serious flooding (north China plain, Yangtze valley). A land form profile drawn westward, south of Shanghai, passes over a series of low mountain ranges interspersed by lowland basins, each unit set a step upward until the last great step onto the Tibetan plateau. Across Manchuria and into central Asia the easternmost portion of the profile is similar to that in the south, but the western portion drops away to the Turfan depression. China proper, with Manchuria, forms the eastern sector of this varied zone, wherein the elevations are lower, and most of the land forms less spectacular, than those of Tibet. China proper, however, is one of the most irregular large areas of the world, with lowland basins, rugged hill and low mountain country, and intricately developed drainage systems arranged in a complex pattern that seems at first glance to have little order.

A. Geology and Structure

1. Structural Features.—The geological pattern of China and its dependencies is determined by two widely spaced series of structural axes, one extending eastward out of central Asia and the other trending northeast-southwest across Manchuria and China proper. The older axial elements are broad but discontinuous hard rock massifs forming low mountains and blocks of rugged hill country that constitute drainage divides, whereas the more recent elements are marked by more imposing mountain ranges that still are undergoing mountain building.

The east-west axes, from north to south, are (1) the Tannu Ola-Kentei-Khingan range system on the Siberian border; (2) the Yin Shan ranges just north of the great bend of the Yellow river; (3) the Tsinling system of ranges extending from the Kunlun eastward across central China and tapering out in the southern north China plain; and (4) the Nan Ling Shan in south China forming the divide between the Hsi Chiang (Chinese, *chiang;* English, "river," "basin") and the Yangtze river.

The northeast-southwest axes are (1) the Fukien massif fronting on the China sea; (2) the discontinuous system of ranges and blocks extending from Hainan Island off the south China coast northward through the Shantung and Liao-tung peninsulas into coastal Siberia; (3) the Great Khingan-T'ai-hang system of ranges whose southern ends lie buried in the east front of the Yünnan plateau, trending north across central China to the Siberian border; and (4) the Ala Shan, a short series of hilly mountain roots just west of the great bend of the Yellow river. South of the Kunlun the eastern ends of the Tibetan mountain systems curve southeastward toward southeast Asia to form the spectacular Chinese-Tibetan borderland, whose geological composition and structure are still imperfectly known.

The several axes intersect and interfere with one another in much of China proper, produce local structural complexities and contribute to the complicated physiography of China. Between the axial trends are located the structural basins, platforms and plateaus which show up either as alluvial lowlands now being filled by the rivers of China, or as lowlands, platforms, elevated basins or plateaus now undergoing denudation by stream processes, karst processes, wind erosion or some combination of these.

(R. M.; J. E. Sr.)

2. Geologic History.—The earth movements, involving both folding and faulting, responsible for the present geological structure of China began in very ancient times and have continued at intervals to the present. The most important were: (1) Pre-Cambrian (widespread, in several stages); (2) post-Silurian (minor except in south); (3) post-Devonian (in southeast); (4) Upper Carboniferous (in southwest and in Nan Ling Shan, where granite intrusions are numerous); (5) mid-Permian (Kunlun mountain axis and its extension into central China, lava flows in southwest); (6) post-Triassic (general uplift of eastern Asia, folding in southwest and east central China); (7) post-Jurassic (widespread, most important in Tsinling axis of central China); (8) post-Cretaceous (widespread, lava flows in Manchuria and southeast China, igneous intrusions in the south with which metalliferous deposits are associated); (9) Late Tertiary (particularly in north China and Mongolia); and (10) Recent (central Asian highlands).

3. Distribution of Strata.—Because of structural complexity, rocks of all geologic ages are widely but irregularly distributed, and the only considerable areas of comparatively undisturbed strata occur in the basins. The total thickness of sedimentary rocks is very great, but in a country of such size the thickness and also the lithologic nature of beds of equivalent age vary greatly in different areas.

The Pre-Cambrian rocks constitute three great systems: T'ai Shan (oldest), Wu-t'ai and Sinian (youngest). The first consists of highly metamorphosed sedimentary and igneous rocks, mostly gneiss and schist, and the second is made up of less metamorphosed sediments. The last is mainly sedimentary and consists of arkosic clastics below grading up into thick cherty limestone; it also includes sedimentary iron ore, tillite and local lava flows. These are unmetamorphosed except where involved in much later mountain-forming disturbances and generally resemble overlying Paleozoic formations.

The Paleozoic succession begins with Lower Cambrian sandstone and grades upward into thick later Cambrian and Ordovician limestone. Toward the end of the Ordovician period all China north of the Tsinling axis was gently uplifted, and subsequent deposits are absent from that region.

Silurian, Devonian and Lower Carboniferous strata are confined to south China and include graptolite-bearing shale (Silurian), plant-bearing nonmarine beds (Devonian) and much limestone. The lower parts particularly were deposited in very shallow water.

Upper Carboniferous strata overlap extensively onto Ordovician and older rocks in north China, and Permian strata are almost equally extensive. In south and central China these beds are mainly limestone, but in the north they include the most important coal deposits of the country, and red beds become conspicuous in the upper part.

Sinian and Paleozoic sediments accumulated in a broad depression extending northeast-southwest and connecting with similar east-west depressions on either side of the Tibetan region. Successive mountain uplifts encroached upon these depressions and reduced in size and multiplied in number the depositional basins of later times, which shifted to some extent with respect to each other.

Nonmarine strata become progressively more important in the Mesozoic, and thick red beds are present in many areas. Rock salt occurs in the Triassic of Szechwan, coal in the Jurassic and gypsum in the Cretaceous.

Tertiary strata, mostly nonmarine red beds, occur especially in the north, where they are many thousands of feet thick. They include some lignite, gypsum, fresh-water limestone and lava flows. The youngest of these beds are nearly horizontal except adjacent to very recently uplifted mountains. Oil is produced from the Tertiary in the northwest.

Deposits of Pleistocene and Recent Age include thick piedmont gravels in central Asia, the loess of north China and extensive alluvium in the Yellow, Yangtze and other river valleys.

(J. M. Wr.)

B. Physiography

The land forms of China are complex, varied and developed around the structural framework described above. Essentially there are a series of elongated zones of hill and mountain country with intervening erosional or depositional basins. In north and central China the pattern is fairly clear, but south China has few basins and a larger share of hill country. Stream erosion and its associated denudational processes have been the primary forces shaping the upland landscape, and stream deposition has created the critically valuable alluvial basins and deltas. Aeolian processes have been important in the northwest; glaciation has played an active role in the higher mountain regions, notably in the Chinese-Tibetan borderland; and solution processes have been important in parts of south China.

1. River Systems.—There are four major and several smaller river systems that drain China proper and Manchuria, serving both to reduce upland areas and to fill the lowland basins and the shallow coastal waters. Primarily the drainage net is guided by the structure. Northern Manchuria is drained by tributaries of the Amur river, of which the Sungari system is the largest, draining the northern portion of the Manchurian plain and its surrounding mountains northward away from the rest of China. Southern Manchuria is drained by the smaller Liao river. The Yellow river (Huang Ho) taps a 486,486-sq.mi. sector across north China, between the Yin Shan and the Tsinling Shan. The northern end of the north China plain carries a series of smaller streams, whereas some 64,000 sq.mi. of the southern part of the plain is drained by the Huai Ho (Hwai river; Chinese, *ho;* English, "river"), into which the Yellow occasionally breaks when in major flood. The Yangtze (Ch'ang Chiang) river system drains a 756,498-sq.mi. zone across central China, between the Tsinling and Nan Ling mountain systems, forming the major drainage basin of eastern Asia. It has several large tributaries within China proper. In the east the Kan joins from the south through P'o-yang Hu (chinese, *hu;* English, "lake"), the Han joins from the north at Hankow, the Hsiang comes in from the south through Tung-t'ing Hu, the Wu joins from the south at Fou-ling, the Chia-ling joins at Chungking from the north, and the Min comes in from the north at I-pin, in western Szechwan. The Hsi Chiang (West river) system, as a whole, drains 170,000 sq.mi. of south China. The Fukien coastal zone is drained by a series of small rivers that are mountain streams rather than lowland rivers.

The Sungari tributaries of the Amur are normal high latitude rivers, subject to winter freezing and spring floods, and though they are degrading most of the basin they do not operate in spectacular fashion. The Yellow river is a typical arid-land river system, with few permanent tributaries, highly variable water flow, a very high silt content when in flood, silting of its bed in its lower course, and frequent changes of course across the north China plain. Its drainage of the loess highlands region of China, subject to easy erosion, provides an abnormal potential load of sediment in flood season. The historic diking of the lower course of the Yellow has prevented the natural distribution of the sediment load and has caused the upbuilding of the river bed and natural levees many feet above the plain. This has led to major breakouts during unusual flood periods, resulting in disaster on a large scale. The Yellow's lower course seldom has been constant for more than a century during the whole of historic time, and it has been the major builder of the north China plain. In 1938 the Chinese cut the dikes and diverted the Yellow to a course south of the Shantung peninsula in an effort to delay the Japanese armies, and it was not returned to its northern course until 1947.

The Liao river is also an arid-land stream, but one that freezes in winter. It is degrading most of its basin, but it carries a small volume of water and a lesser sediment load than the Yellow, so it is not rapidly building its delta margins. The Huai Ho, on the arid margins of north central China, has too small a basin and regular flow volume fully to maintain its course to the sea, and ends in the Hung-tse Hu, though flood control outlets are again being developed to drain off to the sea its frequent summer flood volumes. The Yangtze is a normal humid-region stream, with an intricate system of tributaries and a large flow at all times, but it is very subject to seasonal flooding in some portions of its basin. The western and outer margins of the basin are under active erosion, and its lower portion and delta zone are areas of active alluvial deposition. The main branch of the Hsi Chiang flows chiefly through a region of karst land forms, and though the region is humid the river has fewer than the normal number of tributaries and a fairly even flow.

2. Relief.—*Mountains.*—East of the Tibetan borderland only the western Tsinling mountains and a few ranges in Yünnan and Kweichow reach really high elevations, yet most of China proper is rough and rugged hill and mountain country of high local relief, and much of the west and most of south China appears as a jumbled sea of mountains. Of the roughly 2,000,000 sq.mi. area of China proper, Inner Mongolia and Manchuria, about 1,400,000 sq.mi. could be described as hills and mountains, leaving only about 600,000 sq.mi. in areas of subdued to smooth surfaces. Most of the physical landscape, therefore, is a denudational landscape with large amounts of bare rock exposure. The historic processes of deforestation and soil erosion have added to the amount of bare rock, or to the gullying and roughening of much of the surface, despite the amount of terracing done by the Chinese, for there have been periods in which civil unrest has interfered with terrace maintenance. In areas of hard bedrock, such as the Shantung peninsula, the T'ai-hang Shan, the Fukien hill country or the karst mountains of Kweichow and western Kwangsi, the stripping off of thin soil covers has created broad expanses of bare rock that no amount of careful maintenance can restore to usefulness.

Few of the mountainous areas form well-defined mountain ranges, and none within China proper or Manchuria form real barriers to internal transport of some sort. The Tsinling ranges from eastern Kansu to central Honan form perhaps the sharpest physical divide, of climatic as well as topographic significance, separating the dry loesslands of the north from the green hills of the south. Elsewhere the mountainous districts serve chiefly as watershed divides or zonal separations of the lowland basins.

Around the margins of most of the structural basins the flexures, faults and folds created locally complex patterns that have been roughened by the developing of headwater drainage networks to make many of the basin margins zones of acutely developed land forms of high local relief. In these zones terracing, historically, has been extensive and effective in the prevention of serious erosion, but exceptional rains or periods of civil unrest often have caused widespread deterioration of agricultural areas.

Loess Region.—Much of Shansi, northern Honan, most of Shensi and eastern Kansu are overlain by a mantle of fine-grained wind-deposited alluvium, or loess, between 25 and 250 ft. thick, masking the detailed relief of the underlying surfaces. Loess was deposited beyond these suggested limits in smaller amounts mixed into the water-laid deposits. Within the main loess region the rich, soft soil was very important to early Chinese agriculture, but loess is highly subject to erosion by gullying. Though terracing is both old and widespread there has been general increase in total erosion, so that by modern times the region contains many areas of high local relief, lessening the modern agricultural utility of the farm landscape.

Basins.—The Manchurian basin is a degrading zone rather than a depositional area, but the structural smoothness and the climatic regime have been such that most of the basin presents subdued relief and broad open surfaces. Such surfaces also are characteristic of much of Inner Mongolia, though in this area the aridity is so great that stream drainage is almost entirely sporadic, local and internal within the broad structural basins. The Szechwan basin, pitched well above the level of most of eastern China, is a zone of active denudation. Chiefly horizontal sediments of soft textures have been intricately dissected by stream drainage, so that most of the basin presents a surface of low hills, whose tendency to natural terracing has been easily and highly amplified by agricultural occupance.

Plateaus.—The Yünnan and Kweichow plateaus are not good examples of plateaus, for dissection has etched them deeply. The margins of the Yünnan plateau are very deeply cut by the great rivers of southeastern Asia, though a few portions of the main upland region present broad surfaces located around structural depressions containing mostly shallow lakes. The Kweichow plateau, in reality, is no longer a plateau at all, but a deeply dissected upland region of hills, canyons, valleys and karst land forms. Eastward of the Yünnan plateau these karst land forms are more highly developed, and the Kwangsi platform shows a variety of physical features. In the west the rock outcrops are numerous and the solution basins tend to be ragged in outline, whereas to the east the rock outcrops are but remnants, the open surfaces are broad, and relief is generally more subdued.

Lowlands.—Several lowland basins present smooth depositional land form features. These are the best portions of China wherein the mass of the population is concentrated. The north China plain, the Yangtze delta (properly a filled estuary, which merges into the southern north China plain), the Tung-t'ing basin, the P'o-yang basin and the Canton estuary lowland are the largest of these. Seasonal flooding, alluvial deposition, frequent changes in local minor land forms, the presence of natural levees, river terraces, old channel lines and other flood plain features are normal. Except in the northern north China plain there are many natural and artificial lakes and ponds. The historic procedures of dike building, the canalizing of natural streams and artificial canal building, however, have continuously interfered with natural physiographic processes, and the Chinese have been engaged in a long and difficult struggle to control the precious lowlands. The periodic high floods repeatedly have broken through dike systems to cover local areas with sediments that sometimes obliterate the previous detail of the land surface. The Yellow river has been more difficult to control than the Yangtze, whose several basins and tributary valleys afford temporary storage for flood waters draining from some other sector of the river system. As the inland depositional basins progressively are being filled, the north China coast line is being built outward steadily at a rapid rate.

Coast Line.—North of Hangchow bay the alluvial coast line provides almost no natural harbours except for those around the rocky Shantung and Liao-tung peninsulas. Shantung, originally an island in the Yellow sea, has been tied to the mainland through the growth of the north China plain. River-mouth harbours increasingly are turned into artificial harbours. South of Hangchow bay the submerged coast has many deep inlets and offshore islands as far south as Canton, and excellent harbours are plentiful, but west of Canton the coast again is a smooth coast, though not an active depositional one, and there are only a few good harbours, with shallow waters offshore.

C. CLIMATE

For China proper and Manchuria eight major climatic regions can be distinguished. Their general locations and principal characteristics are as follows:

1. Northern Manchuria.—The northern sector of Manchuria, including both the north end of the basin and its surrounding mountains, is a subarctic region with too short a summer for agriculture, the growing season everywhere being under 140 days per year. The winter is very long, cold and dry except for a little snow, and the summer has warm weather and light rains. Total precipitation is about 20 in. per year.

2. Northwest China.—The northwestern fringes of China proper share the arid climate of the Mongolian region, with steppe to desert conditions and local variations according to relief and exposure. This includes Kansu, northern Shensi, northern Shansi and Inner Mongolia. Precipitation is everywhere under 20 in., and often under 10. Though rain occurs chiefly in summer, the distribution normally is erratic as to timing during the year, as to amount in any one year and as to local distribution. Frost-free growing periods everywhere are under 200 days.

3. North China.—This region includes the southern section of the Manchurian basin, the Jehol and T'ai-hang mountains and most of the loess highlands area. It is a somewhat transitional zone in that the growing season and the annual precipitation lessen from the south to the northwest. Growing seasons range from about 225 days in the south to about 150 days in central Manchuria and the Jehol mountains, and the precipitation total ranges from about 30 in. in the south to about 15 in. in the northwest of the region. Any given summer season may bring both drought and flood, either to the whole region or to some portion of it, for this is a zone of extremely variable and erratic rainfall, and the optimum seasonal distribution needed for maximum agricultural production does not often occur over the whole climatic region. Really good climatic years produce good harvests, but bad years produce disaster in some portion of north China.

4. Yangtze Valley.—Central China south of the Tsinling mountain line, east of Szechwan, into the Tung-t'ing and P'o-yang basins, and as far south as Hangchow bay, comprises a climatic region of mild winters and hot summers. It is a zone of 225–280 days' growing season, with intermittent periods of freezing weather and light falls of snow during the winter months. The summers are very humid and hot, with a peak rainy period in June and July. Total precipitation varies from 45 in. to around 80 in., depending upon location and exposure. Some of the hill margins have cooler conditions in summer.

5. South China.—The southeast coast and the southern hill areas have milder winters than the Yangtze valley, with rain instead of snow, and freezing conditions only during short periods in exposed localities in the higher mountain areas. The growing season for most lowland localities ranges from 300 to 350 days, and slightly less than this in upland exposed localities. The summers are long, hot and humid, except in coastal localities or in the uplands, where cooler temperatures prevail. May, June, July and August each normally have heavy rainfall, the month with the most rainfall, varying with the locality. Though there is adequate rain in every month, the summers receive the largest amounts, and totals range from 50 to over 80 in. The coastal zone is affected by typhoons which occasionally produce heavy rainstorms and destructive winds during summer and autumn periods.

6. Szechwan Basin and Northern Kweichow.—For an inland location this is an unusual climatic region in that it has an all-year growing season, with frosts only in upland exposed localities. The area is protected from cold northerly winds by the high western sector of the Tsinling mountains, and from the mid-latitude sweep of the westerly wind storm belt by the Tibetan plateau. During the autumn, winter and spring this is a region of stagnating air and quiet conditions, and the gradual cooling of the still air up to 6,000 or 7,000 ft. produces a thick blanket of cloud that covers the Szechwan basin and northern Kweichow, normally, from late October until about the end of March. During this period the thermometer hovers a few degrees above freezing for weeks at a time, the sun being seen only occasionally. The Szechwan proverb "The dogs bark when the sun shines" applies to this uncomfortable, depressing set of winter conditions. There is little real rain during the winter, though it often barely drizzles for days at a time. The low temperatures and lack of sun reduce evaporation and permit winter growing of hardy crops. Summers are hot, humid and rainy in the main Szechwan basin, though its margins and northern Kweichow are less uncomfortable. Annual rainfall varies from just over 30 in. in the north to about 60 in. in southern exposed localities. Within the main basin much of the midsummer rain results from local thunderstorms.

7. Southwest China.—The western and southern portion of Kweichow, and the Yünnan plateau, in respect to human comfort, have the most enjoyable climate of all China. The higher elevations reduce maximum temperatures during the day, and the protected location prevents any really cold winter weather, except in the mountain ranges that rise above the plateau. Most of the region has a growing season that is almost yearlong. The winters are rather sunny and dry, with brief showers of rain accompanying cool, cloudy spells from late November through April, the nights being cool and the days delightful. Summers are relatively cool, with few uncomfortably hot days, and there is a peak period of rainfall in July. Total annual precipitation normally amounts to about 40 in. in the north and 60 in. in the south. Yünnan is famous for its magnificent cumulus clouds and bright blue sky (the name may be translated as "south of the clouds" or "southern cloud land").

8. Tropical South Coast.—Hainan Island and the south coastal zone of China, to a point north of the Canton lowland, is a region of tropical climate, with an all-year growing season and with rather high temperatures at all times of the year. There is rain in every month, but in most localities the period from November through February is relatively dry, the maximum rainfall occurring in May through August. Precipitation totals for the year vary from one part of the region to another, but range between 45 and 85 in., so that there are sections that are humid tropical and others that are dry-margin tropical. In this region rice and other crops may be planted in any month of the year, though planting normally follows the rain cycles. It is the only region that traditionally has double-cropped rice and where tropical fruits and flowers flourish. (J. E. Sr.)

D. VEGETATION

The natural vegetation of China ranges from boreal taiga to rain forest and from barren tundra and desert to the littoral vegetation of the coral islands in the tropical seas. In general, the entire territory of China is dominated by two great plant formations: the grassland-desert of the northwestern half of China and the woodland of the southeastern half.

Six major forest types are recognized:

1. The mixed northern hardwood forest is best developed in the northeastern provinces. A similar type appears also in the higher elevations of the northern provinces above the deciduous oak belt. The primary components are maple, linden and birch, intermixed with Korean pine (*Pinus koraiensis*), oak, walnut, elm, *Maackia*, *Phellodendron*, *Kalopanax* and other trees of minor importance.

2. The deciduous oak forest is the major type of the northern provinces. Relics of natural forest indicate that the primary components are *Quercus aliena*, *Q. liaotungensis*, *Q. dentata* and *Q. variabilis*. The common associates are ash, hornbeam, elm, *Pistacia*, *Prunus*, walnut and hackberry. Pine (*Pinus tabulaeformis*), arborvitae and juniper grow on exposed ridges. The denuded slopes are covered with *Vitex*, *Zizyphus*, *Lespedeza*, grasses and thickets of *Cotinus*, *Deutzia*, *Spiraea*, wild roses and lilacs.

3. The mixed mesophytic forest of the Yangtze valley is richest in composition of all the deciduous forests. Preserved in this

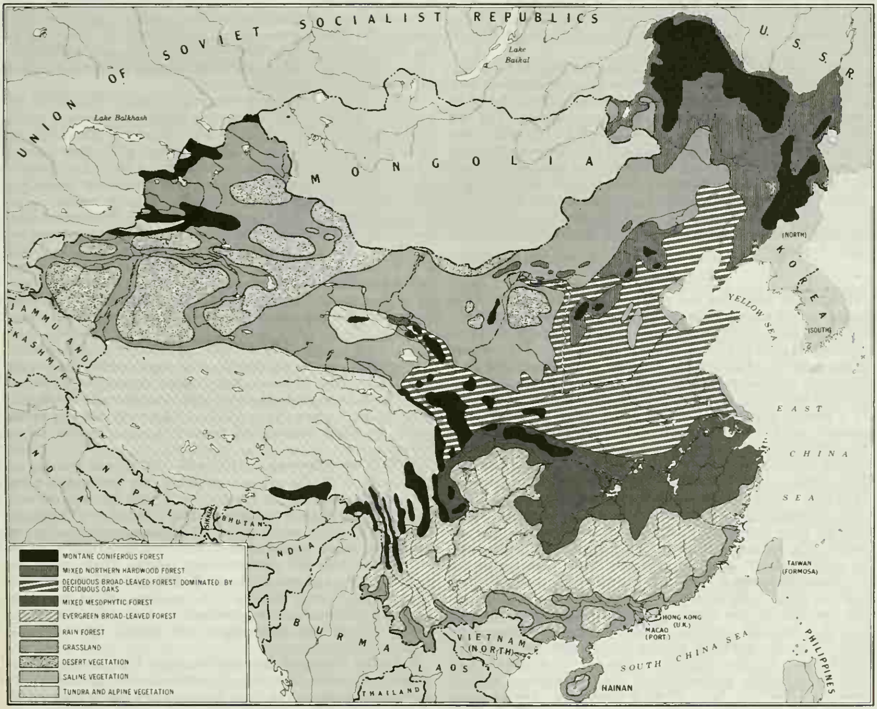

UNION OF SOVIET SOCIALIST REPUBLICS
U.S.S.R.
Lake Baikal
Lake Balkhash
MONGOLIA
JAMMU AND KASHMIR
INDIA
NEPAL
SIKKIM
BHUTAN
BURMA
VIETNAM (NORTH)
LAOS
THAILAND
KOREA (NORTH)
KOREA (SOUTH)
YELLOW SEA
EAST CHINA SEA
SOUTH CHINA SEA
TAIWAN (FORMOSA)
HONG KONG (U.K.)
MACAO (PORT.)
HAINAN
PHILIPPINES
MONTANE CONIFEROUS FOREST
MIXED NORTHERN HARDWOOD FOREST
DECIDUOUS BROAD-LEAVED FOREST DOMINATED BY DECIDUOUS OAKS
MIXED MESOPHYTIC FOREST
EVERGREEN BROAD-LEAVED FOREST
RAIN FOREST
GRASSLAND
DESERT VEGETATION
SALINE VEGETATION
TUNDRA AND ALPINE VEGETATION

FIG. 1.—DISTRIBUTION OF MAIN TYPES OF NATURAL VEGETATION OF CHINA

temperate clime are a number of relics of Tertiary flora (notably *Ginkgo, Metasequoia*) of more than 60,000,000 years ago, and polytopic genera which are represented also in North America (*e.g., Liriodendron, Sassafras, Cladrastis, Gymnocladus*). The forest components include: *Aesculus, Aphananthe, Carya, Castanea, Cephalotaxus, Cercidiphyllum, Cryptomeria, Cunninghamia, Cupressus, Daphniphyllum, Diospyros, Ehretia, Emmenopterys, Eucommia, Fagus, Fraxinus, Halesia, Idesia, Magnolia, Nyssa, Paulownia, Pseudolarix, Pseudotsuga, Quercus, Torreya, Trema* and *Zelkova*.

4. The evergreen oak forest extends over the hilly areas of the southern and southwestern provinces, Taiwan and Hainan Island. It is composed of more than 150 species of evergreen cupuliferous trees (*Quercus, Lithocarpus, Castanopsis, Castanea*) and numerous evergreen trees of the Lauraceae, Theaceae, Magnoliaceae and Hamamelidaceae. Bamboo and secondary growth of *Pinus massoniana* and *Liquidambar* cover large areas south of the Yangtze.

5. Rain forest occurs only along the southern fringe of China from the Yünnan-Assam border to the lowlands of Kwangtung, Hainan and Formosa.

6. The montane coniferous forest of the Greater Khingan range is essentially of larch (*Larix gmelini*), but spruce (*Picea obovata, P. jezoensis*) and fir (*Abies holophylla, A. nephrolepis*) form dense forest on the eastern rampart bordering Korea. The montane coniferous forest of the southwestern plateau is composed of many conifers, including spruce, fir, hemlock, larch and *Pseudotsuga*. Montane coniferous forests appear also on the high peaks of the northern provinces (*Picea asperata, P. neoveitchi, Abies nephrolepis*) and Sinkiang (*Picea schrenkiana*), and on Formosa (*Picea morrisonicola, Abies kawakami*), which lies on the Tropic of Cancer.

A vast expanse of grassland extends from the plain of the northeastern provinces westward to the Tien Shan, interspersed with salt lakes (*nor*), gravel desert and sand dunes. Thick clumps of grass *Stipa splendens* are the most conspicuous feature. The arid areas support only xerophytes and halophytes. Orchards, vineyards and luxuriant groves of poplar and elm, however, thrive in the oases. Marshes of cattail and *Phragmites* teem with nesting geese, ducks and swans in summer. The vegetation of the Sidzang plateau (Tibet) is scanty, consisting only of scattered cushion plants with thick rootstocks. But the Tsangpo (upper Brahmaputra) valley is well wooded. (*See* also Asia: *Physical Geography: Vegetation.*) (W.)

E. Animal Life

Profusion of vegetation and variety of relief have fostered the development of a fauna of great diversity and have permitted the survival of animals elsewhere extinct. Notable among such survivals are the great paddlefish (*Psephurus gladius*) of the Yangtze, the small species of alligator in east central China and the giant salamander (related to the Japanese giant salamander and the American hellbender) in western China. The diversity of animal life is perhaps greatest in the ranges and valleys of the Tibetan border, to which region the giant panda is confined. The takin or goat antelope, numerous species of pheasants and a variety of laughing thrushes are to be found in all the Chinese mountains. China seems to have been one of the chief centres of dispersal of the carp family and also of old world catfishes.

The regional affinities of the Chinese fauna are complex. In the northeast there are relations with the animal life of the Siberian forests. The mongolian deserts bring animals from central Asia into suitable steppe areas in northern China. The life of the great mountain ranges is Palearctic, but with distinctively Chinese species or genera. To the southeast, the lowlands and mountains alike lead directly into the oriental region. This part of China presents a complete transition from the temperate zone Palearctic life to the wealth of tropical forms distinctive of southeastern Asia. Tropical types of reptiles and amphibians and of birds and mammals predominate in the southernmost Chinese provinces. (*See* also Asia: *Physical Geography: Animal Life.*) (K. P. S.)

III. GEOGRAPHICAL REGIONS

A great many different kinds of regionalisms may be recognized in China by the application of differing scales and types of criteria. This section describes only a few of them.

The simplest separation of China into parts is the distinction of north China from south China along the Tsinling mountain system. Such a division separates the cold and drier north—the culture hearth of China, the wheat-millet eating area, the northern plant and animal areas and the seasonally dull brown landscape—from the mild and humid south—the region of colonial expansion, the rice-eating area, the southern plant and animal zone and the perennially green landscape. This division overgeneralizes some elements, for northeast Manchuria is not really dry or brown at any season, and Manchuria also is a zone of recent expansion of settlement. The rice-wheat dietary division actually is a zone extending across the northern portion of the Yangtze drainage system, and the northern plant and animal zone extends south of the Tsinling along the Tibetan borderland.

A more detailed zonal division of China would suggest six regions: south, west, east, north, northwest and northeast. In these terms (1) south China becomes the region roughly south of a line from Hangchow bay to Tung-t'ing Hu and east of Kweichow and Yünnan; (2) the west comprises Szechwan, Kweichow and Yünnan; (3) the east covers the central and lower Yangtze valley region; (4) the north includes Shantung, the north China plain and that portion of the Yellow river drainage system roughly east of the great bend of the Yellow; (5) the northwest comprises Shensi, Kansu and the Inner Mongolian fringe; and (6) the northeast covers Manchuria.

These regional divisions involve climatic, crop, ethnic, linguistic, historical and many other cultural factors, and are often used by the Chinese themselves. They have about the same validity for China as regional divisions labeled New England, the south or the midwest have for the United States.

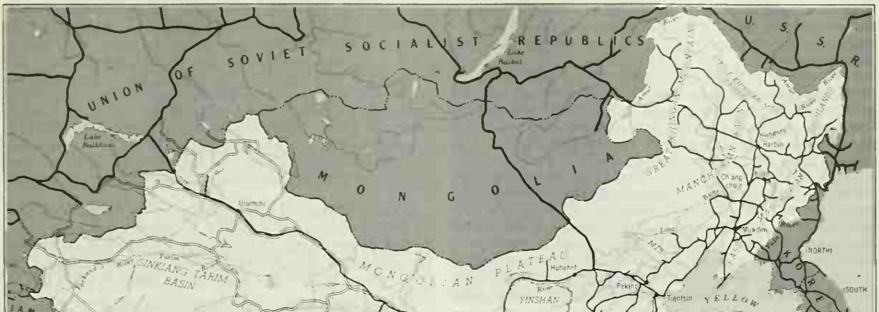
A wide variety of other criteria may be used to distinguish the parts of China, resulting in a varying number of regions of major significance. Physiographically China proper and Manchuria can be described as comprising 19 major regions, with a large number of subregions identifiable in a more detailed study (*see* below). Climatically there are eight major regions and about that many more subregions (*see* above, *Climate*). There is general agreement on nine agricultural regions (*see* below). The major vegetation regions are described in the section *Vegetation*, above; *see* also fig. 1. The 18 traditional political provinces of China proper (prior to the manipulation of boundaries for tactical political and military purposes that has marked China since 1900, and that goes on in Communist China) go far beyond distinguishing political areas for administrative purposes (*see* above, *Introduction*).

A. Physiographic Regions

The major regions are developed on the structural framework (see *Geology and Structure* and *Physiography*, above). Subregions occur in localities in which structure, drainage or physical processes have given rise to special land forms. Starting in the north, the major regions and their chief characteristics are as follows:

1. East Manchurian Highlands.—These are rounded to rugged ranges of hills and mountains trending north-south along the east margin of the Manchurian basin, with the highest elevations near the Korean border, reaching 9,003 ft. in Ch'ang-pai Shan, but elsewhere much lower. Many deep entrant valleys of locally low relief, several internal structural basins and little severe erosion make this region relatively usable. The northern end approaches the east end of the Little Khingan, with the Sungari river passing between the two. The southern end of the region tapers off into the Liao-tung peninsula, a drier, more barren and hard-rock landscape suffering from soil erosion. The total area is about 120,000 sq.mi.

2. Little Khingan Mountains.—The Little Khingans are several low (under 3,000 ft.), little-known mountain ranges that close off the northern end of the Manchurian basin and that merge into the Great Khingan on the west.


UNION OF SOVIET SOCIALIST REPUBLICS
U. S. S. R.
Lake Baikal
Lake Balkhash
MONGOLIA
MONGOLIAN PLATEAU
SINKIANG TARIM BASIN
Tarim River
Urumchi
TIBETAN PLATEAU
JAMMU AND KASHMIR
NEPAL
BHUTAN
INDIA
BURMA
THAILAND
LAOS
VIETNAM (NORTH)
KOREA (NORTH)
KOREA (SOUTH)
GREAT KHINGAN MTS.
MANCHURIAN
Harbin
Ch'ang ch'un
Mukden
Liao River
Amur River
Sungari River
Huhehot
YINSHAN
LOESS PLATEAU
Yin ch'uan
T'ai yüan
Peking
Tientsin
YELLOW SEA
NORTH CHINA PLAIN
Yellow River
Lan chou
Hsi ning
Sian
Chengchow
Nanking
YANGTZE DELTA
Shanghai
EAST CHINA SEA
Ho fei
Hang-chow
Wu ch'ang
SZECHWAN BASIN
CENTRAL MOUNTAIN BELT
Ch'eng-tu
Yangtze River
MIDDLE YANGTZE PLAIN
Ch'ang sha
Nan ch'ang
SOUTH YANGTZE HILLS
KWEICHOW
Kuei yang
KWANGSI PLATFORM
YÜNNAN PLATEAU
K'un ming
Canton
CANTON DELTA
Nan ning
HONG KONG (U.K.)
MACAO (PORT.)
Foochow
TAIWAN (FORMOSA)
HAINAN
SOUTH CHINA SEA
PHILIPPINES
Lhasa
Brahmaputra
Salween River
Mekong River
Yalung
Mo-ch'u
Ch'ia-ling River
BROAD-GAUGE RAILROADS 5' 0"
STANDARD-GAUGE RAILROADS 4' 8½"*
NARROW GAUGE RAILROADS (VARIOUS WIDTHS)*
SELECTED ROADS*
*Completed or under construction
0 100 200 300 400 500 600 700
MILES

PREPARED BY CENTRAL INTELLIGENCE AGENCY, 1959

FIG. 2.—PHYSIOGRAPHIC AREAS OF CHINA WITH BROAD AND STANDARD GAUGE RAILWAYS AND SELECTED ROADS, MAY 1959

3. Great Khingan Mountains.—These north-south trending ranges present steep, rugged and dissected escarpments to the east above the Manchurian basin, but appear as low ranges of hills when viewed from the Mongolian side. The southern zone is lower and less dissected, and there is a broad gap affording access between the Manchurian basin and Mongolia. The area, including the Little Khingan, is about 170,000 sq.mi.

4. Jehol Mountains.—This is a rugged, complex region of dissected hills and mountains located at the crossing of two structural lines. The northern portion, in the west, has surface lava flows and is raised only slightly above the Mongolian plateau; in the east it is more rolling. The region was long an imperial Manchu hunting area; its opening to settlement after 1911 brought short-term occupation, destruction of the forests and culturally induced soil erosion that greatly increased the bare rock exposure on the naturally steep slopes of the southern sector. Maximum elevations are just above 5,000 ft. in the central section. The area is about 40,000 sq.mi.

5. Manchurian Basin.—A broad open structural basin everywhere below 1,000 ft. elevation, it is in its central zone a gently rolling plain, with little entrenchment of the stream net. Toward either end the Sungari river in the north and the Liao in the south have lightly entrenched their courses, and river terraces and flood plain features are evident near the channels. The Sungari (1,215 mi. long) is navigable by river steamers for about 600 mi. during the summer, and some of its tributaries also are navigable by shallow-draft craft. The Liao Ho (835 mi. long) is generally shallow and navigable for a short distance only by shallow-draft boats.

The total area of the physiographic region is about 170,000 sq.mi., though only about 130,000 sq.mi. is normally considered to constitute the Manchurian plain.

6. Yin Shan.—A series of discontinuous ranges of bare rocky hills and mountains, the Yin Shan separates the Mongolian plateau from China proper. Several breaks permit passage to and from Inner Mongolia. The total area is about 27,000 sq.mi.

7. Loess Highlands.—An irregular region comprises the area from the Ala Shan and the Yin Shan to the Tsinling mountain system and eastward to the north China plain in which fine wind-blown loess forms a thin to deep veneer over the underlying surfaces, with water-laid deposits locally intermixed. The higher original surfaces project through the loess cover as local hill and mountain ranges. There are several alluvial basins and river valleys with normal valley features of stream-process origin within the region, chiefly located in Shansi province. The northern end of the region is of low general relief, with varied deposits of coarser wind-blown sands and, near the Yellow river, of flood plain alluvium that often is quite saline. This portion lies outside the Great Wall beyond the zone of permanent Chinese occupation. Where the loess is deep it often has suffered intricate dissection, frequently increased by agricultural soil erosion despite the terracing, so that many areas are quite rough and of locally high relief.

The whole region suffers frequent earthquakes, which, where steep slopes and river bluffs occur, cause serious landslides in the soft-textured loess. The total area of the loess region is a little over 200,000 sq.mi., though the loess surfaces themselves amount only to about 120,000 sq.mi.

8. North China Plain.—This gently sloping plain, nearly 600 mi. long, has elevated river channels that mostly spill onto but do not drain the plain itself. Local drainage is not effective, and there are a number of low areas in which floodwaters pond. The plain is marked by minor land forms only, and the dike lines built across it often are of greater proportions. The western margins are close to 400 ft. in elevation. Most of the rivers flow across the plain on elevated beds that are considerably above the interstream regions. The surface of some part of the plain is built up every time a flood escapes the channel of any of the streams flowing onto the plain, and the seaward margin is extending as rapidly as a mile per decade. Variations in soils are numerous, ranging from sands and recent alluviums to older and heavier lakeland soils in which flood ponds occur, and to local areas of saline soils.

None of the northern streams is navigable unless dredged, and Tientsin has an artificial port and water connection with the sea. The Yellow river and some central channels are navigable only by rafts and very shallow-draft craft. In the south there are more watercourses, and the Huai Ho is navigable most of the year by launches and native boats for over 400 mi. All ports along the shallow alluvial coast must be dredged. The area of the plain is about 130,000 sq.mi.

9. Shantung Uplands.—Rolling to rocky and steep low mountains of high local relief, with large areas of bare granites and limestones exposed in the higher areas, the Shantung uplands reach 5,069 ft. in T'ai Shan, China's most sacred mountain, located near the western margin of the region. Elsewhere elevations seldom exceed 3,000 ft. The uplands are irregular in outline and much broken by fault zones, the largest of which cuts a broad lowland gap through the uplands from the northwest to the port of Tsingtao on the south coast. Many fault zones carry shelves of sediments and soils, and a thin veneer of loess covers locally exposed surfaces, derived from the north China plain. Soil erosion has increased the bare rock exposure, despite terracing. Some of the best ports in north China occur in the rocky inlets of the peninsular portion of the upland. The area is about 30,000 sq.mi.

10. Central Mountain Belt.—This region normally is taken to include the Tsinling proper, the Ta-pa Shan to the south, the more southerly mountains between the Szechwan and Tung-t'ing basins, and the eastward extensions known by several names that reach into the southern edges of the north China plain. The Tsinling proper is a series of high parallel ridges with steep fault and erosional scarps above deep canyons. Maximum elevations in the west exceed 15,000 ft.; the eastern portions become lower in elevation. The Ta-pa Shan is lower and less spectacular in relief.

Between the Tsinling and the Ta-pa Shan the Han river flows in a narrow alluvial valley eastward into the northern end of the Tung-t'ing basin. South of the Ta-pa Shan are round-shouldered hills and mountains with deep narrow canyons, through which the Yangtze river flows in a spectacular series of gorges and canyons. Eastward from the Tsinling and Ta-pa Shan the general trend is to lower elevations and local relief, with one broad gap between northwestern Hupeh and southern Honan. The eastern sector of this mountain belt is a confused mass of low hills, where structural lines meet, that is rather deeply etched by streams, and whose final eastern ends appear as remnants buried in the fill of the north China plain-Yangtze delta. The total area involved is close to 125,000 sq.mi.

11. Middle Yangtze Plain and Yangtze Delta.—Sometimes separated into two units, this riverine lowland is a region of active deposition and seasonally changing water expanses under 100 ft. in elevation. Dike building, canalizing and lowland terracing have obstructed natural sedimentation, but the permanent water area of the region has been decreasing over the centuries, particularly in Tung-t'ing basin. Some long-protected areas of the lowland are below mean river level. During low-water periods the water area, exclusive of canals, may be no more than 3,500 sq.mi., whereas during flood stage the normal water area is close to 8,000 sq.mi., and severe floods that break numerous dikes may cover up to 35,000 sq.mi. The Yangtze itself is navigable by ocean-going ships as far as Hankow during the summer, and regular river steamers reach I-chang, at the foot of the Yangtze gorges, all year. Many tributaries are navigable for considerable distances by launches, and native craft penetrate deeply into the basin hinterlands. In the delta thousands of miles of canalized streams and canals provide water transport to every village and locality.

The port of Shanghai is on a tributary of the Yangtze that must be kept dredged to afford entry of larger ocean-going ships. Though its site is poor, its situation at the mouth of the greatest river in eastern Asia affords Shanghai the largest single trade hinterland. The total area of the whole region is about 105,000 sq.mi.

12. Szechwan Basin.—The basin is surrounded on all sides by mountains of rugged surface and high relief. Its floor is just under 800 ft. in elevation, and its outer margins lie at about 2,000 ft. The country rock is composed of clay and lime shales in generally horizontal structure, with a tendency to natural terracing that has been increased by terrace building. The intricate stream network is entrenched into the basin floor, so that the whole of the basin is very hilly, except for a narrow flood plain along the main Yangtze river above the city of Chungking, and the small alluvial basin in the northwest corner around the city of Ch'eng-tu. Locally structural folds have produced low ranges of sandstone hills, chiefly aligned north-south. Though a degrading and hilly basin the country rock is soft enough that it weathers rapidly into rich soils.

Within the basin the Yangtze and several of the tributaries are navigable for varying distances by launches and for longer distances by native craft. The area of the basin normally is taken at 75,000 sq.mi.; it is surrounded by perhaps 30,000 sq.mi. of hill country.

13. South Yangtze Hills.—The hill country that rims the southern portions of the Yangtze river system east of Kweichow is an irregular zone that surrounds the southern sections of the Tung-t'ing and P'o-yang basins and separates the two. It is an intricately dissected area, with deep entrant valleys penetrating the hill country. Only the crest lands show much bare rock exposure or have really high local relief, and the lower zones of gentler gradient are terraced to make much of the region usable in agriculture. Maximum elevations are around 4,000 ft., but most of the region is considerably lower. At the southern extremity two easy passes afford access to the Canton lowland: Che-ling pass at 1,400 ft. leading out of the Tung-t'ing basin, and Mei-ling pass at 1,000 ft. leading out of the P'o-yang basin. Total area is about 150,000 sq.mi.

14. Southeastern Coast.—The region between Hangchow bay and the Canton lowland has a rocky irregular coast with about 3,000 offshore islands and many deep inlets that provide the best harbours on the whole China coast. Several mountain streams empty into the sea along this coast, but they carry little sediment and there are only a few small alluvial lowlands along the coast. Inland the hills grade into mountains of high relief and much hard rock exposure, with maximum elevations that exceed 5,000 ft. The ridge trends are northeast-southwest, and the streams in the central zone have developed trellis-type drainage systems. Valleys are narrow with steep gradients, and there is little flat land anywhere except at the northern and southern ends of the regions, where elevations taper off, relief is subdued and the stream valleys widen out. This is one of the poorest agricultural regions of all China. The total area is close to 70,000 sq.mi.

15. Canton Lowland.—The small estuary fill at the mouths of the Tung, Pei and Hsi rivers covers only 3,000 sq.mi., but it is the largest depositional fill in all of south China. Rocky hills project above the alluvial fill throughout the delta region, former islands in the embayment. Other islands lie farther out, not yet attached to the mainland by filling. The delta is a watery landscape whose lower river reaches are tidal channels. Canton is located on the Chu (Pearl) Chiang, a short lowland stream at one side of the alluvial lowland.

16. Kwangsi Platform.—West of the Canton lowland lies a limestone zone that has been developed by solution processes and is a zone of karst landscapes. The easterly section of the whole zone forms the Kwangsi platform, pitched at a few hundred feet above sea level and drained by the Hsi river system. The Hsi Chiang has relatively few tributaries, particularly in its headwater zone (a characteristic feature of karst landscapes). The present platform lies across one of the main structural lines of China. The eastern portion of the platform (about 20,000 sq.mi.) presents old karst land forms in which broad open surfaces are present, erratic limestone remnants are scattered, and stream channels and flood-plain features exist in sparse arrangement. The Hsi Chiang is navigable by steamers and launches for about 250 mi., and shallow craft can go farther on the main river. Progressively, to the west and north, elevations increase, the karst topography shows younger stages, and the country becomes rougher. The western portion of the platform exhibits very rough country of high local relief, a minimum of flat land, and much bare rock in erratic and ragged conical hills and rock piles. There streams are few and seldom continuous, and solution basin patterns dominate the landscape, so that transport is difficult. It is from this general region that some of the motivation for Chinese landscape painting is drawn, and bizarre forms do exist somewhat as painted. Southward the platform grades off into a smooth, sandy coastal littoral of low relief and shallow offshore water. The total area of the platform is close to 60,000 sq.mi.

17. Kweichow Hills.—West and northwest of the Kwangsi platform elevations and relief increase, and the karst land forms are in the mature stage of development. This is one of the roughest parts of China, from close to the Yangtze river on the north to the Indochina border on the south. Long streams are not numerous, but locally stream action combines with solution processes, and dissection by master streams has cut deeply into the region. It frequently is labeled a plateau, since it is pitched close to 4,000 ft. elevation, rising to about 7,000 ft. in the west where it adjoins the Yünnan plateau, but the Kweichow region is no longer properly a plateau, since there are few broad upland surfaces. Much bare rock is exposed in steep slopes, and there is almost no large area of level land. The originally folded limestones do present some massive mountain sections still, particularly in the north and west, but most of the country is of karst land form pattern. Soil erosion has added to the amount of bare rock exposure, and this is the poorest physical region of all China. Its area totals about 100,000 sq.mi.

18. Yünnan Plateau.—The Kweichow hills grade westerly into the Yünnan plateau, with general increase in elevation to about 6,000 ft. A number of folded and fault-block mountain ranges stand above the plateau, the northern ranges reaching 17,000 ft. Within the plateau there are many structural basins containing shallow lakes, and the southeastern sector presents other basins that are in the early stages of karst development, in which the solution cycle has not yet produced the spectacularly rough landscapes found in Kweichow and western Kwangsi. Most of the basins and some of the plateau crest lands carry deep though leached soils, and are generally areas of agricultural utility. The southern margins of the plateau have been cut deeply by streams, and the southwest margins are carved into tremendously deep and narrow canyons. The area of the plateau is close to 125,000 sq.mi., excluding about 300,000 sq.mi. of the mountain-and-canyon Tibetan borderland.

19. Hainan Island.—The roughly circular island off the south coast has a coastal plain that is widest on the northern and eastern sides, but narrow or discontinuous on the south and west. A central mountain core with radially outward drainage has numerous peaks above 6,000 ft., and is a dissected region of high relief. Its area normally is given at 13,124 sq.mi.

B. Agricultural Regions

Though dozens of field crops, a very wide variety of vegetables and a large number of fruits are grown in the different parts of China, a relatively few crops are the dominant elements in agriculture, and there is a distinctly regional pattern to their distribution. The nine major agricultural regions, their primary crop associations and their distinctive characteristics follow.

1. Manchurian Spring Wheat-Soybean-Sorghum-Millet Region.—The Manchurian basin is a zone of recent settlement, apart from the southern littoral, and farms there were larger than farms in old China. Manchuria is a zone in which agricultural production exceeds local consumption demands. Japan long had a strong economic interest there, initiating a degree of mechanization and developing foreign trade in agricultural products. Communist control furthered the industrialization of agriculture, with the establishment of tractor stations and mechanized farms. Only one crop can be grown per year, and the crop pattern is closely related to the length of the growing season. Spring wheat, maize (corn) and tobacco are the first crops planted in April, quickly followed by sorghum (kaoliang), soybeans, millet, barley and cotton. Some of these drop out northward, being replaced by white potatoes in the far north. Some fruit is produced in the south, and Korean settlers raise rice in the upland valleys of the eastern margins of the basin. Yields per acre are less than those in old China, since Manchurian agriculture is extensive rather than intensive. This is the only part of China in which the land can absorb a larger population (at the risk of losing its production surpluses), but even there the best land is in use and the reserve is chiefly marginal. Around 70% of the lowland main basin is in use.

2. Northwestern Spring Wheat-Millet Fringe Zone.—The aridity and the long winters of the northwest fringe of China enforces a pattern of one crop per year, spring wheat and drought-resistant millets being the chief crops, with some spring barley, oats and buckwheat. In this region there always is a gamble with dryness, frequent crop failures occur, and there is a considerable fluctuation of the frontier of agricultural settlement. Dry periods force it back into China, and moist periods bring expansion toward Mongolia. Many farmers raise some livestock. Locally where water is available for irrigation the variety of crops increases, and such fruits as apricots, peaches, cherries and plums, and grapes and melons, plus many vegetables, become important. Less than 20% of the land normally is in crop.

3. Loessland Winter Wheat-Millet-Sorghum Region.—Roughly south of the Great Wall the spring planting of wheat shifts to autumn planting for winter wheat. Millets, sorghums and spring barley are the other basic crops. Where water is available such fruits as persimmon, jujube, apricot and peach, and melons, cotton, tobacco, maize, white potatoes, sesame, peas and even a little rice may be grown. Just over 20% of the land normally is in crop.

4. North China Winter Wheat-Soybean-Sorghum-Cotton Region.—The north China plain, its western mountain margins and the Shantung uplands form a region in which farms were fairly small and often fragmented; Communist reorganization of agriculture has made marked changes in land control. Farming uses about a dozen crops per year to take full advantage of local variation in soils and weather conditions and to minimize the problem of crop failure. In the northern sector wheat is still spring planted, but in the central and southern areas winter wheat or barley share the land with spring plantings of other crops. In all parts of the region millets, sorghum, soybeans, cotton, maize, sweet potatoes, tobacco, broad beans, sesame, peanuts, peas and a variety of vegetables are grown. Excellent fruit, including apples, peaches, pears, plums and persimmons, is grown in the Shantung uplands. In the past only vegetable gardens normally were irrigated, but the Communist government expended much effort in broadening the facilities for irrigation. A significant amount of crop loss to flood also has been normal, and Communist efforts at flood control have been region wide. Well over 60% of the lowland is in crop, but in the uplands the percentage drops.

5. Szechwan Basin Rice-Wheat-Sweet Potato Region.—This is a region of highly integrated cropping systems that often produces four and five harvests in two years. Its yearlong growing season permits growing both northern and southern crops, and the basin has almost the widest range of crops of any part of China. Summer rice dominates the lowlands and the lower terraced lands to which water can be delivered, and sweet potatoes, maize, sorghum, rape, millet, cotton, tobacco, soybeans, peas and a wide variety of vegetables are summer crops on the nonirrigated higher terrace fields. Winter wheat, barley and broad beans, plus hardy vegetables, are the chief winter crops, using all kinds of fields. Sugar cane often is integrated into a cropping cycle spanning both seasons. Mulberry and tung oil trees are scattered over the dry upland fields, and a wide variety of fruit is grown in small volume. In many favourable areas citrus fruits become dominant orchard plantings. In the rougher lands of the basin margins white potatoes enter the cropping cycle and, with maize and sweet potatoes, form the basic crops. In the main part of the basin the cultivated area exceeds 60% of the land, but toward the drier north and the rougher east the percentage drops. A high degree of terrace building has made possible an unusual degree of cultivation of a hilly region.

6. Yangtze Valley Rice-Winter Wheat-Winter Barley Region.—Over most of the Yangtze valley rice is the dominant summer crop, with winter wheat and winter barley being important alternates, particularly north of the Yangtze river. The southern boundary of the region is not far south of the Yangtze river, though in the east it includes the Hangchow bay hinterland. Summer cultivation involves important acreages of peanuts, maize, soybeans and sesame on nonirrigated lands, and cotton appears in the coastal districts. The aquatic crops such as lotus and water chestnut, in addition to duck raising and pond-fish culture, are important in the delta zone. Mulberry plantings for silk production are common in the eastern sector. Near the cities market gardening has become commercialized. Well over 60% of the Yangtze delta zone is in crops, but elsewhere the percentage is somewhat lower. This is a food-deficient region, owing to its heavy urban population and its annual flood problem.

7. Southeastern Rice-Tea Region.—The southeastern coastal area and a broad zone west to the Kweichow hills comprises a region in which a somewhat different agriculture is practised. The winter wheats and winter barleys and the millets, soybeans and cotton largely drop out, as do many of the northern fruits such as plums, cherries, apples, peaches and pears. Tea, the bamboos and the more subtropical fruits enter the cropping pattern significantly. Rice is by far the dominant basic food crop, and the southern Tung-t'ing and P'o-yang basins produce rice surpluses. There the Communist regime is pushing the double cropping of short season rices. Sweet potatoes, beans and peas are widely grown in the hill area. This is the traditional area of tea production, with regional specialization in variety as a cash crop on hill fields. The tung tree is important as a hill crop away from the coast. Citrus fruits are a regional specialty in the lower areas, and the southeastern coastal zones produce the best tangerines and pomelos in the whole of the orient. Locally forest cropping of both timber trees and bamboos on the hill lands is significant to the agricultural economy. The degree of land use varies widely, from about 10% in the rougher areas to as much as 60% in some lowland localities.

8. Southwestern Rice-Maize Region.—In the southwestern portion of China, including most of Kweichow and all of Yünnan, rice is the dominant crop wherever flat land or terraces can be provided with water. Maize is an important crop grown on dry and unterraced lands. In the hill country maize and white potatoes, supplemented by yams, become the chief crops. A little winter wheat, winter barley and winter broad beans are grown in some localities. Tea and fruits are locally important, as are tobacco, rape and a variety of vegetables. In the high zones above the plateau walnuts and chestnuts are important food crops, and in the lower hill country sectors of Kweichow the tung tree is widely grown. This was the last region in which the opium poppy was a standard crop, and agriculture has not recovered its balance after the general cessation of poppy growing. In the past the Chinese came to own the better lands, including most of the rice lands, whereas the non-Chinese tribal populations were restricted to the rougher hill country. In some areas shifting cultivation still is locally important as a relict system. Well under 20% of the total land is under cultivation. The concentration of population on the areas that can be cultivated means that the agricultural density of population is about the highest in China.

9. Tropical South Coast Double Crop Rice Region.—The southern littoral and much of the territory south of the Nan Ling Shan and east of the Kweichow hills is almost tropical. There rice lands long have borne two crops per year. Sugar cane is the only crop normally competing with rice for land, except in the eastern urban fringes where market gardening is important. In the hill areas sweet potatoes, maize, tobacco, ginger root, cassia, mulberry and a wide range of tropical fruits are auxiliary crops. In the delta region pond fish and aquatic crops also are important. Hainan Island grows rice on the coastal lowlands, and is the only portion of China able to grow coconuts (an old crop) and rubber (a new crop). Much of the island interior still is used in shifting cultivation by non-Chinese tribal peoples. In broad terms the percentage of land in crop is well under 20, but this varies greatly from the Canton delta to the western littoral and the interior of Hainan. (J. E. Sr.)

IV. THE PEOPLE

A. Ethnic and Language Groups

China is a multinational country made up of a large number of ethnic groups. This point was emphasized after the advent of the Communist regime in 1949. The official nationality policy of the Nationalist regime was assimilationist; for example, Chiang Kai-shek in his book *China's Destiny* (1947) presents the idea that China is inhabited by a single nation. According to this Nationalist thesis, China includes only a single "Chung-hua nation" or "Chinese nation" (Chung-hua min-tsu), subdivided into various "stocks" of common blood, such as Mongols and Tibetans. The Communists, on the other hand, have sought to apply a nationality policy based on Soviet practice. This policy is based on Stalin's definition of a nation or nationality as "a historically evolved, stable community of language, territory, economic life, and psychological make-up manifested in a community of culture." On the basis of this definition, Chinese Communist theoreticians have concluded that China is a state inhabited by diverse nationalities. The Communist government has put this view into practice by identifying the country's diverse nationalities, delimiting national autonomous areas of several types on the basis of the geographical distribution of the nationalities, and encouraging the development of national languages and cultures within the limitations of overall policies.

Foremost among the nationalities in China is the Chinese nation or Chinese people, also called the Han nation or Han people. The English use of the expression "Chinese people" is confusing because it may refer to three different Chinese terms used in Communist China. The first, Chung-hua min-tsu, is commonly used as a collective name for the various nationalities of China. (*Chung-hua* is a somewhat flowery term for China or Chinese, and *min-tsu* means "people," "nation"). The second, Han tsu, refers to an ethnic or cultural group that is considered to be a distinct nationality because its members speak Chinese, have a distinct Chinese culture and otherwise contrast with other distinct national groups like the Mongols and Tibetans. (In the following discussion, the term "Chinese people" will be used in the sense of this ethnic group.) Finally, there is a third term, Chung-hua jen-min or Chung-kuo jen-min, which refers to the people, or population, of China as a political unit.

According to the 1953 census, the Chinese (Han) nationality made up 93.9%, or 547,283,057, of the country's total population, representing thus the overwhelming majority among the diverse nationalities. However, being concentrated in traditional China proper and in Manchuria, the Chinese inhabit only two-thirds of China's total area, while non-Chinese minorities, numbering only 35,320,360 in 1953, are settled in the remaining third of the country's total territory.

The Chinese and the non-Chinese minorities of China are best classified into linguistic families, branches and groups generally recognized for classifying the languages of the world. China's ethnic or linguistic minorities, as well as the Chinese themselves, belong mainly to two of the world's great language families—the Tibeto-Chinese and the Altaic. The Tibeto-Chinese family, formerly called the Indo-Chinese family, includes Chinese and Tibetan and is by far the larger of the two linguistic families represented in China. It is divided in turn into three branches—the Chinese-Thai (T'ai), Tibeto-Burman and Miao-Yao.

1. Chinese-Thai Languages.—*Chinese.*—Chinese is the principal language of the Chinese-Thai branch. Although Chinese has a universal written form, in which characters (ideographs) represent words or ideas, its spoken forms display marked regional differences. The diversity of dialects, however, has been much exaggerated. There are probably not more than eight mutually unintelligible dialects, most of which are spoken in the coastal belt of southern China stretching from Shanghai to Canton.

By far the most important Chinese dialect is the Mandarin (*kuan-huah*, or official language), which is spoken by more than 400,000,000 persons throughout the Chinese-language area, except along the southern coast. There are three varieties of Mandarin: (1) the northern variety, of which the Peking dialect is typical and which is spoken in north China, northwest China and Manchuria—in fact, anywhere north of the line formed by the Tsinling Shan and the Huai Ho; (2) the western variety, also known as Ch'eng-tu or Upper Yangtze variety, which is spoken in Szechwan and adjoining parts of southwest China; and (3) the southern variety, also known as Nanking or Lower Yangtze variety, which is spoken in Anhwei and northern Kiangsu.

Related to Mandarin are the Hunan dialect, spoken by 25,000,000 persons in central and southern Hunan, and the Kiangsi dialect, used by 15,000,000. The Hweichow dialect, spoken by 7,000,000 persons in the Tunki area of southern Anhwei, forms an enclave within the southern Mandarin area.

Less intelligible to speakers of Mandarin are the coastal dialects extending south from Shanghai to Canton. (1) The most important of these is the Shanghai, or Wu, dialect, spoken by about 45,000,000 persons in southern Kiangsu and in Chekiang. (2) This is followed southward by the Foochow, or Min, dialect of northern Fukien, which is spoken by 10,000,000 persons in the drainage basin of the Min Chiang; and (3) by the Amoy-Swatow dialect of southern Fukien and easternmost Kwangtung, with 15,000,000 speakers. (4) The Hakka dialect of southernmost Kiangsi and northeast Kwangtung is spoken by almost 20,000,000 persons. (5) Probably the best known of these southern dialects is Cantonese, which is spoken by at least 35,000,000 persons in central and western Kwangtung and in southern Kwangsi, a dialect area where a large proportion of overseas Chinese originated.

In addition to the Chinese (Han) proper, the Communist regime distinguishes two national minorities that speak Chinese. They are the Hui (Chinese Muslims) and the Manchus. The Hui, also called Dungans in Russian sources, are descendants of Chinese who adopted Islam when it penetrated into China in the 7th century. Before the Communists, the Hui group was usually included with all Muslims living in China, most of whom were non-Chinese of the Turkic language branch. According to the 1953 census, there were 3,559,350 Hui in China, out of a total of 10,000,000 Muslims. (Pre-Communist estimates of the total number of Muslims in China ranged as high as 50,000,000.) Most of the Hui people live in northwest China, where the Ningsia Chinese Muslim autonomous region was ordered established in 1957 and formally inaugurated in 1958. Other Hui communities are organized as autonomous *chou* (districts) in Kansu and Sinkiang, and as autonomous *hsien* (counties) in Tsinghai, Hopeh, Kweichow and Yünnan.

The basis for identification of the Manchu nationality is unclear. According to the 1953 census there were 2,418,931 Manchus, who apparently declared themselves as descendants of the Manchu warriors who invaded China in the 17th century and founded the Manchu (Ch'ing) dynasty (1644–1912). Ancient Manchu is virtually a dead language, and the Manchus have been assimilated completely into Chinese culture. They are found mainly in north China and Manchuria, but form no separate autonomous areas above the *hsiang* (township) or commune level.

Chuang-Thai.—In addition to Chinese, the Chinese-Thai language branch includes three language groups represented in China. They are the Chuang-Thai group, which includes the Chuang, Thai, P'u-yi and Nung minorities; the T'ung-Shui group, and the Li people.

The Chuang, with 6,611,455 persons in 1953, are China's largest minority group. More than 80% of them live in Kwangsi, which was converted in 1957 into the Kwangsi Chuang autonomous region. The Chuang also are represented in national autonomous areas in neighbouring Yünnan and Kwangtung. The Thai people of China are concentrated in Yünnan province. Numbering altogether 580,000, the Thais of Yünnan are constituted as two autonomous *chou* (districts): the Hsi-shuang-pan-na *chou*, whose population is related most closely to the Thais of northern Thailand; and the Tehung *chou*, whose Thais are related to the Shan people of Burma. The P'u-yi people, formerly known as Chung-chia, number 1,247,883 and are concentrated in southern Kweichow, where the P'u-yi share an autonomous *chou* with the Miao people. The Nung minority, the smallest of the Chuang-Thai language group, has 170,000 persons living on the border of North Vietnam in southeastern Yünnan.

T'ung-Shui.—The T'ung-Shui group is represented in the Kweichow-Kwangsi-Hunan region. The T'ung people, numbering 690,000, are settled in small communities in Kwangsi and Kweichow and share with the Miao people an autonomous *chou* set up in southeast Kweichow in 1956. The smaller Shui minority, with 150,000 persons, lives in the karst district of southern Kweichow, where an autonomous *hsien* (county) was set up for them in 1957 at Santu.

Li.—The Li people of the island of Hainan form a separate group of the Chinese-Thai language branch. The Li number 330,000 persons and share with about 30,000 Miao people a joint autonomous *chou* in southern Hainan.

2. Tibeto-Burman Languages.—The Tibeto-Burman branch of the Tibeto-Chinese language family falls into three groups: the Tibetan, the Yi (formerly called Lolo) and the Kachin (or Chingpo).

Tibetan.—According to the 1953 census, there were 2,775,622 Tibetans in China. They were distributed over the entire Tibetan highland area, including 1,273,969 in Tibet proper, 800,000 in Szechwan (including former Sikang), 450,000 in Tsinghai and 200,000 in Kansu. Tibet proper, which includes the Chamdo area, was placed in 1955 under a governmental committee which led to the establishment of a Tibetan autonomous region. Outside Tibet proper, Tibetan minorities are constituted in autonomous *chou* and autonomous *hsien*. There are five Tibetan autonomous *chou* in Tsinghai, two in Szechwan, and one each in Yünnan and Kansu.

Among small splinter groups closely related to Tibetans are the Chiang people, 70,000 strong, who were established as an autonomous *hsien* in 1958 in the Mao-hsien and Wen-ch'uan area of Szechwan; and the Nu (12,000) and Tulung (2,400), who had a joint autonomous *hsien* in northern Yünnan after 1956.

Yi.—The Yi language group is limited almost entirely to Yünnan province and adjoining areas. The Yi proper (formerly called Lolo) numbered 3,254,269 according to the 1953 census. Their principal concentrations are in the Liang-shan Yi autonomous *chou* of Szechwan province, with about 800,000 Yi, and in the Tsuyung Yi autonomous *chou* of Yünnan province, with 385,000 Yi.

Among lesser minorities within the Yi language group are the Lisu, Nasi (former Moso), Hani and Lahu, all of which are set up as autonomous areas within Yünnan province. Also part of the Yi group is the Pai (former Minchia) minority, with 480,000 persons, constituted in 1956 as an autonomous *chou* in the Ta-li area of Yünnan.

Kachin.—The Kachin people, who live mainly in Burma, have a community of 110,000 persons just across the Burmese border in western Yünnan province. There they share the Te-hung Thai autonomous *chou* with the Thai minority.

3. Miao-Yao Languages.—The Miao-Yao branch of the Tibeto-Chinese linguistic family is geographically one of the most widespread in southern China. The 2,511,339 Miao people are settled in Kweichow, Hunan, Kwangtung, Kwangsi, Yünnan and Szechwan provinces. Two-thirds of the Miao minority is concentrated in Kweichow, where it shares two autonomous *chou* with the Tung and P'u-yi peoples. The Yao people, numbering 640,000, are concentrated in the Kwangsi-Kwangtung-Hunan border area.

4. Tungusic Languages.—While the minorities of the Tibeto-Chinese language family are thus concentrated in southern and southwestern China, the second major family—the Altaic—is represented entirely by minorities in northwestern and northern China. The Altaic family falls into three branches: Turkic, Mongolian and Tungusic (or Manchurian).

The easternmost and least significant numerically is the Tungusic branch, which extends into northern Manchuria from Siberia where it is widely represented. The Tungusic branch falls into two groups, Manchu and Tungus. The Manchu group includes the virtually dead ancient Manchu language, with the related languages of the Nanay (also known as Gold in Russian and as Hoche in Chinese) and the Sibo. The Nanay of northeasternmost Manchuria, numbering fewer than 5,000, live in the marshy watershed near the Amur-Ussuri confluence. The Sibo, of whom there are 20,000, are descendants of 17th-century Manchu warriors who were garrisoned in the I-li valley of western Sinkiang along the Russian border. The Tungus group includes the small primitive Orochon (Olunchun) and Evenki (Solon) tribes of northern Inner Mongolia and Heilungkiang province.

5. Mongolian Languages.—The Mongolian branch of Altaic has 1,462,956 speakers in China. About 1,100,000 Mongols live in Inner Mongolia, 150,000 in Manchuria and 200,000 in northwest China (Kansu, Tsinghai, Sinkiang). The Mongols are constituted in two autonomous *chou* in Sinkiang, a joint *chou* with Tibetans and Kazakhs in Tsinghai, and several autonomous *hsien*, as well as in the Inner Mongolian autonomous region.

Also regarded as members of the Mongolian language branch are three minorities of the Kansu-Tsinghai border area. They are the Muslim Tunghsiang (140,000 members) and Paoan (4,000) and the Buddhist Tu (60,000), all of whom speak Mongor, a variety of Mongol. Also counted with the Mongolian branch is the Dagur (Daur) minority of Inner Mongolia and Manchuria. (*See* DAGUR.) This group of 50,000 persons is of Tungus origin but has been heavily mongolized.

6. Turkic Languages.—The Turkic language branch is by far the most numerous of the three Altaic branches, with a total of 4,500,000 speakers. The largest Turkic minority is the 3,640,125-strong Uighur group of the Tarim basin of Sinkiang, which furnished the basis for the establishment of Sinkiang in 1955 as the Sinkiang Uighur autonomous region. Other Turkic minorities in Sinkiang are splinter groups of nationalities of Soviet central Asia. Sinkiang includes 470,000 Kazakhs, who are mainly nomadic herders in Dzungaria (northern Sinkiang), where they are constituted as the I-li Kazakh autonomous *chou;* 80,000 Kirghiz, in westernmost Sinkiang, where they form the Kizil Su Kirghiz autonomous *chou* adjoining the Kirghiz Soviet Socialist Republic of the Soviet Union; and 13,000 Usbeks, settled chiefly in the I-li valley. In Kansu are 3,000 Yüku (Yugur or Sary-Yugur), who unlike the other Muslim Turkic minorities are Buddhists. The easternmost Turkic minority is the 30,000 Salars of northeast Tsinghai, who are constituted as an autonomous *hsien* at Shunhwa (Hsün-hua).

7. Others.—A few linguistic minorities in China belong to neither of the two main language families. The Tajiks of westernmost Sinkiang, numbering 15,000, are related to the population of the Tadzhik Soviet Socialist Republic and belong to the Iranian branch of the Indo-European family. The 280,000 primitive Kawa (Wa) people of the Chinese-Burmese border area belong to the Mon-Khmer branch of the Austroasiatic family. Finally, the Koreans of Manchuria, who number 1,120,405 and form the Yenpien Korean autonomous *chou* in Kirin province, cannot be assigned with certainty to any of the standard language classifications.

(For further information on the ethnic groups and languages of China, see the various articles on languages—*e.g.*, CHINESE LANGUAGE; MONGOLIAN LANGUAGE; TURKIC LANGUAGES; etc.—and on peoples—*e.g.*, MIAO; KACHIN; YAO; etc.)

8. Language Reforms.—In an effort to spread literacy, the Chinese Communists engaged in a major effort to reform the Chinese written language and to devise new written languages for non-Chinese minorities. The Chinese language reform proceeded along three lines: (1) simplification of the present Chinese characters; (2) teaching of a common standard spoken language throughout the country; (3) gradual introduction of an alphabetic script.

Simplification of Characters.—This has been a continuing process in the evolution of the Chinese written language. In the past, however, simpler forms crept into the writing of the language one by one without formal recognition or official acceptance. Conservative officials and scholars, who looked with reverence upon the traditional ideographs, opposed any systematic attempts at character reform according to officially formulated sets of principles. With the coming to power of the Chinese Communists, the situation changed radically. Intent on transforming China into one of the world's leading powers, the Communist regime gave unprecedented priority to mass education and to language reform as an indispensable tool of such mass education.

Many of the Chinese characters are clumsy and unwieldy. Of the 2,000 commonest characters only 28% have fewer than 8 strokes, the rest containing from 9 to 27 strokes. Learning to read and write this elaborate ideographic script is very difficult. Although the Communists looked to the introduction of an alphabet as the ultimate solution of the written-language problem, they approached such a drastic overhauling cautiously and favoured a period of transition in which the existing written language would be made as simple as possible. Accordingly, a language reform committee devised lists of simplified characters, the first 230 of which went into effect in Chinese Communist publications as of Feb. 1, 1956. The complicated forms of these characters were excluded from use by government decree, except in reproductions of ancient classics.

Spoken Language.—Achievement of uniformity in the spoken tongue throughout Chinese-speaking areas is an essential prerequisite for the establishment of a phonetic alphabet. The Chinese Communists therefore stressed national linguistic unity as a step toward their ultimate goal of complete literacy of the population. The Peking (Peiping) variety of Mandarin, being the most widespread Chinese dialect, long had suggested itself as a basis for a national language. In Chinese usage the term Mandarin (*kuan-huah*), with its connotations of imperial officialdom, gradually was dropped after the 1911 revolution that set up the Chinese Republic. Instead, the Nationalists used the term *kuo-yü*, meaning "national language," to describe the standard Peking dialect. After 1949, under the Communists, the term *kuo-yü* in turn was replaced by *p'-u-t'ung hua*, meaning "generally understood language." By the early 1960s it was estimated that more than 70% of the Chinese people already understood and used *p'u-t'ung hua*, and increasing efforts were being made to teach and publicize the use of this standard speech in other dialect areas.

While the trend toward a national spoken language continued, a similar revolution took place in the written language. Before the 1911 revolution, Chinese literature was written in the old concise classical literary language (*wênyen*), which may once have corresponded to common speech but had gradually deviated from the spoken language as speech had evolved over the years. In a literary revolution which got under way in the 1920s the popular vernacular (*paihua*) partly replaced the literary style in the new literature. However, the classical style continued to be used in government documents, business correspondence and newspaper articles even under the Nationalists. Under the Communist regime, after 1949, the new colloquial style based on the living language completely replaced the old classical language in all writing. (*See* also CHINESE LITERATURE.)

Alphabetic Script.—The ultimate goal of the Communist regime appears to be the use of an alphabetic script, which alone is held to be suitable for the achievement of universal literacy and the establishment of a modern industrial state. Alphabetization is not a new idea in China. Over the years transcription systems were developed as an aid to learning the difficult ideographs and to render such characters in western alphabets. Such systems never obtained governmental support, however, and deep-rooted conventional thinking prevented their being put into general use. The Communist government was committed to the reform of the written language and began to study proposed alphabetic systems soon after coming to power. After long consideration of alternative proposals, the first draft of a new alphabet plan was published in Feb. 1956. The alphabet of 30 letters included 25 letters of the Latin alphabet and 5 special characters. As a result of nationwide appraisal of the first draft, the five non-Latin characters were eliminated and a number of other revisions were made. The final alphabet, consisting of all 26 letters of the Latin alphabet, was approved by the national people's congress on Feb. 11, 1958. This alphabet, for the time being, was not intended to replace the Chinese characters. Its main uses were in the phonetic transcription of the characters. By using this alphabetic transcription, the Communists hoped to speed the spread of a standard spoken language throughout the country. The alphabet also was expected to speed the end of illiteracy among the Chinese masses. It is used in teaching Chinese to the national minorities and in devising alphabets for the language of the non-Chinese minorities. The alphabet had important uses in the rendering of international scientific and technical terms in Chinese and in many other applications related to the building of a modern industrial society. In short, for the period immediately following its introduction, the alphabet was to be used as an auxiliary tool side by side with the traditional characters, whose progressive simplification continued to be stressed.

Of the 50-odd minority languages, only 20 had written forms before the coming of the Communists. Only relatively few written languages (for example, Mongolian, Tibetan, Uighur, Kazakh, Thai and Korean) were in everyday use. Other written languages were used chiefly for religious purposes and by a limited number of persons. The Latin alphabet, partly adapted by missionaries, was used for Kachin, Lahu and Kawa in Yünnan province; the Arabic alphabet was used for Uighur and Kazakh in Sinkiang; Tibetan, Mongolian, Korean and Thai had their distinctive alphabets. Communist efforts were directed to reforming existing written languages to make them more serviceable or to devise entirely new written forms. In general, Latin alphabets were used for this purpose. Such alphabets were devised, for example, for the large Chuang minority of Kwangsi and for the Yi people of Yünnan and Szechwan.

B. RELIGION

For untold years writers have spoken of the Chinese as having three major religions: Confucianism, Taoism and Buddhism. This is a misconception. Westerners usually adhere not only to one faith but to one denomination or even to one branch of a denomination. Members of different churches of the same sect have a sense of rivalry. Such phenomena are unknown to the Chinese. The average Chinese tends to have something to do with any or all religions but adheres exclusively to none.

The most universal system of belief in China is ancestor worship (*q.v.*). Under that traditional belief, it is part of the filial duty of sons to provide for their parents before and after death, for the dead are believed to have the same needs as the living. Like the father-son relationship within the family, the relationship between the departed ancestors and their living descendants is also reciprocal. The conduct of the living affects the welfare of the dead, and the actions of the latter in the spirit world continue to help the living.

Ancestor worship, however, is part of a wider belief system of the Chinese. The departed ancestors are spiritual beings closest to the living descendants, but each descendant also is affected by a tremendous hierarchy of nonancestral gods. The hierarchy ranges from the Supreme Ruler of Heaven down to local gods, whose temples are found in nearly every Chinese village and town. It is in this hierarchy of gods that Confucianism, Taoism and Buddhism find their places. To the ordinary believing Chinese, Confucius and his many disciples, Buddha and his followers, and the spirits of Taoist origin are merely intermediary between the Supreme Ruler of Heaven and man. In public prayer meetings called to deal with emergencies such as drought, earthquake or epidemic, it is not unusual to find the tablets of Mohammed and Jesus Christ placed side by side with those of Confucius, Buddha and Lao-tzu, all in a position subordinate to that of the Supreme Ruler of Heaven.

While the great majority of believing Chinese adhere to these eclectic religious mixtures, most non-Chinese ethnic minorities follow one or the other of the main Asian religions. Although pre-Communist estimates of the number of Muslims in China ranged as high as 50,000,000, the 1953 census reported only 10,000,000 Muslims. The largest Muslim groups are the Turkic-speaking Uighurs of Sinkiang and the Chinese-speaking Hui (Chinese Muslims), each community numbering more than 3,500,000. Other Muslim minorities are the Kazakhs, Kirghiz, Salar and Tunghsiang. All except the Mongor-speaking Tunghsiang, who are related to the Mongols, belong to the Turkic language family. The Tibetans and the Mongols, though belonging to two different linguistic and cultural groups, share the same branch of Buddhism (*see* TIBETAN BUDDHISM). The small Turkic-speaking Yuku people and the Mongor-speaking Tu people of the Tsinghai-Kansu region are also Tibetan Buddhists. The Thai people and related minority groups in southwestern China are predominantly members of the Theravada branch of Buddhism.

The disintegrating effect of modern influences inevitably invaded the religious sphere. Even before the Communist regime there was some change in the attitude toward religion, and the traditional observances were greatly weakened. Of the three historic religions of China, Taoism in its later phases has been little more than a collection of superstitions that was bound gradually to lose its vitality. Moreover Taoist belief frequently has been associated with secret societies, which played a role in the overthrow of dynasties in the past. The Taoists' belief in magic, divination and secret organization made them a natural target for the Communists. Taoists were persecuted as counterrevolutionaries, and it is probable that Taoism will cease to have any importance in China.

Confucianism, although it has a religious aspect, denotes a social code and an attitude. Although weakened by the changed conditions of a modern society, it retained a large part of its vitality under the Nationalists. It formed the mental background and in part oriented the lives of many educated Chinese who held no definite religious beliefs. Under the Communist regime, however, the shift of emphasis from family loyalty to loyalty to the state and party signified an attack on the entire Confucian pattern of family life and ancestor worship. Although the Communists engaged in no organized campaign against Confucianist beliefs as such, Communist propaganda against undesirable "feudal" aspects of traditional Chinese civilization was implicitly directed against some of the teachings and practices of Confucianism.

To the extent that Buddhism, in both Theravada and Tibetan forms, was identified with non-Chinese minority groups, the Communist regime proceeded slowly against the Buddhist religion. This was true particularly in the case of the tightly organized religion of Tibet. However, the role of Buddhist monasteries in everyday life was greatly limited. Monastery lands were seized and redistributed among landless peasants during the land reforms. Many temples and shrines were converted into recreation centres. Similar restraint was adopted by the Communists toward the Muslim minorities.

Although less than 1% of the Chinese population was converted to Christianity (mainly Roman Catholicism), the influence of Christianity proved considerably greater than the relative smallness of the number of its adherents would indicate. Under the Communist regime, Christianity came under heavy attack, largely because it is identified in Communist doctrine with western imperialism in China. Foreign missionary enterprises were nationalized and almost all missionaries were compelled to leave. Yet an indigenous Christian church, subservient to the regime, was not discouraged. This was especially evident in the case of the Roman Catholic Church, which was forced to break all ties with the Vatican but was permitted to function under the supervision of the Communist state.

See also Buddhism; Confucianism; Taoism.

C. Civilization and Culture

China during the 20th century experienced the most momentous transformation in its history, affecting every aspect of life: economic, social, political, intellectual, ethical and cultural. Changes were at first sporadic, the automatic result of infiltration of alien ideas and foreign commodities. Then under the modern-minded Nationalist government and particularly under the Communist regime there occurred a purposeful, co-ordinated remolding of the society and the economy and a systematic attempt to refashion the habits and even the ethics of the entire people.

Traditional Chinese civilization was based on the family system. The sanctity of the family was the cornerstone of Confucian teaching. It extended to elaborate rites connected with marriage and death, the maintenance of ancestral halls, family reunions at fixed seasons and countless other symbolic acts. Marriage, for example, was a contract arranged between two families without reference to the individuals concerned. The association of families in a community in turn provided a system of local government enabling village and district life to maintain an effective organization even during periods of political anarchy. The village attempted to avoid relations with officials of the central government or to reduce them to a minimum. Any dealings that were necessary with higher state officials were handled by the village elders.

Even before the Communist regime began its effort to reduce the control of the family in favour of that of the state, many influences were at work in modern China to destroy the traditional structure of Chinese society. One of these was the gradual introduction of modern industry. This in turn led to the rise of a trade-union movement that broke down the old guild system, which was similar to the family organization. The advent of a modern educational system in the 1920s played an important role in disrupting the traditional society.

The forces that began to come into play under the Nationalists were greatly fostered after the coming of the Communists in 1949, but were at the same time channeled into a pattern of tight totalitarian control unprecedented in China. Borrowing Soviet techniques of political organization and manipulation, the Chinese Communists effectively brought the entire population under political, social and psychological controls in a way that many students of the Chinese national character would have believed to be impossible. Virtually every person in China has been brought into Communist-controlled mass organizations, which the regime regards as communication intermediaries between itself and the masses. These organizations, established on the basis of specific social and economic groups (peasants, women, urban labourers, children, youth, students, etc.), conduct frequent meetings, indoctrinate their members and direct activities of many sorts. Through them the energies of active supporters of the regime are put to work, while others are subjected to constant, organized social pressure to conform.

Under this social and cultural revolution, changes of tremendous significance have taken and are taking place. The role of the family in society has been disrupted. Women, formerly regarded as inferior, have been given complete equality with men in all phases of life. Political pressures have created an entirely new pattern of individual and group behaviour. Education has been radically changed, training youth for socialism and for service to the state. Using these and other tools, the Chinese Communists are mobilizing the nation's population in a program of economic development aimed at transforming China from an agricultural nation into one of the world's leading industrial powers.

See also below, *Administration and Social Conditions.*

(T. Sd.)

V. HISTORY

A. Prehistory and Archaeology

To the Chinese scholar up to the 20th century, archaeology was a discipline closely linked with historical and literary studies. Archaeological materials were valued according to whether they verified or illustrated the past as encompassed in the classics and annals. Epigraphy, therefore, naturally became all-important, while objects without inscriptions were neglected. Thus the documents of the scriptless prehistoric past remained practically outside the sphere of scholarly research in China until westerners began to organize explorations in the field from about the early 1920s onward. Their activities, soon shared by the Chinese themselves, resulted in geological, paleontological and archaeological discoveries of the utmost importance. After a hiatus caused by the Japanese invasion of 1937 and World War II, field work was conducted with renewed vigour and on a large scale under the Communist authorities, and a good deal of the rapidly accumulating material was published in journals and monographs.

1. Paleolithic in North China.—The famous site of Chou-k'ou-tien, 30 mi. S.W. of Peking, was first investigated in 1921 and in part excavated between 1923 and 1939, and again after 1949. It is a limestone hill with fossiliferous deposits ranging from the Miocene to the end of the Pleistocene. The remains of *Sinanthropus pekinensis* and his primitive industry came from two strata of the deep fissure of Locality I, which was sealed by red clays and stalagmitic formations still of Middle Pleistocene Age. *Sinanthropus* is a hominid that ranks in age with the closely related *Pithecanthropus* of Java. Its discovery had added significance because skeletal fragments and artifacts were found in association. The latter consist chiefly of cracked pebbles and splinters of vein quartz, monotonous and accidental in character. Hand axes are absent. The geologically oldest identified artifact came from the red clays in Locality 13, estimated to date about 500,000 years back in time; it is a chert chopper reminiscent of the early Soan (Sohan) industry of north India. An advanced stone technique appears in flaked tools made of various rocks such as those found in the deposits of Locality 15, deposits consisting of red clays still of preloessic age but containing a fossil fauna that points to a geologically younger period than those of Localities 13 and 1. Whether these superior tools also were made by *Sinanthropus* is a question that for lack of skeletal evidence cannot safely be answered.

A wide gap separates the finds of the so-called Upper Cave of Chou-k'ou-tien from the preceding finds. Instead of the red sediments there appear the yellow ones typical of the Late Pleistocene loess formation. Four human skulls found there revealed the presence of what has been termed an early Homo sapiens asiaticus. Cultural remains, poor and atypical in regard to the stone implements, include perforated stone beads and animal teeth, a bone needle and polished objects of bone and antler, which taken together suggest a burial place of some stage comparable with the Magdalenian.

In 1954 another Lower Paleolithic site was found at Ting-ts'un in Shansi. The artifacts—large pebble flakes (some of which exhibit secondary trimming), nuclei and hammerstones—as well as the osteological remains represent a stage comparable with that of Locality 15 at Chou-k'ou-tien.

2. Ordos Industries.—Several important Upper Paleolithic sites have been discovered along the southern fringe of the Ordos steppe, the area skirted by the great bend of the Yellow river. They belong in their entirety in the Late Pleistocene, the time of the formation of the yellow earths (loess), but vary in age. None of them yielded skeletal remains of man. A series of very hard quartzite implements, mostly made of round pebbles chipped along one edge, as well as some flakes, came from the basal gravels underneath the loess, the maximum thickness of which does not exceed 50 m. according to Pierre Teilhard de Chardin, and often is far less. Finds of this category were reported from a number of other sites. In the loess stratum itself, two dwelling places and workshop sites were explored: Shui-tung-k'ou, close to the Yellow river opposite Ningsia, and Sjara-osso-gol, southeastern Ordos.

Shui-tung-k'ou.—This is a loess-filled depression, stretching east-west for 10 mi., where five hearths with ashes and a great number of artifacts were located at various depths in a stratum of loess measuring 15 m. A rich and diversified stoneworking industry comprising such types as scrapers, points and gravers suggests a stage more developed than that of the aforementioned group; yet tools of the primitive "Soan chopper" variety occurred in the same assemblage. The materials used, chert and silicified limestone, were taken from the gravel of streams embedded in the yellow loam that later were buried under renewed deposits of wind-carried loess dust.

Sjara-osso.—The site of Sjara-osso is remarkable on two accounts; namely, the extraordinary depth of the fossil-bearing beds of dune sands and lacustrine clayey sediments overlying the Paleolithic floor, and the smallness of the stone implements, chiefly scrapers and points, made of small siliceous pebbles such as are available in that area. Typologically, this "micro-industry" is considered by Henri Breuil as advanced beyond the Shui-tung-k'ou stage. However, it is separated from the Neolithic horizon of the same site by no less than 55 m. of deposits, sands and sandy clays rich in fossils.

The absolute age of Shui-tung-k'ou and Sjara-osso is about 100,000 years and separated from the final phase at Chou-k'ou-tien by a gap of another 100,000 years, more or less; the Upper Cave of Chou-k'ou-tien follows much later, about 25,000 B.C.

3. South China.—Except for some isolated finds of probably Late Pleistocene stone implements, south China has offered little beyond promises of future discoveries. Reported finds include: some flakes collected from loess deposits in the area of Ta-tien-lu (western Szechwan); a chipped flinty tool found at the surface of the Yangtze terraces near Wan-hsien (Szechwan); strongly weathered chipped quartzite implements embedded in conglomerates of limestone and river gravels in the Yangtze gorges above I-ch'ang; and a quartzite chopper, heavily rolled and apparently reworked by Mesolithic cave dwellers of Kwangsi, which has some claim to be the oldest implement so far encountered in south China.

4. Mesolithic Phase.—A Mesolithic phase comparable with that of post-Pleistocene Europe has not been identified in China proper. In the southerly province of Kwangsi, however, a possibly Mesolithic culture was discovered in cave deposits of perhaps still Late Pleistocene Age but devoid of remains of extinct animals or any strongly fossilized bones. It is a pebble industry including crude types of choppers, scrapers, hammerstones and, occasionally, perforated stones. Polished or only partly polished stone implements and pottery are absent. The stage is comparable with, and probably related to, the early Bacsonian of neighbouring Tongking (Vietnam).

In the northern borderlands—Mongolia and Manchuria—geographic and climatic conditions of the postglacial period apparently favoured the development and spread, over millenniums, of a culture of hunters, and later of primitive farmers, who have left abundant traces of their culture in microlithic tools made of fine minerals such as jasper, agate, carnelian, chalcedony and flint. The commonest shapes among those tools are small and slender flakes and the conical cores, or micronuclei, from which these flakes were obtained. The foremost site in Mongolia is that of Shabarakh-Usu in the Gobi desert. Widely diffused to the east, into Manchuria, and southward (Ordos), and no doubt related to Siberian microlithic cultures, this Shabarakh or Gobi culture corresponds to the Tardenoisian and Azilian of Europe, but differs from the latter in that the "geometric" silices are wanting. In regard to China it should be observed that microlithic chipped implements are not encountered to the south of the line of the (much later erected) Great Wall; it appears as though this gigantic line of fortification followed a cultural borderline of hoary age and remarkable stability.

5. Neolithic Stage.—This northern orbit seems to have undergone a gradual transition toward a primitive Neolithic culture of sedentary farmers and husbandmen. This can be observed at two sites in Ch'eng Te, Lin-hsi and Ulan Hata (Ch'ih-feng), discovered by Émile Licent and Teilhard de Chardin in 1924. The artifacts at Lin-hsi were found either embedded in a post-Pleistocene layer of black earth on top of Quaternary white sands above ancient schist, or exposed on the sand where the black earth had been blown away. Crude rhyolithic pebble tools and blades as well as nuclei of fine siliceous rocks occurred side by side with grinding stones and pestles usually made of granite. A few hoelike implements and perforated round pebbles were recovered. Polished implements were rare, and true axes or celts were absent. The pottery encountered in the stratum of black earth was a handmade, poorly fired ware. Bones of the domesticated horse, ox and sheep, but none of wild game, were found.

Geologically and archaeologically similar conditions prevail at the site to the south of the "red rock," which gave Ulan Hata its name. In addition to the Lin-hsi inventory mentioned above, however, this site yielded rather advanced types in stone as well as pottery, the later age of which seems unquestionable but could not be ascertained stratigraphically.

The "Mongolian Neolithic," typified by the presence of microliths, agricultural tools and some pottery such as are known from Lin-hsi, expands north into north Manchuria, where it assumes or retains a character that has been described as Maglemosian, since the finds speak of a stronger dependence on fishing and hunting there; farther west it was traced in the Gobi (later Shabarakh) and southwest in the Ordos. This culture, which must have comprised the wide territories to the north of the yellow clay or loess of China proper and to the south of the Siberian forest zone, seems to have vanished without further local developments, presumably because of an increasing desiccation and the desertlike conditions resulting therefrom. Some traces of it were found in sites spreading between western Kansu and the Gulf of Liaotung, where—similar to what was noted in Ulan Hata—a new Late Neolithic culture with painted pottery and polished stone tools supervened. These "mixed sites," on the whole, have to be understood as evidence of an expansion of the new culture into the southern fringes of the territory previously and perhaps still held by the makers of the microliths.

The rare case of what appears to be an intrusion of north Eurasian *Kammkeramik* in a south Kansu site (Ch'i-chia-p'ing) visited and described by Andersson, a ware with comb stamped ornaments entirely foreign in China, probably belongs in the period preceding the appearance of the painted pottery.

6. Yangshao Painted Pottery Culture.—The period between the Late Paleolithic of the Upper Cave at Chou-k'ou-tien and the appearance of the Painted Pottery or Yangshao culture in north China, a period of many millenniums, is (in contrast with Mongolia) archaeologically obscure. Except for a series of limestone and quartzite artifacts of Paleolithic character collected by C. C. Young and W. C. P'ei at Yang-shao-ts'un in 1934, there are no finds to shed light on that long period. But this is an isolated and puzzling case that does not go far in altering the apparent fact of an archaeological blank, Andersson's "Neolithic hiatus." Climatic conditions may account largely for this hiatus. The final Pleistocene, when the loess formation was still in progress, was a cold and semiarid phase; afterward, in postglacial times, the river valleys and plains may have been swamplands.

> Then suddenly, at the very end of the Neolithic, at a time only four thousand years distant from our own, the hitherto seemingly empty land becomes teeming with busy life. Hundreds, not to say thousands of villages occupy the terraces overlooking the valley bottoms. Many of these villages were surprisingly large and must have harboured a considerable population. Their inhabitants were hunters and stock-raisers but at the same time agriculturalists, as is evidenced by their implements and by the finding of husks of rice in a potsherd at Yangshao-ts'un. The men were skilled carpenters and their womenfolk were clever at weaving and needlework. Their excellent ceramics, with few or no equals at that time, indicate that the then inhabitants of Honan and Kansu had developed a generally high standard of civilization. There must have been, by some means or other—new inventions or the introduction of new ideas from abroad—a rather sudden impetus that allowed the rapid spread of a fast growing population. (From J. G. Andersson, *Researches Into the Prehistory of the Chinese*, Bulletin of the Museum of Far Eastern Antiques, no. 15, p. 297 [Stockholm, 1943]).

It was in 1921 at Yang-shao-ts'un (Mien-ch'ih-hsien, western Honan) that Andersson discovered the culture so succinctly described in his above-quoted words. Further explorations revealed that this culture had covered the wide area between western Kansu and northern Honan, with extensions into Szechwan, Ch'eng Te and Liaoning, and that the ancient settlements were close to the rivers Hsi-ning, T'ao-erh, Wei, upper Chia-ling and Han and to the Yellow where it flows eastward after the great Ordos bend. The surprising and basic fact arising from this discovery is that

China falls in line with west Asian and Indian sequences. For not only does there appear in China a painted ware, but, exactly as in the west, this ware is gradually replaced by a burnished black ware. This is, or was, however, a complicated process, far from being clarified by field work. The observations made are summarized briefly below.

Stratigraphy.—In most of the dwelling sites explored, the cultural stratum was rather shallow, but in two very large ancient villages, Hsi-yin-ts'un (southwestern Shansi) and Yang-shao-ts'un, partial excavations revealed cultural strata varying between 2.50 to 4.00 m. and 2.50 to 3.00 m., respectively. However, judged by the occurring types of pottery shards, no clear subdivision or stratigraphic sequence was seen in either place. Andersson stated that Yangshao represents one single cultural stage comprising both painted and burnished black wares. The only stratigraphic change noted by P. L. Yüan, Li Chi and Liang Ssu-yung at Hsi-yin-ts'un in 1926 was a slight increase in the percentage of the black shards as compared with the painted shards in the upper layers, while the percentage of the cruder pottery, gray and reddish, with or without cord impression, remained constant throughout.

In a few northern Honan sites, on the other hand, excavated by staff members of the Academia Sinica in 1931 and 1932, a stratigraphic sequence of painted pottery overlaid by black pottery and, topmost, gray Shang pottery was observed. In other sites in northern as well as western Honan, however, black pottery associated with, or overlaid by, gray pottery but with no trace of painted pottery was found to be a recurring and typical assemblage. Field observations made in the upper Wei valley by W. C. P'ei in 1947 tended to show that the ceramic wares in the many prehistoric sites of that area—the main route from Kansu to Honan—suggest three stages, early, middle and late, characterized by painted pottery first of good style, then of degenerate style and finally by utter decay and disappearance. From Kansu came the finest of the painted ceramics but little of stratigraphic interest.

Some inferences can be drawn. In Honan and Shensi, the painted ware preceded, but apparently overlapped with, the black pottery, and the latter in turn preceded a Bronze Age gray ware. In Kansu, where the black pottery seems to be almost absent, only a very few shards being reported, the Yangshao ware is older than the Hsin-tien ware of the beginning metal age and older than the (unpainted) Ch'i-chia ware, which is unknown in Honan.

Painted Pottery Styles.—The phenomenon of clearly differentiated styles of ornament was observed only in Kansu. Named after type sites in Kansu, most of these styles suggest an evolutionary sequence and, consequently, relative dates: (1) Pan-shan; (2) Ma-ch'ang; (3) Hsin-tien; and (4) Sha-ching.

The Pan-shan style is distinguished by an amphora type, of noble shape and with exquisitely painted ornaments, among which a design of rotatory S curves running horizontally round the vessel predominates. Other common patterns are rhombic chequers, diamonds, zigzags and a gourd motif. One tomb of this phase that Andersson was able to excavate at Pien-chia-kou (Pan-shan hills, T'ao-erh valley) contained the skeleton of a man of about 40, in a flexed position and sprinkled with ochre. The Ma-ch'ang wares are of reddish clay and are painted, sometimes carelessly, with black ornaments such as large concentric circles, rhombic T hooks and large meander bands consisting of parallel lines; the beautiful dynamic spiral patterns have disappeared.

It was with the pottery of the following Hsin-tien stage that some minor bronze objects came to light, none of them, by the way, typically Chinese (Shang). These Hsin-tien wares retain the meander as the predominating motif of their sparse decoration, while their shapes mark a departure from the Pan-shan-Ma-ch'ang tradition. Sha-ching, the fourth phase, appears to have derived from Hsin-tien.

More closely comparable with the repertory of ornamental designs found in Shansi, among which stand out large, flowerlike, sweeping patterns, are decorations known from minor find spots in south Kansu. The exact relationship of these latter styles to those of the above-described sequence is not fully clarified, but it appears likely that they postdate the Pan-shan style; they presuppose the spiral motif, which here is transformed into free and asymmetrical curvilinear patterns foreign to the geometric development of the Ma-ch'ang phase.

Ma-chia-yao and Lo-han-t'ang in central Kansu, two large dwelling sites, exhibit designs that may well stand midway between Pan-shan and these south Kansu styles.

As new material is uncovered, however, the picture of the Yangshao culture becomes increasingly complex, necessitating continuous reappraisals. The excavations carried out in 1953 and 1955 at the site of a large Neolithic village at Pan-p'o-ts'un (Shensi), for instance, brought to light some previously unparalleled pottery designs, in addition to rich architectural remains, including kilns, which for the first time give evidence of a long-continued occupation.

The range of ornamental patterns known from Shansi and Honan is comparatively narrow; to put it in the briefest interpretive statement, it may be said that after a splendid manifestation in Shansi (Ching-ts'un and Hsi-yin-ts'un) decline set in in west Honan (Yang-shao-ts'un), followed by a rapid decay in north Honan, so that a loss of diversity and freshness becomes the more noticeable the farther east we move.

Stone Implements.—The following four tools are, according to Andersson, characteristic of the Pan-shan phase: heavy axes of rectangular cross section with rounded-off corners, flat adzes, small adzes and rectangular or trapezoidal knives with one or two perforations. There are pendants and beads of jade, amazonite, turquoise and marble and perforated disks of jade, which in more regular shapes reappear in Shang and Chou times. The techniques of sawing and drilling hard stones thus were familiar to those vase painters. The occurrence of composite tools such as bone knives set with small flint blades points to connections with the Gobi microlithic cultures.

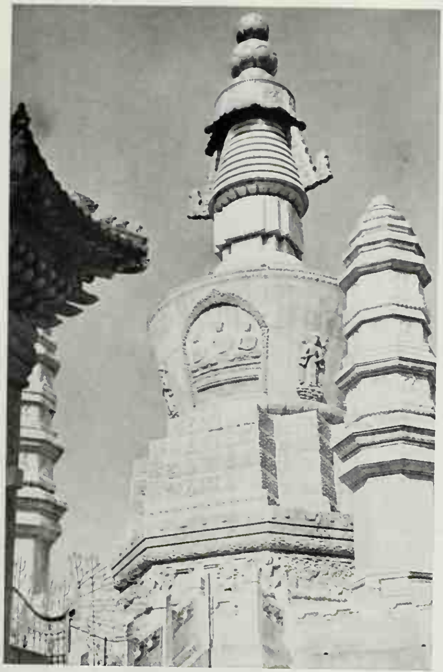
7. Lungshan Black Pottery Complex.—It was noted above that a black ware is associated with the painted ceramics in Shansi and Honan. In the eastern provinces of Shantung, Kiangsu, Anhwei and Chekiang, however, only the black wares are found, without any traces of painted pottery. The existence of a culture or cultural phase traceable through this black ware became known through the excavation in 1930 and 1931 of Ch'eng-tzu-yai, in west Shantung.

The typical black pottery is a very thin ware with a blackish or brownish body and a burnished, shiny, black surface. The shapes are distinguished by angular silhouettes that bespeak the potter's wheel. Save for some occasional incised geometric design of great simplicity, there is no decoration. Among the vessels are found types not known in painted pottery, such as tripods, spouted vases with bulbous hollow legs and, most characteristic, bowls on high ringed stems. Specimens of these stemmed bowls were unearthed not only in Shantung but also as far south as the Hangchow bay and in westerly Szechwan. Sparse occurrences of black pottery have been reported from outlying regions such as northwest Kansu, south Szechwan and Port Arthur. The centres of the black pottery culture appear to have been located in Shantung and the Huai Ho valley, areas held by tribes that as late as the Chou dynasty had not yet been assimilated.

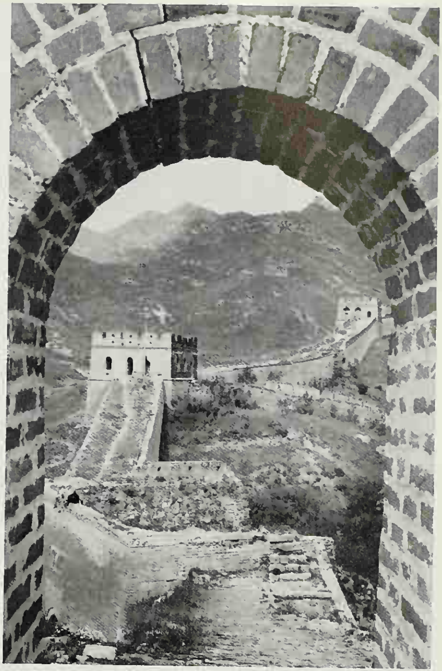
It is certain that the Lungshan culture preceded the Bronze Age level of An-yang (north Honan), site of the last Shang capital, and that several Lungshan features live on in the Shang culture: bone oracles, shapes of vases (in gray Shang pottery and in bronze) and tamped earth structures.

It appears, moreover, that the pottery of the later Lungshan phase was barely distinguishable from the typical Shang ware, a thick-walled gray ware made with pad and beater (wound with cord), but whether this was due to an internal evolution or an assimilation to the powerfully emerging Shang culture with dissimilar potting traditions is an open question. The fact that the known early Shang sites always overlie Lungshan settlements argues in favour of continuity.

8. Chronology and Western Connections.—An earlier Lungshan I without metal was found to be separated by a thin, sterile, sandy layer from a later Lungshan II with scarce bronze objects at Ch'eng-tzu-yai. It is likely that Lungshan II belongs in the early Shang period (from about mid-16th to early 13th cen-



Marble pagoda, Peking



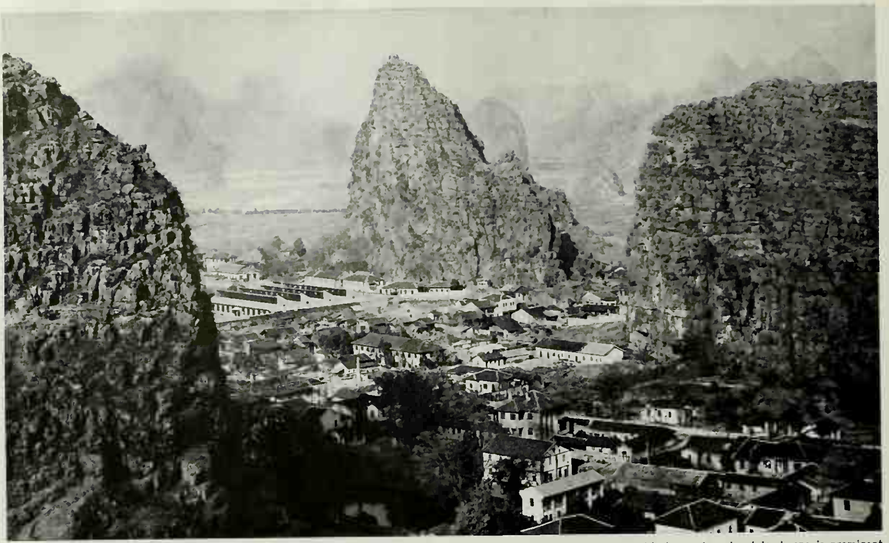
A view of the Great Wall of China through one of the block tower gateways at the Nank'ou pass

Two-camel caravan on the Gobi desert near Yü-men, seen through a train window

SCENES IN CHINA

PHOTOGRAPHS, (TOP LEFT) FRITZ HENLE, (TOP RIGHT) BLACK STAR, (BOTTOM) HENRI CARTIER-BRESSON—MAGNUM

CHINA



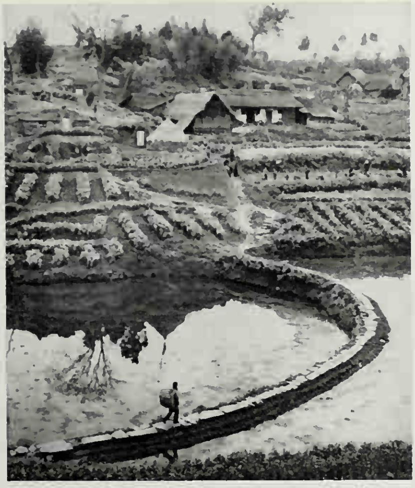
Part of Kuei-lin, chief city of Kwangsi Chuang Autonomous Region, situated in the northeast part of the region on the Li river, where karst landscape is prominent

The great falls in the Kweichow mountains in southwest China

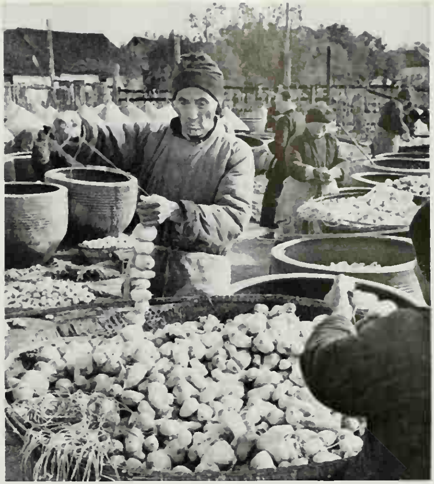
Chinese fishing junk, off the coast of Hong Kong, British crown colony

VIEWS OF CHINA

PHOTOGRAPHS, (TOP) EASTFOTO, (BOTTOM LEFT) SI MERRILL—RAPHO GUILLUMETTE, (BOTTOM RIGHT) WIDE WORLD



Rice paddies and vegetable plots on a Chinese commune in the Yangtze valley

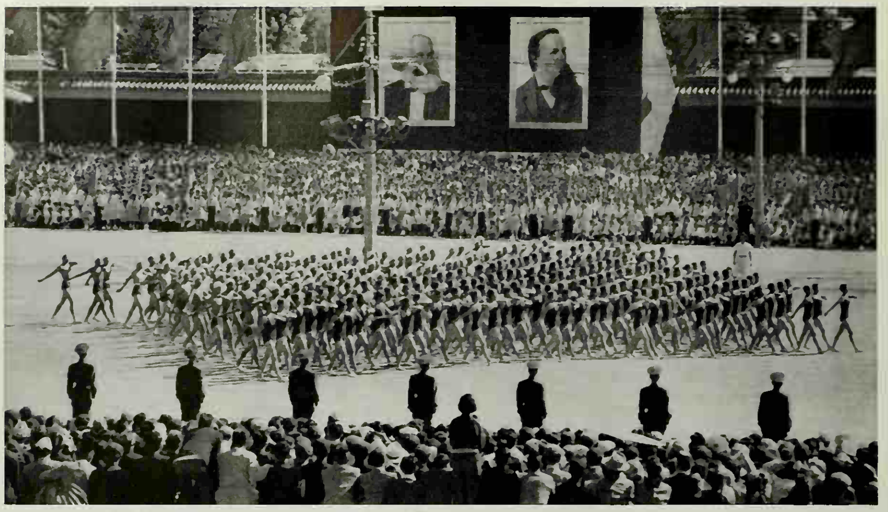


Chinese farmers stringing seed potatoes for winter storage

Human muscles still make up for China's shortage of machines and draft animals

VIEWS OF CHINA

PHOTOGRAPHS, (TOP LEFT) MARC RIBOUD—MAGNUM, (TOP RIGHT) BRIAN BRAKE—MAGNUM (BOTTOM) HENRI CARTIER-BRESSON—MAGNUM



Chinese youth march in Peking celebrating an anniversary of the People's Republic

Peking university students ice skating

Market in a village, part of a Yangtze valley commune

One of Shanghai's main streets

PEOPLE AND SCENES IN CHINA

PHOTOGRAPHS, (TOP, BOTTOM RIGHT) HENRI CARTIER-BRESSON—MAGNUM, (CENTRE, BOTTOM LEFT) MARC RIBOUD—MAGNUM

Students reading in a Canton library

Dining car of the Canton-Peking express

Chinese wrestlers. Wrestling is a popular sport in China and never fails to attract an audience

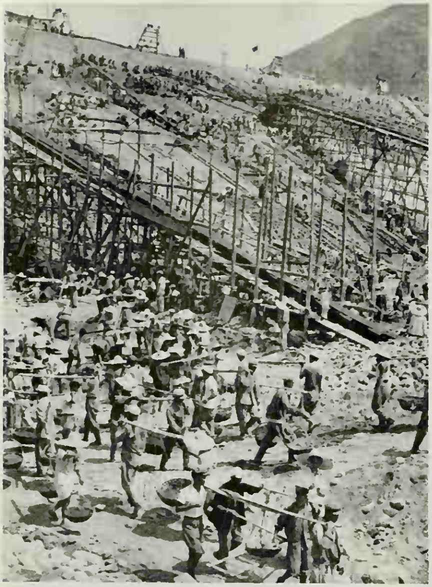
A classroom at Peking university

Peking university student

CHINESE PEOPLE

PHOTOGRAPHS, (TOP LEFT, CENTRE LEFT) PESC—PIX FROM PUBLIX, (TOP RIGHT) BRIAN BRAKE—MAGNUM, (BOTTOM LEFT) MARC RIBOUD—MAGNUM, (BOTTOM RIGHT) ERGY LANDAU—RAPHO GUILLUMETTE

CHINA



The construction of the Ming Tombs dam near Peking. Workers cut blocks of stone by hand and carry away the earth in the traditional Chinese fashion of baskets hung on a pole

Construction workers in China

Peasants helping to build smelting ovens at the Shiu Shin blast furnaces

A view of the An Hsin foundry

CHINESE INDUSTRY

PHOTOGRAPHS, (TOP LEFT, BOTTOM LEFT, BOTTOM RIGHT) HENRI CARTIER-BRESSON—MAGNUM, (TOP RIGHT) BRIAN BRAKE—MAGNUM

tury B.C.), and that Lungshan I accordingly dates from the first half of the 2nd millennium, beginning perhaps around 1800 B.C. Consequently the painted pottery must be placed, in its beginnings in Kansu, around or shortly before 2000 B.C., because its secondary styles in Shansi and Honan overlap with the black pottery.

Both the painted Yanshao and the black Lungshan ceramics point to early contacts with western Asia, where possible prototypes of similar shapes, ornamentation and techniques are widespread. In the case of the painted pottery, moreover, an apparent want of archaic forerunners, hence the phenomenon of a sudden unfolding, make it almost necessary to think of outside stimuli. These may have come from Iran, where similar shapes of tripods, urns and steamers occur, dating from around 2000 B.C., or from south Russia, where both the shapes of the urns and their décor of running spirals offer striking parallels to the Chinese types. For the black pottery, close similarities to north Iranian and east Caspian types of stemmed bowls dating from about 2000 B.C. seem to warrant actual connections through cultural transmissions or, possibly, migrations. Even a type of tripod with hollow legs, widely regarded as uniquely and specifically Chinese, occurs as far west as Anatolia.

The approximate dates of the relevant western Asian and European material agree fairly well with the rough estimates permitted by the Chinese evidence.

9. Late Neolithic of South China.—The beginning of exploration dates only from about 1932, along the coast between Hong Kong and Swatow, an area that under the ancient Yüeh had remained independent until as late as 111 B.C., when it was finally subdued by Han Wu Ti. Field observations made by J. Shellshear, D. J. Finn and R. Maglioni (which led to the recognition of several Late Neolithic and chalcolithic cultures) were summed up by Maglioni in an attempt to arrive at a coherent if preliminary and admittedly obscure picture. This included three Neolithic stages, termed—after a district in Kwangtung—Hoifung (Mandarin: Haifeng) I (Sov), Hoifung II (Sak) and Hoifung III (Pat), and a chalcolithic and bronze period that is only a continuation of the Pat culture modified by the acquaintance with metal. The various stages are differentiated on the basis of the ceramic wares and stone or bronze tools as well as the sites discovered. In most cases these sites revealed objects of only one of the three cultures; among more than 20 sites in the Hoifung district, only two or three showed a mixture of remains of two different cultures.

Numerous reconnaissances undertaken during the 1950s make it clear that south China was lagging behind the north. The evidence collected from no fewer than 159 sites along the lower Yangtze river shows that as late as Western Chou (1027 [1122 or 1111 or 1050]–771 B.C.) these parts had not advanced beyond a Chalcolithic phase. The commonest ceramic ware of the epineolithic Hu-shu culture (after the eponymic site of Hu-shu-chen, about 20 mi. S.E. of Nanking) is a coarse sandy red ware in shapes which reveal influences from the north, as do the sparser blackish wares. The later phase is distinguished by a hard-fired grayish ware with stamped patterns derived from Chou bronze ornaments. This stamped ware is found throughout the coastal provinces, in Chekiang, Kiangsi, Fukien, Kwangtung and Hong Kong during the centuries of Eastern Chou to Han (771–202 and after).

Most of the stone implements current in north China occur in the south also. Occasionally a stone imitation of some typical Shang or Chou bronze weapon is encountered in a seemingly Neolithic assemblage (*ko* halberd from She-chu, Kiangsu). The shouldered ax, which is less common in the north, is found in many sites between Nanking and Canton. Most typical is the stepped adz with a tang of elliptic cross section distinctly set off from the angular body, a boatbuilders' tool that forms one important link with Neolithic Formosa, the Philippines and Polynesia, while it seems to have remained unknown in northern China.

10. Early Bronze Age in North China.—Until the excavations at Chengchow, concepts of the early Bronze Age were dependent on the material excavated at several sites near An-yang in northern Honan, known as the Ruins of Yin (Yin-hsü). Yin was the last capital of the Shang dynasty (whose dates are still debated) and it lasted from 1300 to 1028 B.C., according to the chronology of the *Bamboo Annals* (or 1388–1122 in the computation of Liu Hsin, 7 B.C.). The year 1300, therefore, was the archaeologically safe upper limit for the Bronze Age chronology of Shang China. Scanty occurrences of primitive metal objects from several painted pottery sites in remote Kansu and Ch'eng Te (Jehol) (bronze buttons, bell-shaped pendants, armlets, simple knives, tubes, arrowheads and the like) which probably are older than 1300 B.C. shed little light on what happened in the Shang domain before An-yang, say between 1500 and 1300.

The discovery at Chengchow (Honan, south of the Yellow river) of the remains of an older Shang city (identified with the ancient Ao) in no fewer than 24 scattered localities, excavated from 1951 onward by the Archaeological Research institute of the Chinese Academy of Science, brought certainty with regard to the pre-An-yang bronze phase as a fact, its nature and its limitations. Four Shang levels have been recognized at Chengchow, preceded by a Lungshan level, at least in some of the sites. The latest level corresponds to the An-yang horizon from 1300 and after; but in the main the Chengchow strata end where An-yang begins. Thus it appears that at Chengchow was a large Shang settlement, indeed a walled city, whose flourishing period fell to the earlier phase of the dynasty, more precisely the period of the tenth Shang king, who made Ao his capital, and his successors down to P'an-keng who abandoned the city in favour of Yin.

Of the architectural remains, the ancient city wall, built in layers of pounded earth and about 20 m. in its greatest width at the base, is most impressive. Within and without the wall were numerous pits for dwelling and storage, as well as foundations of houses, which by their stratigraphic positions and varying designs suggest occupation through many successive generations. Ceramic factories and kilns, workshops of bone carvers and several bronze foundries were found there. The Erh-li-kang site of Chengchow yielded oracle bones, but only two of them were inscribed; it would appear, therefore, that writing was practised on a limited scale and not until toward the end of the pre-An-yang period. The bronze objects and vessels from Chengchow compare with those of early style from An-yang. More primitive than the typical Shang bronzes, the vessels are still close to pottery shapes, and their decoration is of an archaic cast, with geometric designs of unevolved or nascent animal motifs.

The bulk of the finds consists of ceramic wares, the typically gray, heavy, cord-marked Shang wares, sometimes with elaborately carved patterns like those of the bronzes. It is on the basis of the typological correlation of the pottery that finds made at other localities such as Lo-yang (Honan), Hsing-t'ai (Hopeh), Liu-li-ko in Hui-hsien (Honan) are considered contemporary, that is, pre-An-yang. Bronze is always rare in these early settlements. (*See* also below, *Beginnings of the Chinese Civilization: Shang, or Yin.*)

Measured by the wealth and character of the finds made at An-yang, however, the foregoing stages amount to little more than vague promises of a breaking away from the Neolithic traditions with their parallels in western Asia and in Europe, away from their "international" aspect. During the last three centuries of Shang rule in Yin, Chinese civilization appeared for the first time in history, distinct from other ancient civilizations, in a process which, if no longer unheralded, seems sudden and unpredictable. Even so, some of the Shang people's most significant cultural possessions were paralleled in the west and ultimately may have come thence: the horse-drawn war chariot, the idea of a script and the technique of bronze casting as such. The form they took, however, is uniquely Chinese.

The excavations carried out by the Academia Sinica in 15 campaigns between Oct. 1928 and June 1937, in an area stretching more than three miles along the Huan river to the west of the city of An-yang, revealed a considerable number of individual sites of varying age and importance.

Clear links with older cultures exist in the case of the gray pottery, which in a coarsened fashion continues the black pottery traditions. They exist also in the case of many types of bronze vessels, the shapes of which were dependent on then-current pottery prototypes. To ceramic traditions points also a limited but common repertory of geometric ornaments such as diapers, angular meanders and T hooks, found on gray pottery and bronzes as well as on a peculiar new kind of ceramic ware, the Shang white pottery. This is a heavy, hard-fired, whitish ware distinguished by its carved décor.

The same white pottery, on the other hand, marks a new departure, being carved in a technique foreign to the Neolithic potters and decorated also with animal images of the abstract, heraldic style that is one of the Shang novelties in archaic bronzes as well as on carved bones and ivories. A bone carver's tradition looms as the uniting agency behind the abstract animal imagery in all those mediums including wood, but the origins of this tradition are unknown. Another new feature is small animal sculptures in jade; they have no precursors in Neolithic sites, while in a general way they are reminiscent of much earlier animal amulets in stone such as were unearthed at Ur, Erech (Warka), Tepe Gawra and Khafaje in Mesopotamia.

Among the magnificent bronze weapons of the Shang there are types of tanged axes that appear to be autochthonously Chinese. Others are suggestive of foreign connections. Some rarer types of shaft-hole axes recall designs current in Mesopotamia, Luristan and Persia. The spearheads, socketed celts and certain kinds of daggers and knives, on the other hand, have close analogies in east Russia, Siberia, Mongolia and the Ordos steppe inside the great bend of the Yellow river. Conditions thus would seem to repeat a pattern observed when dealing with the Neolithic painted ceramics, which likewise point toward south Russia and the ancient near east as centres of diffusion.

The true standard of Shang culture, however, was attained in the sacrificial bronzes such as they were developed in the few centuries at An-yang. The technical excellence and the monumental designs of these vases, which were used in the ancestral temples of the aristocracy, are unmatched in the ancient world. (*See* CHINESE BRONZE.)

11. Ordos.—On the evidence of numerous stray finds of bronze objects made there, the Ordos region and adjacent Inner Mongolia form part of the geographical and cultural continuum of the Eurasian steppe belt, an area that was to remain alien to that of the Chinese culture. The Ordos bronzes have close affinities in the Bronze Age inventory of central and south Siberia and south Russia, and after they became known in the 1920s were rightly recognized as related to Scythian art. However, older, pre-Scythian strains also are present in Ordos art. In fact, it seems that the Bronze Age sequence established for Siberia is fully answered by the Ordos bronze material so far known, whereas correspondences with Shang art appear to be limited to the types mentioned above. These types belong, in Siberia, in the periods called Andronovo (*c.* 1500–1300 B.C.) and Karasuk (*c.* 1300–700 B.C.). It is the influence of these cultures, including early Ordos, that in the author's opinion accounts also for the lesser bronze finds in several Kansu and Ch'eng Te painted pottery sites.

The Karasuk phase is archaeologically important in that it offers early examples of what is known as the Eurasian animal style. This culture has been explained as the result of an amalgamation with Mongoloid elements which, absent in the older Andronovo population, were traced in the skeletal remains of the Minusinsk area of southern Siberia. Even so, most of the Karasuk inventory, whether metal tools or pottery, is linked with Andronovo, and the animal sculptural adornments of daggers and knives (which might be taken as testimony of influences from An-yang or the Shang cultural sphere at large) agree so well with older Siberian animal sculpture in stone, antler and bone that there is little need to look to China for their origin; particularly since the comparable specimens from An-yang appear to be novelties with no background of native traditions. A grave disadvantage in an attempt at disentangling these Bronze Age Chinese-Siberian relations is the lack of excavations in the Ordos region. Evidence rests with stray finds of metal tools and chronology. Taking this latter fully into account, it can only be assumed that metallurgy came to China from the northwest, ultimate filiations with Mesopotamia notwithstanding.

Perhaps no other single factor so aptly illustrates the degree of obscurity prevailing in regard to the pre-An-yang period (before 1300 B.C.) as does the Chinese script. Appearing in the archaic but essentially developed system of the oracle inscriptions on tortoise shells and animal bones found in one of the An-yang sites, this script, an eminent achievement of Chinese civilization, undoubtedly presupposes some span of time prior to An-yang for its evolution. Yet the only trace of ideographic writing known from before An-yang is that found on the two inscribed oracle bones unearthed at Chengchow and dating from near the end of the pre-An-yang period. It is justifiable, therefore, to conceive of the creation of the Chinese script some time during the obscure two centuries or so before An-yang, a creation which save perhaps for the basic idea of writing was entirely indigenous. (M. L.)

B. BEGINNINGS OF THE CHINESE CIVILIZATION

1. Origins.—The origins of the Chinese people and their civilization are still undetermined. It need not be assumed, indeed it is unlikely, that the people were of one original stock or that the civilization spread from one centre either within or outside the modern boundaries. It appears more likely that many different ethnic groups and many separate centres of primitive culture gradually merged and mingled to produce the civilization that has been continuously unfolding and spreading over this continental region. The Neolithic culture revealed by archaeology in numerous sites in China bore fundamental resemblances to the Neolithic in many parts of the Eurasian continent but also had some distinctive features. In different parts of China, moreover, there were from early times regional variations. There was apparently a continuity of population from Neolithic times into the historic period, and there are some evidences of cultural continuity as well. But the sources of information available allow no simple conclusion about the complex question of the connection between the civilization of China and other ancient centres to the west.

The oldest Chinese historical literature, that in the *Shu Ching* (*Book* or *Classic of History* or *of Documents*)—parts of it the so-called "ancient text," a late forgery—and the earliest extant collection of ancient songs and poems, the *Shih Ching* (*Book* or *Classic of Odes* or *of Songs*), cannot be depended upon for information earlier than the 1st millennium B.C., and much of that is by no means uncontested. The earliest documents in even these books show a civilization that is already far removed from primitive conditions and contain no certain proof of either a native or a foreign origin for the Chinese. Archaeological researches in central Asia have disclosed extremely ancient seats of culture east of the Caspian and suggested the possibility of migrations from what is now Sinkiang and Mongolia and possibly from farther west, and also the possibility of very early transmission of some art forms from western Asia and southeastern Europe. The excavations in China proper described above (under *Pre-history* and *Archaeology*) have revealed, in this regard, only that clear glimpses of what can be called with assurance Chinese culture are caught first in the present area of Honan, Shantung and Shensi, that at the time from which we have remains it was already old, and that it and the people who possessed it were probably the result of several strains from different parts of Asia. Much and perhaps all of Chinese culture may have developed in China itself.

2. Legends.—The Chinese, like every other people, have legends about their earliest times. These, however, are not of much use for history, since they come from late literature that may have been modified for political or social purposes. Of ten figures of most ancient times, cited in the 1st millennium, only three are of real significance: Fu Hsi, Shen Nung and Huang Ti. Fu Hsi and Shen Nung were sages as well as rulers, and sacrificed on T'ai Shan, a mountain of hoary antiquity even in the time of Confucius, who lived in its shadow. Fu Hsi taught people to hunt, while Shen Nung cultivated the five grains, invented the plow and established markets. Huang Ti, also ruler and sage, stands out most prominently, for during the period of the Chou (*see* below) men both in the royal house and in the feudal states revered him as primal ancestor. He too sacrificed on T'ai Shan. His inventions included boats and oars and the fire drill. With fire he cleared the hills and the plains of their trees and brush, and he rid the country of wild beasts, making cattle breeding possible. He even instituted music among his officials. Two royal houses before the Shang are mentioned in the texts—Yü and Hsia—but their historicity has not been determined. If they did exist they may be considered to have been roughly contemporaneous with the Late Neolithic stage. The traditional dates for Hsia are 2205–1766 B.C., but one prominent Chinese scholar revised this to 2183–1751, and another (following the oldest text of the *Bamboo Annals*, or *Chu shu chi nien*) put them at 1994–1524.

3. Shang, or Yin (c. 1766–c. 1123 B.C.).—In this age, though made more secure by archaeology, the dating is still uncertain. The orthodox school puts it at 1766 to 1123, Tung Tso-pin at 1751 to 1112, and others either at 1558–1051 or 1523–1027. It is the spade that has brought this period into the light, and continuing discoveries may be expected. Settlements of the Shang have been identified all the way from Sian in the west to Tsinan in the east.

Chengchow.—According to early literature the royal house successively occupied several seats, and archaeology seems to support this tradition. One of the royal seats may have been at modern Chengchow, Honan, where a walled town, about 1½ by 1 mi. in size, has been revealed. The walls were made of tamped earth measuring 19 to 55 ft. thick at the base. In addition to tombs, workshops of several kinds distinguish the area. Notable among these are pottery kilns of vertical type, with round or oval oven chambers some four feet in diameter. Clay stamps for impressing decorated designs were located in the debris. The patterns included many that were to remain popular for a long time: glutton, dragon, trellis and squared spirals. These same designs occur on pots and shards. Some of the pottery pieces show indications of having been made with the potter's wheel. Most of them are gray. No painted ware, like that of nearby Yang-shao-ts'un of several hundred years earlier, has turned up. The *li* tripod is common, and some black pottery occurs, but none of it is as fine as that discovered at Lungshan, west Shantung, in a Late Stone Age site (*see* above). White pottery is completely absent, but there is glazed ware with a brownish body, which must have been fired at high temperature.

Shops for the casting of bronze also existed. Here were fashioned such objects as arrowheads, knives, fish hooks, socketed axheads, awls, ritual vessels. In the tombs lay examples of the *ko*, or halberd—a chief weapon of the Shang—hairpins, washbasins and vessels for liquor. Other objects were artifacts made of bone, stone, shell, ivory, jade and gold. Among the first, made of bone of oxen, were some pieces used for oracular purposes; so too were a few tortoise carapaces. Other bones with incised characters may well represent the first appearance of script in China. Obviously this was an important city, but though it reveals the first certain beginnings of the use of bronze in China, its cultural level is below that which is yet to come.

An-yang.—Some time around the 14th century (1401 B.C. according to orthodox dating, 1397 or 1315, etc., according to others) one Shang ruler named Pan (or P'an)-keng is said to have moved his capital to Yin by the Huan river near modern An-yang, and there he and his successors remained for over two and one-half centuries. The town and its tombs have yielded evidences of a civilization brilliant and barbaric. Bronze had come into its own, as had glazed pottery and a fine white ware bearing impressed or incised designs similar to those found on bronze ritual vessels. Woodcarving too was probably advanced, for the bronzes seem to have been based on wood originals. Carving in stone, jade, marble, bone and ivory was far advanced. Objects of bronze and bone sometimes were inlaid with turquoise or mother of pearl.

While the poor may have continued to live as their ancestors did, the patricians put up large timber houses with roofs supported on rows of wooden pillars with stone or bronze bases. Palaces, government offices and ancestral shrines also were erected. The craft of building must have been well advanced, for numerous architectural terms are found in contemporary inscriptions.

The tombs, many of the finest probably for members of the royal house, are magnificently constructed and furnished. One such tomb—26 ft. long, 39 ft. wide, 26 ft. deep—with 17 sacrificial pits, had two sloping passages opening out from its north and south walls. The pits contained bodies of decapitated human beings, dogs and horses. Its grave furniture included ceremonial vessels of bronze, stone and pottery, bronze weapons and bridle fittings, stone, jade and bone ornaments, and a musical stone or chime of gray limestone with tiger design on its face. Other tombs revealed occasional chariot burials. (*See* also above, *Prehistory and Archaeology: Early Bronze Age in North China.*)

Social.—The royal house that ruled from this city over the countryside was obviously one of importance. At its apogee the kingdom was probably bounded by the sea on the east, the Yangtze river on the south, Shensi on the west and southern Hopei on the north. The king was not alone in government but was assisted by a hierarchy of nobles. His state was largely a kind of tribute-collecting machine; hence the numerous wars with peoples on its borders. Succession to the throne was irregular; of 38 successions, 19 were from father to son, 14 from elder brother to younger brother, with 5 deviations from both practices. Queens were of some consequence, particularly the one who bore the heir apparent, who after her decease might be awarded her own shrine in the family temple and be worshiped as an ancestress. The kings, with one or two exceptions, were not war leaders but intermediaries between man and unseen powers. The king's ancestors were ostensibly the real power; he consulted them through his diviners and sacrificed to them. Ti was the supreme god, whose aid was invoked indirectly for good harvests and success in war. Other lesser divinities, such as the god of wind (called Ti's messenger), of the river (Yellow), of earth, of the sun (worshiped at sunrise), of the moon, of the six clouds, of Yüeh (T'ai Shan), were worshiped. Whether ancestor worship went beyond the royal house has not been determined.

Calendar.—The calendar was important to the Shang, for the chief industry of the people was agriculture, and the king must inform them as to the right times for sowing and reaping. The appropriate functionaries understood lunation; the character for month is the moon. The month was normally 30 days in length, two months making a 60-day cycle, and 360 days a year. Intercallation was practised. In the time of Wu-ting (orthodox dates of reign, 1324–1266 B.C.) an intercalary month was added when necessary at the end of the year, and called the 13th month. Tsu-chia, his third son by his third queen (traditional dates, 1258–26 B.C.), evidently a less superstitious and more forward-looking prince, placed the intercalary month after any month when it was required, and called it the same as the month just preceding. It was an awkward but a stable calendar. One Chinese scientist has ascertained from study of a period of 152 years (1313 to 1161, according to his reckoning) that the mean length of a solar year was 365¼ days. In the time of Wu-ting days were divided into seven, but in Tsu-chia's into ten. This is interesting as one of several indications that the Chinese leaned toward the decimal system from earliest times, and with remarkable consistency carried it forward in measurements of all sorts. As a result of this concern for calendrical reckoning the chief astrologer and recorder of events (for long he was the same man) came to have an important place, and the recording of lunar eclipses, considered a portent of evil, and other celestial phenomena began. Eclipses of the moon were reported to the capital even from distant states, and several stars and planets (Jupiter, for example) are mentioned in the inscriptions.

Warfare.—In warfare the nobles led armies of 3,000 to 5,000 men, but there are notices of 23,000 and 30,000 men conscripted for service. The nobles, armed with bronze spears and halberds, and protected by shields and helmets, rode in chariots drawn generally by two horses, though four-horse vehicles are not unknown. The troops or conscripts were supplied chiefly with composite bows that shot arrows tipped with points of bronze, bone or stone. One inscription on a bone dated in the 12th century tells of a successful military campaign against a state on the western marches in which the booty included 1,570 prisoners, 2 chariots, 180 shields, 15 pieces of armour and a few arrows.

Industry and Commerce.—In farming the peasantry used hoes and mattocks, shod with stone or shell, spades and a foot plow. Millet, apparently the only common cereal indigenous to China, was the chief crop; wheat and some rice may have been introduced about this time. In addition to domesticated animals known earlier, goats and fowl were added to the economy. Tamed elephants were brought in to assist in heavy building operations. Some irrigation was practised. Commerce may be taken for granted, since much of what has been found at the An-yang site and much of what the people required came from elsewhere. Seashells and salt probably derived from the Shantung coast; some of the tortoise shells came from the Yangtze valley and beyond, possibly as far south as the Malay peninsula; tin and lead and some copper as well were imported from the south and southeast; cinnabar (a principal ingredient of red paint) was produced in Szechwan; and turquoise derived from outside the Shang sphere. More conspicuous examples are jade, probably mined in Khotan, and cowrie shells—chief medium of exchange—which may have come from as far distant as the Maldive Islands. Shang tradesmen were so well known that the name *Shang jen* ("Shang man") became standard for merchant. Textiles included silk and hemp cloth. Names for these and such words as dress, shawl, fur, silkworm and mulberry are given in the inscriptions, and traces of silk have been identified in wrappings for precious weapons. Names for a number of musical instruments (mostly wind and percussion) also are known, as are a few examples of stone chimes, ocarinas and bells.

Script.—Of highest importance among the archaeological discoveries are the bones and tortoise carapaces employed both for sacred and profane use. Over 162,000 of these are scattered in public and private collections around the world. The biggest discovery came in 1936 when 17,096 were located in a single pit. A few bones lay among a great mass of tortoise shells, 300 of them complete. The inscriptions on a large percentage were incised against a scorched area, but some also were written with a brush, using cinnabar or black fluid. A number of the inscriptions reveal a king consulting the oracle and getting replies that at times are signed by the diviner. For example: "Kuei-ch'ou day. (Question) What about this year's rice crop? (Answer) Greatly favourable. (The oracle made in) the 8th moon of the 8th year." There are also, besides oracle inscriptions, records of receipts and historical records dealing with events of the royal court; these are not scorched. The diviners wrote sometimes from right to left, sometimes left to right, probably to suit the "oracle signs"; the recorders or archivists, however, wrote in the same way as at present, from top to bottom. About 3,000 different characters have been identified but only 1,400 or so are readable. Whence comes this script, found incidentally on bronze and other hard surfaces as well? The *idea* of script, long known in Babylonia and Egypt, may have come from outside, but the Chinese examples except for the simplest pictograms are conspicuously different from the writing of the people of the Tigris and Euphrates and Nile valleys and of the island of Crete. Chinese characters of the Shang period may be divided into three types: pictographs, ideograms and phonograms. By 1100 B.C. they had already developed over a stretch of several hundred years.

4. Chou (c. 1122–256 B.C.).—There is a tradition that in the reign of Ti-hsin, last ruler of the Shang, there was a period of extreme drought: a portent indicating failure on the part of the king. Doubtless also the house had lost its power to govern; after about 270 years in the same locale (about average for a long-lived dynasty) its line may well have become effete and its bureaucracy inefficient and corrupt. In any event the most powerful of the march states, the Chou, on the western frontier—long a battleground between the settled folk and the nomadic invaders—led by King Wu, seized this opportunity to strike. Forming a coalition with eight other states it gradually (in about 20 years) overwhelmed the Shang and ruthlessly destroyed its capital. Blood, it is said, flowed like a river at the battle. Survivors fled in every direction and may well have served as culture bearers to places as far removed as Hunan in the south and Manchuria and Korea in the north and northeast. A scion of the royal family together with members of his court eventually was installed in a small state called Sung, near modern Kuei-teh (Shang-ch'iu) in Honan, and there allowed to continue the ancestral rites. The Chou made a centre, called Hao (near Sian), their capital and parceled out the conquered territory to near of kin and favoured generals, thus instituting a Chinese type of feudal control. These fiefs, said to have numbered 1,773 at the start, were small, thus precluding at the outset any danger of a massive attack such as the Chou themselves had delivered against Ti-hsin of Shang.

For two and one-half to three centuries (the dating at the beginning is uncertain: 1122 or 1111 or 1050 or 1027) ending in 771 B.C. a succession of 13 Chou kings ruled from Hao, only to be ejected by enemies from without and a breakdown of authority within. The ruling king was slain, but surviving members of his clan, together with the court, succeeded in fleeing to a secondary capital on the Lo river, where the dynastic line was re-established but never ruled with power. From this point until, in 256 B.C., the last prince was eliminated, the royal house observed certain rituals and held court for visiting dignitaries, but its domain grew smaller and smaller. Even near the beginning of its existence near Lo-yang it was subjected to attack (by Cheng in 707), and to a large extent it was ignored by states growing in military strength. For example, between 722 and 481, princes of the state of Lu had only two audiences with the kings of Chou, and paid a ceremonial visit to the capital but once. They stopped their material gifts as well. At this time there were 170 states but by 403 B.C. all but seven were swallowed up. In 221 B.C. one man, from the state of Ch'in, could pronounce himself master of all China. The five centuries then, from the 8th to the 3rd, were characterized by almost ceaseless struggle, political chicanery and aggrandizement, and diplomatic jockeying, as well as by the beginnings of higher forms of artistic expression, literature and thought.

Who were the Chou? In all probability people ruder and less cultivated than the Shang, but nonetheless Chinese. The royal line traced its ancestry to Hou Chi, 14 generations earlier, who held a fief about 50 mi. W. of Ch'ang-an. Later the tribe shifted its base 50 mi. to the north, and still later 75 mi. to the southwest, following attacks by northern "barbarians," to a place called Chou or Chou Yüan (Chou plain), whence the name. From this point their chief, Tan Fu, according to tradition, gave up barbarian ways, threw up walls about his seat of residence and began to imitate the Shang. His grandson achieved sufficient stature to take a Shang lady to wife, to increase his domain and to give himself the name of Hsi Po ("chief of the west"). In due course this chief, known to posterity as King Wen, bested all other contenders for power in his vicinity. It was his son, King Wu, who finally displaced the Shang.

Political and Social.—To govern so huge a territory was no easy matter for him and his successors. Roads must have been execrable, the Yellow river every summer flooded the plain, and wild animals and even aboriginal folk who clung to remote regions in his domain may have made communications hazardous. An early description of the countryside near modern K'ai-feng relates that "all one sees is only woodland, marshes, lakes. There the king shot birds and hunted. In the second month of winter, in a hunt near Shen-kuan, he took 420 stags of different kinds and wild boar, and killed two tigers and nine wolves." Nevertheless the Chou monarchs traveled widely, living off their vassals, drawing their subsistence from them on the spot. They were assisted by various officials—administrators, inspectors, subordinate officers, scribes and pages. Their lords also returned the king's visits and went to court. When they showed signs of insubordination he dispatched expeditionary forces to bring them to heel. At his capital were altars, temples and palaces. But each successive king, at least at the beginning, incurred the considerable expense of abandoning the palace of his predecessor and putting up a new one.

The lords themselves developed tiny courts of their own with a bureaucracy rivaling that of their master. At the top was an intendant, or more than one if the lord had several domains. Below him were superintendents of forests and cultivated lands. A supervisor of roads and bridges, a chief of engineers, a controller of merchants, a justice (whose writ was subject to the royal judge), a controller of prisoners or of brigands and a director of horses to look after military needs also are mentioned in surviving inscriptions and early literature. In fact, each vassalage was a kind of state in miniature, copying royal institutions. The kingdom was only more complex and demanded more manpower. It also needed archives where the pronouncements of the king and his acts were duly recorded and preserved. This office was presided over by the grand scribe; he was charged in addition with the calendar and with intercalation.

In the years from 771 to 222 B.C. (usually known as the Eastern Chou from the location of its capital), the royal house, with priestly, ritualistic and diplomatic functions but diminishing authority, slowly sank out of sight as the nobles struggled with each other for power. Survival took no little skill, as it soon became evident that only coalitions with one or another neighbour would save anyone from extinction. Each needed wealth as well from produce of the land, the forests and the rivers and from manufactured commodities. To effect this, many drainage operations, canals, dikes, reservoirs, roads and the like had to be undertaken, often on an interstate or multistate basis. Long walls too were thrown up as means of protection not only against each other but also against aboriginal or nomadic tribes. In the latter part of the period one or more states saw the wisdom of creating monopolies in such universally needed staples as salt, iron and even liquor. Merchants and artisans began to assume some significance. Bureaucrats—so necessary in maintaining large undertakings—started to supersede the patricians. The first canal mentioned, possibly dug before the 720s, is the Hung Kou ("Great Ditch"); it connected with the Yellow river at a point in central Honan and ran eastward past K'ai-feng and thence southeast to join the Huai river tributaries in northwest Anhwei. The earliest reservoir recorded (it had a circumference of about 40 mi.) was built around the year 600 at the order of the prince of Ch'u, near Shou-hsien, in northern Anhwei, the site of one of his seats of power. It irrigated approximately 1,000 sq.mi. of land. Dikes were thrown up in the 4th century by the states of Ch'i and Chao and Wei, all of which bordered the Yellow river. The Ch'i also constructed a wall east and west across the Shantung peninsula, the northern face serving as an embankment against the overflow of the Yellow river, while the southern fortified the border against the rising state of Ch'u. In 487 B.C. the state of Wu, centred around Soochow, dug the earliest canal connecting the Huai with the Yangtze. At a later but uncertain date the same state constructed canals to reach the "three branches" of the lower Yangtze and the five lakes (the present T'ai Hu). This marks the beginnings of the Grand canal, and testifies to an increase of farming in this area, which was to become the grain centre of China, and to a marked growth in population. Ssu-ma Ch'ien, the grand historian, who visited the region before 100 B.C., was to write:

> All the canals were used for boats; and if there was sufficient water they then would be used for irrigation. Peasants enjoyed the benefit; wherever the canals passed, the peasants made use of the water. There were tens of thousands of ditches—nay, an incalculable number of them —to lead the water from the canals to the fields (translation of Chi Ch'ao-ting, *Key Economic Areas in Chinese History*, p. 66; George Allen & Unwin Ltd., London, 1936).

At the very end of the Eastern Chou, possibly around 300 B.C., the great plain of the Ch'eng-tu area was irrigated. Two main channels, subdivided eventually into 158 and 130 canals, respectively, led the water that pours down at certain times from the melting glaciers of the Tibetan massif to enrich this region in Szechwan, another of China's great grain-producing sections. These and other examples that might be cited tell of the backbreaking activity of the peasants in this creative period when the Chinese were coming of age.

Commerce and Industry.—The capitals of the states of this time were not only political but also commercial and industrial centres, known variously for their production of copper, textiles, salt, fish and, after 500 B.C., iron. One passage of the *Odes*, placed in the 8th century, suggests that profits could be triple the investment, yet nobles were supposed to be above engaging in trade. But were they? The first noble to receive the fief of Ch'i (in Shantung) "promoted its silk textile industry, perfected its skilled handicrafts, and opened up production and trade in fish and salt." As a result, "both people and goods came to it. They arrived carrying babes on their backs and converged on it like the spokes of a wheel. Consequently, Ch'i provided the world with hats, sashes, clothes, and slippers" (translation by Wang Yü-ch'üan, *Early Chinese Coinage*, p. 32; New York, 1951).

One scholar has estimated that by the year 300 B.C. or thereabouts the city of Lin-tzu had a population of not less than 370,000. Such wealth was possible not alone of a state on the coast. Around 550 B.C. in the northeastern state of Chin, "the rich merchants of Chiang (the capital) could decorate their carriages with gold and jade and have their clothing embroidered with flowery patterns." Besides, "they could distribute gifts to the feudal lords" (translation by Wang Yü-ch'üan, *Early Chinese Coinage*, p. 35; New York, 1951). The patrician class might scorn the thought of trade, but they fattened on it nonetheless. To their deserving officers they must give large donations; the bronze inscriptions tell of gifts of horses, land, slaves, weapons, strings of cowries, jade, chariots, cattle, red shoes, silk banners and millet liquor. The nobility craved palaces and pleasure houses and lavishly furnished tombs in addition to a following of servitors.

Far to the south, too, wealth was increasing. In the year 597 a minister reported that in Ch'u "neither the merchants, the farmer, nor the artisans have shown any relaxation in production." Archaeology supports this testimony. The areas around Ch'angsha and Shou-hsien, both important in Ch'u, have revealed the magnificence of material culture in these times.

While bartering must have been common, industrial developments led to a money economy. Though cowrie shells and their imitations continued for some time in use, metal coins, simulating the commonest tools or objects, came into circulation: knives in Ch'i and spades in the middle regions of the Yellow river valley (both cast in copper), and gold plates in Ch'u. Quantities of these of pre-3rd-century date have been found far removed from their places of origin, especially the knife coins of Ch'i, which have been discovered in Ch'eng-te, Liaoning and Korea on the east and Koko Nor on the west. This speaks volumes for the enterprise of the merchants and the confidence in Chinese money on the part of non-Chinese.

Intellectual Life.—All this indicates the need for literate people, sufficiently literate at least to serve as judges, diplomats, scribes, archivists, temple priests, teachers and the like. Education indeed advanced steadily through the time of Eastern Chou. Even before the 770s there was a certain amount of literature produced, but little besides some of the odes of the people and the court and part of the annals of the royal house has survived. By the 6th and 5th centuries and on to the end of the Chou there was a steady increase in writing: poetry, historical anecdotes, belles-lettres, political theorizing, laws and works on music, mathematics, medicine, divination, agriculture, arboriculture and horticulture. Some of the greatest minds that China has ever produced wrote and taught and argued about the way to solve the problems of their day.

Most of the thinkers seem to have been associated with the government. Certainly the problem that chiefly engaged their attention was the welfare of society. Cosmogony did not greatly concern them. To their minds, however, the disorder that attended the breakdown of the central government and the division of the country into warring states dominated by autocratic rulers was of great moment, and they sought to build a new order that would bring happiness to all. More is said elsewhere of the teachings of the Chou philosophers (*see* CHINESE PHILOSOPHY). It is sufficient here to state that Confucius (551–479 B.C.) sought to save society by a return to the way of the ancients. This he believed to involve an emphasis upon ethics—especially upon moral education—and upon ceremonies. By the leadership and example of the educated, and by the careful regulation of society by the ceremonies which had come down from the past, he would bring in a golden age (*see* CONFUCIANISM).

In his train and approving his solution came others, chief among them Mencius (*q.v.*), who stressed the essential goodness of human nature and the right of subjects to revolt against a persistently unjust ruler. Another school, Taoism (*q.v.*), had as its foundation classic the *Tao-te Ching* and attributed this to Lao-tzu who is said to have been an older contemporary of Confucius. The authorship and the dates of Lao-tzu are highly doubtful. The solution for the woes of mankind offered by the *Tao-te Ching* was conformity to the way of the universe. The way of the universe was believed to be the absence of all man-made restraints and freedom from elaborate regulations and from what passed for civilization. This solution obviously was quite different from that advocated by Confucius, and members of the two schools engaged in frequent controversy. Belonging to the school of the *Tao-te Ching*—Taoism—were many other thinkers, notably Chuang-tzu (*q.v.*; d. *c.* 300 B.C.). A book bearing his name is a witty exposition of the Taoist view that happiness may be achieved only by the free development of man's nature and that the best way of governing is through nongovernment.

Mo Ti (*q.v.*), who lived between the times of Confucius and Mencius and who was the precursor of two schools that for several centuries were to have great vogue but were eventually to disappear, taught that institutions should be submitted to the pragmatic test—were they of benefit to society? He was deeply religious, believed that T'ien (Heaven) loved men and that all men should love one another. It was his doctrine of universal love as the basis of ethics that brought against him the vigour of Mencius' dialectic. Yang Chu, a contemporary of Mencius, declined to trouble himself about society, maintained that death ended all and held that each man should live for himself and for his own pleasure. Hsün-tzu (*q.v.;* 3rd century B.C.) denied immortality and the existence of spirits and held that man, although bad by nature, could be improved by regulations and ceremonies. The legalists, as their name indicates, wished autocratic rule through the enforcement of law rather than the Confucian influence of moral example.

These and others show how diverse and vigorous was the thought of the age. Never again was Chinese philosophy to be so creative and so untrammeled by the past. Systems then begun were to persist until modern times.

Arts and Artifacts.—The last centuries of the Eastern Chou, so famous for their conflicts that they are called the period of Warring States (*Chan Kuo;* approximately 450–221 B.C.), are highly significant too for their native developments and foreign importations. Iron came gradually into use to displace the more expensive bronze for weapons and tools. The *Kuan-tzu,* a book of the 4th century B.C., tells of farmers needing plowshares, hoes, sickles, sledges and scythes; cartwrights needing axes, saws, wheelnaves, drills, chisels and wheels; women needing knives, awls, long and short needles. Archaeology has confirmed the accuracy of these details and has made clear how far ahead of the rest of the world the Chinese were in casting iron. For the cutting of jade the craftsmen of the 4th century had available the rotary wheel, the wire saw and the diamond drill. Bone and wooden chopsticks were added to kitchen and table. Ink and brush for the scholar and painter underwent improvements. The use of lacquer was perfected, preserving many articles that would otherwise have disintegrated: shields, scabbards, trays, bowls, cups, caskets, wooden figures, musical instruments, many of them decorated with delicate designs. Silk, sometimes (then as later) used as a surface for painting, has appeared in 4th-century tombs. Invention of the crossbow, one of the important weapons of the Chinese against their neighbours, is placed in the same century.

To these and other developments may be added what seem to be importations from outside. Objects of glass—undoubtedly made in China, for some at least contain barium while those of the west do not—are strikingly similar in design to examples from the rim of the Mediterranean. The two-humped camel, long known in central Asia, appears in the latter half of the 4th century and was to become essential for trade across the barren stretches of the continent. Mules and donkeys followed. Horseback riding, probably unknown in China before 350, penetrated the states of the northwest and revolutionized the art of war. No longer could a charioteer or his master survive against a galloping mounted bowman. Chariots, except for ceremonial use, began to disappear in China just as they did after Alexander's time in western Asia.

This is not all. Ideas too may have trickled into Asia over the routes of trade: geographic ideas, astronomical notions, musical formulas, even a few philosophical concepts, carried by caravan owners and passed from person to person to such a market as that which grew up near Lanchow (in Kansu) around 300 B.C. Before and around this time the Chinese seem to be aware of more of the Asian world than just the Middle Kingdom, and show an awakening knowledge of regions from the islands of Japan to the mountains of the west. Finds in the Altai of Chinese silk of the 4th century B.C. attest to the range of some of their goods. Calendrical science and ideas about the 28 resting places of the moon may have been stimulated by activities of the Babylonians in these fields, though proof of this is lacking. The Chinese were themselves careful students of celestial phenomena and by the 4th century had mapped 1,464 individual stars (200 years before Hipparchus and one-third more than his number). They were also making lists of solar eclipses, comets, meteors and shooting stars, for these were taken to be signs and portents. The division of the octave into 12 semitones of the untempered chromatic scale, derived from studies of string and wind instruments and bells, appears in a book completed in 238 B.C., and may have been touched off by Babylonian stimulus. In the oldest book on mathematics, which includes some late Chou material, the Pythagorean geometrical theorem is stated; in addition there is much that shows how the Chinese computed measurements, both celestial and earthly. They used the gnomon, sighting tube, circle and square, and measured heights and distances. They talked of the sun's shadow and estimated its differences in length at different latitudes. They calculated the annual movements of the sun. They took account of fractions, and knew how to multiply and divide them and how to find common denominators. Square roots were known. Counting rods were used from at least *c.* 400, and doubtless led to the Chinese use of place value, apparently ahead of any other people. Geometry became a special study in one of the schools, that of Mo Ti, about the same time as Euclid in Greece, but disappeared as that school ceased to exist three or four centuries later.

The Chou period closed as one after another of the larger states succumbed to superior craft and might. Wu submitted to its southern rival Yüeh in 474. Ch'u in 334 enveloped Yüeh and in 286 Sung (in Anhwei), thus dominating the Yangtze from the Gorges to the sea. Ch'in in the northwest by 318 subdued a coalition of states in the north; in 316 and later it reduced Shu and Pa in Szechwan. This brought Ch'u and Ch'in face to face for a life and death struggle that has been compared with the contest for supremacy between Rome and Carthage at about the same time. The discipline of the Ch'in troops and their mobility as mounted archers may well have helped them win the day. Ch'u was eliminated in 223; Chao, Wei, Yen and Ch'i between 228 and 221.

C. Middle Period

1. Ch'in (221–207 B.C.).—The prince who became supreme in 221 B.C. called himself the first emperor (Shih Huang Ti). Indeed he deserved the name, for China was now in fact an empire. No longer was there a cluster of states with nobles swearing (but not observing) fealty to their liege lord. Shih Huang Ti divided the country, stretching from the great bend of the Yellow river to certain areas south of the Yangtze, into 36 commanderies, adding 5 or 6 as other territories came under his control. Each commandery had officials subject only to the emperor. He shifted people without regard for local loyalties; the most powerful families were brought to the capital to remain under his eye. Brigands and ne'er-do-wells were transported to the marches to keep the nomads at bay. In 214 the first emperor connected such defensive walls as lay in the north into a single system and threw up watchtowers to guard the bulwark and to send signals—smoke by day and fire by night—to his capital at Hsien-yang, near Sian. A 100-mi.-long canal was dug in Shensi, in the valley of the Ching, in 246, during his minority, enriching the metropolitan area. Another was cut in 219 in the deep south, through mountainous terrain, making water transport from the Yangtze to the Hsi Chiang possible for the emperor's troops. Roads, 50 paces wide in the north, 5 ft. in the southwest, built between the years 220 and 215, supplemented the system of canals. Standard dimensions for cart and chariot axles were imposed. The script was standardized.

Unification of laws, weights and measures took place. Books and philosophies at variance with the thought of Ch'in were eliminated (the celebrated "burning of the books" of 213 was designed to assure the supremacy of legalism; *see* CHINESE PHILOSOPHY). Condign penalties were imposed on learned men who refused to be subservient.

Actually the reforms of Shih Huang Ti were not new. What was new was their application not to a single state but to an empire. Ch'i and Wei had experimented with some of them 200 years earlier. A native of Wei had carried them to Ch'in in 352 and had persuaded the prince there to put them into practice. The fact that he did accounts for the discipline and single-minded concern for conquest that occupied the princes of Ch'in for over a century thereafter. The first emperor died in 210, and with removal of his strong hand the dynasty crumbled. It was extinguished in 207. For five years various military officers contended for supremacy. Two emerged as rival leaders, with Liu Pang victorious after a severe struggle.

2. Han (202 B.C.–A.D. 221).—*Former Han.*—This period began with a rough and ready general and military officers who included a dog butcher, an undertaker, a silk dealer and a cart puller in the seats of authority. It is to the credit of Liu Pang (posthumously known as Kao-tsu) that he was finally persuaded to call in the bureaucrats and seek their help in administering his vast empire. He made the mistake, however, of assigning the administration of various distant regions to favoured members of his personal and official family. This blunder almost led during the next 50 years to the breakup of the realm, until the power of the "seven kings" was broken (154 B.C.) and civil service examinations were instituted for the selection of some of the officials in the imperial service in 124 B.C. Equally dangerous to Han rule were the nomads of the north and northwest, the Hsien-pi and the Hsiung-nu. Each, with a reputed 200,000 archers, constantly menaced the northern marches. Indeed, one of the purposes of the Great Wall was to impede their horsemen, and its watchtowers kept incessant guard. For the first century and a half it was the Hsiung-nu who provided the greater worry. At the very start of Liu Pang's reign they almost destroyed him, trapping him in a northern citadel in the year 201 and forcing him to pay subsidies of silk, wine, grain and food to gain release. The handing over of a palace maiden in marriage then (and frequently later) was another part of the agreement. Not till the days of the emperor Wu (reigned 141–87 B.C.) were the Hsiung-nu subdued, first by an attempt to gain allies against them and then by daring raids deep into their own territory.

The attempt to gain allies led to a memorable embassy. A people called the Yüeh-chih, who had once occupied part of the Kansu corridor, were forced out of this region by the Hsiung-nu in 161–160; three decades later they arrived in Bactria. After numerous adventures a Han envoy, Chang Ch'ien (*q.v.*), reached Bactria (in 129–128) to try to persuade them to assist the Han in confounding their mutual enemy. His mission failed, but the data he collected and brought back to his emperor persuaded Wu to embark on numerous military and diplomatic forays. In 121 one army attacked the Hsiung-nu at Kuei-hua and killed or defeated 19,000 of them, also capturing a vast herd of sheep. Another went 700 mi. farther west and seized 80 Hsiung-nu chiefs. In 115 the envoy returned to central and western Asia, this time with 300 men; from then on diplomatic connections with a score of states developed. Far to the south, in Kwangtung and Tongking, which had once been absorbed by Ch'in but whose colonizers had declared their independence of Han, Wu dispatched another force in 111, taking over the administration of the region. In 108 he turned his attention toward the east, to northern Korea, where many Chinese had settled following the rise of Ch'in. Here again his army and his fleet were successful. Four commanderies were set up in the occupied territory.

Han was now an empire rivaling if not exceeding Rome in size and probably also in wealth, power and prestige. Its envoys, officers and merchants could and did roam far afield, some apparently even voyaging across the Indian ocean in the 1st century B.C. Almost certainly they stopped at Kancheepuram (old name Kanji) on the southeast coast of India, traveling by foreign vessel. They stimulated the export of goods and tribute by land and sea to Ch'ang-an, the capital city, now a place of grandeur. The historian Pan Ku in the 1st century A.D. wrote of the imperial park of Ch'ang-an:

> In the suburbs to the west are the parks of the emperor, private gardens, groves, forests at the foot of the mountains, lakes and pools, basins and marshes. They . . . are surrounded by a long wall more than a hundred miles in circumference. The independent palaces and separate pavilions are thirty-six in number; supernatural springs and marvellous pools are encountered at every turn. In the interior are unicorns from Annam, horses from Ferghana, rhinoceroses from Kanchi, and birds from Chaldea.

The name of no individual foreign merchant is known until A.D. 181, but that such people came is hardly subject to doubt. A song of the time runs:

> The itinerant foreigners, whence do they come, and what do they bring from their various lands? Rugs and carpets and frankincense, rosemary, camphor, and thorough-wort (translation of Arthur Waley, *History Today*, p. 92; 1953).

As merchandise and plants and animals and even disease traveled westward, so did Chinese goods and products make their way across the Asiatic continent. The Romans, after conquering Syria in 64 B.C., came to prize Chinese silk and set up a market for it in the Vicus Tuscus in Rome. Patricians in distant Spain, Gaul and Britain demanded silk. Chinese bronzes and jades and lacquer goods followed in the trail of silk, but were in less demand.

Interim.—With the death of the emperor Wu (or Han Wu Ti) came a gradual decline in power and prosperity and increasing corruption in high places. The consort families acquired such authority that eventually one of their number, Wang Mang, then first minister, after a bloodless and well-managed coup, took over the empire changing its name to Hsin (A.D. 9–23). A great controversy has raged over this man ever since. Though many of the reforms he instituted were overdue, he operated under difficult circumstances. The peasants in the east, already impoverished, were affected by a major shifting of the bed of the Yellow river (twice: *c.* 1 B.C.–A.D. 6 and A.D. 11). The government tried to ameliorate their condition, but the numbers of dispossessed increased. The bureaucracy co-operated at best without enthusiasm. Merchants took advantage of the situation. The government became discredited, and soldiers finally stormed the capital and slew the monarch.

Later Han.—It was two years before a scion of the house of Han restored the dynasty, now to be known as the Later Han. Actually, however, not until A.D. 36 was the country again at peace. It then set about recovering its former colonies. The commanderies in Korea were not a problem, but the southland (Tongking) had to be recovered (this was done in 42) and the northern tribes in Manchuria and Mongolia pacified. In 73 Pan Ch'ao was selected to win back the chieftains of the oases of the Tarim basin and dislodge the Hsiung-nu, once more independent, who bestrode the Altai and blocked the trade routes to the west. With expert use of both force and treachery he cleared the way and by the year 94 was supreme as far as the Pamirs, exacting tribute (*c.* 90) even from the Yüeh-chih, who had themselves erected a flourishing empire known by the name of Kushan.

This feat brought the Chinese face to face with Buddhism, the greatest missionary force in Asia. The religion penetrated slowly but effectively, first befriended, then spurned by the Taoists, steadily gaining ground as the Han tottered again to its fall in the last 40 years (*c.* 180–220). Conflicts among the consort families, the eunuchs, powerful families in the capital and in the provinces, and the military, plus another serious uprising of peasants (184), brought misery all around. In the end the military gained control and divided the country into three dominions.

During the Han dynasty China came of age. Its earliest historians, Ssu-ma Ch'ien (writing about 100 B.C.) and Pan Ku (A.D. 32–92), set the pattern for the majestic series of annals that are one of China's glories. Agriculture, mathematics, astronomy, belles-lettres, music and industry took forward steps. The skeptical writings of Wang Ch'ung (1st century A.D.) punctured the superstitious theology of Tung Chung-shu (2nd century B.C.).

Education so flourished that by the middle of the 2nd century A.D. there were 30,000 students in the capital (then Lo-yang) alone. Paper was invented and began to displace wooden and bamboo surfaces for writing. The first important dictionary, explaining about 10,000 characters, was published; likewise the first important pharmacopoeia. The alchemists began to make discoveries useful in medicine and industry; the proto-porcelain of the last decades of the Han may be the result of their experimentation.

3. Six Dynasties (221–589).—From A.D. 221 to 589, the Chinese, particularly those of the north, suffered division and turmoil. Split at first into three states, Wei in the north, Wu in the middle and lower Yangtze valley, and Shu in the Szechwan area, China was united for a few decades by the Tsin (265–317), only to be broken by invasions of Hsiung-nu, Hsien-pi and other ethnic folk who penetrated passes in the Great Wall at will. While non-Chinese ruled mainly in the north, a series of native houses held sway in the south, thus preserving much of the Chinese heritage. In fact, the south was becoming more "Chinese" all the time as exiles poured in across the frontier to escape the exactions and discomforts of life under alien conquerors. In addition to the above-mentioned state of Wu, these houses were the Eastern Tsin (317–420), the Former Sung (420–479), the Southern Ch'i (479–502), the Southern Liang (502–557) and the Southern Ch'en (557–589), all of which had their capital at Nanking; hence the oft-used term "Six dynasties" for the period, in utter disregard for what was transpiring elsewhere in China. In the north the most important dynasties were the Northern Wei (ruling from 386 to 495 at Ta-t'ung in northern Shansi, and for the next 40 years at Lo-yang), the Eastern Wei (at An-yang from 534 to 550), the Western Wei (at Ch'ang-an from 535 to 556), the Northern Ch'i (at An-yang, 550–577) and Northern Chou (at Ch'ang-an, 557–581).

Troubled as those centuries were, they did not pass without significant developments. Indeed they cannot rightly be compared with the dark ages into which Europe sank after the fall of Rome. The period was essentially one of transition in civilization. Many of the invaders adopted Chinese culture, but they could not but modify it. Buddhism now achieved popularity, perhaps in part because with the breakdown of central authority the Confucian school could not offer the resistance that it could under the Han. Many of the monarchs espoused the foreign cult, missionaries came in numbers, and Chinese, the best known of whom was Fa-hsien, went on pilgrimages to the sacred sites in India and returned with Buddhist scriptures.

By the time the empire was once more united, Buddhism had become an integral part of its life and was having profound effects upon other religions, popular thought, literature and art. The Buddhist sculptures of the period are noteworthy. During the last years of disunion and during the first century or two of the union that followed, Buddhism was more prosperous than it was ever again to be in China. The many new sects that arose within it testified to its vigour. Taoism, too, under the stimulus of Buddhism, developed and became a great popular religion.

Though it was a period of disunion and turmoil, the 3rd to 6th centuries showed great increases in knowledge of medicine, mathematics, astronomy, botany and chemistry. Through foreign missionaries and returning pilgrims, merchants and embassies, the Chinese became much better informed about the outside world. Sea connections and commerce between China and southern Asia increased. The lower Yangtze region became more highly developed economically and culturally.

It was during this age that P'ei Hsiu (224–271), who produced a large map of China in 18 sections, laid down specific rules for the use of the grid system in cartography, each gradation corresponding to 100 *li* (about 30 mi.). During the Six dynasties, too, a start was made on the writing of local histories or gazetteers for specific parts of the Chinese world. A work to be noticed is an account of the southern regions that gives, *inter alia,* the first notice of biologic control through use of insects in the culture of oranges and lychees. A book on agriculture, horticulture and animal husbandry, produced before 550, so excelled other works in the field that it went through more than 20 editions after it was first printed in the years 1023–31. Tea was introduced, possibly from Burma, in the 3rd century. The practice of welding hard and soft steels to make the blades of weapons, probably derived from central Asia, and wootz steel, imported from India, appeared in the 3rd and 5th centuries respectively. Mica came to be widely used for lanterns, screens and windows and for decorative purposes in the 3rd century. Water mills, ships, the wheelbarrow and the stirrup came into general use in those centuries. The value of π in mathematics was developed with great accuracy by a mathematician of the 5th century. In studying the heavens the astronomers of the Tsin made a list of 28 solar halos between the years 249 and 420; not until the 17th century did anyone in Europe record such phenomena.

4. Sui (589–618).—A long time had elapsed since the days of empire, but the historically minded Chinese had never forgotten that all China had once been ruled by a single house. The Sui dynasty that finally achieved unity did not hold power for long, but its monarchs laid the foundations for the T'ang to follow. The Sui rulers actively patronized Buddhism and embarked on domestic construction at home, much of it extravagant, and recovery of territory and prestige abroad. Perhaps nothing so served to unite the country politically and economically as the improvement and extension of the waterways that formed the Grand canal. The two capitals, Lo-yang and Ch'ang-an, at prodigious cost in *corvée* labour and other expenditures, were now linked to the lower Yangtze valley and Hangchow bay in the south, and to a point close to Tientsin in the north. The Great Wall was rebuilt to protect the northern flank. The forays abroad were only partially successful. The Chams and the Chen-la kingdom in Indochina were forced to pay tribute and Taiwan (Formosa) was raided, but excursions into Korea (611–614) and against the T'u-chüeh (or Eastern Turks) in Mongolia were a failure. Rebellions begun in 613 ended in 618 in the murder of the second emperor. He was succeeded by a general of his northwestern command who established the house of T'ang—as memorable a dynasty as that of Han, and ruling for a time the largest and strongest empire on the globe.

5. T'ang (618–906).—After consolidating their hold at home the first emperors reopened the war with Korea, but they did not annex the whole peninsula until the 660s. Contacts with Japan, begun under the Sui, continued under the T'ang until the 9th century, with students, envoys, merchants and monks coming to the capital or to the ports and monasteries for stays of considerable duration, a few even remaining for life. At the same time Chinese missionaries and teachers carried Buddhist, Confucian and Taoist thought and ritual to the Koreans and Japanese. The second emperor, T'ai-tsung (or Li Shih-min), who regarded himself as a worthy successor of the Han emperor Wu, carried his arms into central Asia, defeating the T'u-chüeh (both Eastern and Western Turks) in Mongolia and beyond as far as Ili, by 648 achieving mastery of the whole Tarim basin. Princes of Bokhara and Samarkand recognized his suzereignty. At his death in 649 his tomb was protected by statues of 14 vassal kings, from the khans of Turkestan to the king of Champa (Annam). Less successful in his struggle with the rising power in Tibet, he at least was able to crush a Tibetan attempt at invasion and to improve relations by sending a Chinese princess to Lhasa as consort of Songtsen Gampo.

At home the central administration was organized so well that the pattern stood, with few changes, up to 1912. Confucianism again began to flourish, growing strong especially in educational circles, with the Confucian canon required study for all candidates for civil office. Schools at the capital attracted students from many lands. Foreign missionaries preaching Mazdaism, Nestorian Christianity and Manichaeism established temples and translated their sacred works, while Buddhist Chinese eager to make contact with the wellsprings of their faith continued to make long journeys to India and Ceylon. A great map of the Chinese world, measuring some 30 by 33 ft., which treated in addition seven great trade routes from China to other parts of Asia, appeared in 801. Even under the Sui a landmark in dictionary making was published (601), to be followed by other scholarly works under the T'ang, such as the first historical encyclopaedia (801). Astronomy and mathematics made marked advances, partly as a result of increased contact with Buddhist and Manichaean scholars from abroad. One government-sponsored research project is one of the most remarkable studies carried out anywhere in the world in those days: in 721–725 nine stations, ranging from a point near Hué in Annam to the Great Wall in the north (over 2,175 mi.), were set up to make simultaneous measurements of summer and winter solstice shadow lengths. At the same time investigators mapped the constellations of the southern hemisphere. Wealth and peace brought leisure and a renascence of the arts. Calligraphy and painting, poetry and belles-lettres touched new heights. With the demand for multiple copies of literature of all sorts, from almanacs to sacred scripture, the art of printing arose.

In spite of its vigorous start the course of the T'ang dynasty was not smooth. Through palace intrigue a former concubine of the second emperor succeeded not only in becoming empress but also in calling herself emperor (the only female emperor in Chinese history) and in changing the name of the dynasty for a time (690–705) to Chou. A half-century later worse was to come, with the chiefs of Nan Chao in full cry against the T'ang (751–754), defeat of its army by the Arabs in western Asia (751) and a rebellion by dissatisfied generals at home (755). The emperor and his court fled ignominiously, leaving the two great capitals to be sacked by the Uighurs and Tibetans respectively (763). The Tibetans and the Uighurs withdrew in due course, but the latter, with an empire stretching across Mongolia to the Altai, became a dangerous and burdensome ally for the next 80 years.

The T'ang court returned to Ch'ang-an, but it never again exercised suzerainty over so vast a territory. Military officers and eunuch favourites took over in many areas of control, though the country at large continued to be administered with a high degree of efficiency. In 842–843, because of the collapse of the Uighurs who patronized the followers of Mani in China, Manichaean monasteries were closed, their priests sent north or slain, their property confiscated and the religion proscribed. Two years later, for political and economic reasons among others, a similar disaster befell the Buddhists, affecting, according to the decree, 4,600 temples and all their lands and precious treasures, 40,000 shrines, and 260,500 monks and nuns. The Nestorian and Zoroastrian religions too were proscribed. Buddhism recovered in some measure, but never again was it to assume the major place in Chinese life that it had held between the 5th and the first part of the 9th century. Zoroastrianism, on the other hand, was destroyed, and Christianity died a lingering death; Manichaeism survived, more or less surreptitiously, for a few more centuries.

Fifty years later the country began to fall apart as powerful generals assumed control of areas under their command. The T'ang bowed to the inevitable in 906. (*See* also T'ANG.)

6. Five Dynasties and Ten States (907–960).—The years assigned traditionally to this period are 907–960, but actually the state of Ch'ien Shu in Szechwan broke away from T'ang in 890 and that of Pei Han in Shansi was not made part of the Sung empire until 979. Politically these decades were chaotic, with two Chinese and three non-Chinese houses laying claim to empire around the ancient cities of Lo-yang, K'ai-feng and Ch'ang-an, and with the rest of China parceled out among self-appointed despots. Even this was not all, for the Khitan, a people of Hsien-pi descent and Mongol tongue who were based on Jehol and Liaotung, swept into the area around Peking in 938 and maintained their hold for nearly 200 years, ruling under the name of Liao.

The picture is not all black, however, for this is the era of printing. Between 932 and 1019 the entire Confucian (130 volumes), Buddhist (5,048 rolls) and Taoist (4,565 rolls) canons were carved on wood blocks and the resultant works distributed far and wide. In addition there were printed all the dynastic histories up to that time and numberless other books, both official and unofficial. In the meantime one ambitious general, Chao K'uang-yin, gained the upper hand after the death of his emperor in 959 and established another dynasty that was to lend distinction to China for over 300 years.

D. EARLY MODERN PERIOD

1. Sung (960–1279).—The establishment of the Sung dynasty inaugurates the period that has been described rightly as early modern. It was modern in government, with the appearance of political parties with differences in policy. A certain modernity also may be seen in the decline of aristocracy and rise of the status of commoners; in the development of the system of civil service examinations to serve more genuinely as a device for the discovery of talent; in the growth of a money economy (paper currency was resorted to in 1024); in a sensible willingness to admit more than one interpretation of the Confucian canon; and in the rise of new media in fiction, drama and art. Perhaps even more striking is the fact that, due to the now wide availability of books, the level of general education rose and in many fields there was a close approximation of the spirit of science.

The Sung faced major difficulties on its frontiers from the start and never overcame them. To the north of the Yellow river were the Khitan, with whom they fought an exhausting war from 986 to 1005; this ended with the Sung being compelled to pay a sizable annual indemnity. In the west were the Tangut of Tibetan ancestry who established themselves athwart the Kansu panhandle and demanded costly tribute every year after 1043. Annam in the south and Nan Chao in the southwest sealed off the southern frontier. In 1122–23 the Khitan were displaced by the Jurchen, a people ancestral to the Manchus, who founded the house of Chin; they crossed the Yellow river and descended in force on the Sung capital, taking prisoner the entire court (1126). One prince escaped and set up temporary capitals in a number of places before reaching Hangchow, where the capital remained from 1135 to 1276. Meanwhile the Jurchen menaced the entire area north of the Yangtze. Not until 1215 were they compelled to withdraw from Peking and in 1233 from K'ai-feng, to be entirely destroyed the following year by the Mongols.

Ringed around as they were, the Sung were forced to develop their domestic economy and take to the sea. These steps they took with conspicuous success. Great cities were built, generally according to plan. K'ai-feng, the first capital, rebuilt after 1078, had an area within its walls of over 16 sq.mi., and its population, including suburbs, was estimated at 1,200,000. Soochow was about its equal in size and Huchow was even larger. These cities, together with Hangchow and Canton, were among the greatest urban centres of the age, catering to almost every need. The main streets were wide, and public baths, street cleaning, street lighting and fire protection existed. Fairs and markets, eating places and amusement centres enlivened them by day and doubtless far into the night. City officials also ran orphanages, homes for the aged, first-aid stations, granaries and schools. The coastal regions from Yangchow to Canton grew increasingly prosperous, due to foreign trade. Native craft became perhaps the finest and safest ships on the high seas thanks to the development of watertight compartments, balanced rudder and wave-resistant superstructure, and to the invention of the magnetic needle. Ports such as Ch'üan-chou (Chin-chiang) and Canton had large non-Chinese settlements where Indians, Arabs and other foreigners lived and erected their temples and mosques. The Chinese shipped silks and porcelains to Japan in the east and Egypt in the west, receiving in exchange spices, incense, ivory, jewels, pearls, steel, cotton and precious woods. Revenue taken by the government on imports around 1200 amounted yearly to 65,000,000 strings of cash. For defense the Southern Sung, in 1127, created a navy; by 1237 it had 20 squadrons armed by nearly 52,000 men.

In an age such as this the Chinese made advances in almost every field. Use was made of explosive power in fire arrows, flame throwers, bombs, grenades, proto-muskets and cannon. They experimented with movable type. They developed human inoculation against smallpox. One medical author wrote the world's first treatise on legal medicine; a pharmaceutical author insisted on the need for investigation of any doubtful drug.

The first astronomical clock was realized—a technical achievement of the first order. The zero (from India?) made its first appearance. The introduction of cotton and sorghum and green lentils from India and drought-resistant rice from Champa brought about a mild revolution in Chinese agriculture. In political economy statesmen of the 11th century developed enduring principles in arguments before the court, and carried them into practice. One statesman, while out of office, wrote one of the great histories of China, covering the long period from 403 B.C. to A.D. 959, a work in 294 chapters plus 30 additional chapters in which he gave special attention to divergencies in the records he used as sources. Buddhism, though no longer the power that it once had been, had nonetheless unconsciously affected the thinking of scholars; the resultant thought, a synthesis of the ethics of older times and a new metaphysics, was the theme of countless discussions and writings, culminating in the formulations of Chu Hsi (*q.v.*). (*See* also SUNG.)

2. Yüan (1280–1368).—Temujin (born between 1155 and 1167, died 1227), after a youth spent largely in overcoming tribal enemies, became supreme over the Mongols in 1206 and was proclaimed Genghis Khan. Invading Kansu, he conquered the Tanguts (1209) and pushed on into north China, taking the Chin capital (Peking) in 1215 after a bitter siege. In 1234 his successors annexed the Chin empire and followed up this campaign by penetrating Szechwan. Later Genghis' grandson Kublai established the Yüan dynasty, beginning in 1260, though it was not until 1280 that all China was invested. During the reign (to 1294) of Kublai, Peking, again the capital and rebuilt by a Muslim architect, succeeded Karakorum as one of the principal centres of world attention. There the storytelling of the Sung period and the puppet and marionette shows of earlier days developed into maturer fiction and drama. The Grand canal, running now from Hangchow to the suburbs of Peking, was restored for travel and commerce; so too were the waterways in Kansu. Imperial roads were put in condition, and postal stations with relays of 200,000 horses were installed for imperial service. Government funds and even ships were lent to private traders to stimulate overseas commerce; maritime trade bureaus were established first at Ch'üan-chou (1277) and later at Ningpo, Shanghai and other ports. Crops and the food supply were checked periodically, and grain was stored away against shortage.

Failing in 1274 to conquer Japan with a Mongol army transported across the straits by a Korean fleet, Kublai assembled two other fleets, one Korean, one Chinese, but failed again in 1281. Other marauding adventures to Champa (1282–83), Annam (1257 and 1285), Burma (1287) and Java (1293) were hardly more successful, but the kingdom of Nan Chao (in modern Yünnan) was forced to submit (1253) and in 1274 came under the governorship of a Muslim. Other Muslims followed, establishing flourishing communities there and in other western provinces. Nestorian Christians, forced out of Sung China not long after 1000, though holding on precariously in the north, came back in strength under the Mongols, to be followed by Roman Catholic missionaries and traders and Greek Catholic guardsmen—the Alans, who eventually (1336) asked to be accepted into the church of Rome.

Through his brother Hulagu in Persia Kublai received models of astronomical instruments and even a terrestrial globe. Of more significance perhaps were the instruments—designed by a Chinese engineer and astronomer and erected in the imperial observatory—with which officials of the observatory were able to ascertain facts of primary concern. China during the 13th century had what may have been the most advanced mathematics and astronomy of the age. Kublai also promoted a search for the source of the Yellow river. A map of the then known world, published after 1330, included the whole of Asia, Europe and Africa.

With Kublai's passing the dynasty gradually declined. Tribute to Peking dwindled, but the costs of supporting public enterprises, the Mongol nobility and Buddhism and Taoism continued. Metallic currency was drained away into the west. A study of the issues of paper currency shows rapid inflation, until government notes became valueless; in 1356 printing of them was discontinued. In 1351 the Yellow river overflowed its dikes, causing great distress. Grain transportation to the north, necessary because of the insufficient supply of farm produce in the metropolitan province, fell away after 1342, and famine faced the court. The region south of the Yangtze, which had suffered only moderately in the time of Mongol conquest and which had been allowed even to maintain many of its bureaucrats, became a breeding place for rebellion. Starting in 1325 numerous uprisings broke out. How much they were directed against the Mongols and how much the several leaders were struggling with one another is not clear, but by 1368 all but one of the leading insurrectionists were eliminated, and so were most of the Mongols.

3. Ming (1368–1644).—The founder of the Ming dynasty, Chu Yüan-chang (reign title Hung Wu), like Liu Pang of the Han came of humble origins. Instead, however, of adopting a policy of reform that might have benefited the people of his own kind, he upheld the landholders, suppressed all differences of opinion, even deleting large segments of antiautocratic pronouncements from the text of Mencius, and became as much of a despot as ever sat on the dragon throne. Perhaps this was the policy required during his reign. The people had to be coerced into accepting his rule, dikes and walls rebuilt, the peasants coaxed back to the farms. Having depended heavily on ships during his rise, he created a navy, with supporting stations on the coast, to patrol the littoral. Secret societies, widespread during the time of rebellion, were suppressed, a new code was authorized, and attempts were made to establish a safety zone around the empire. Mongolia and Korea at the time were too weak to resist; the princes of Liuchiu (Luchu Islands) and certain oasis states of central Asia acknowledged China's suzerainty; Japan, however, brushed aside Chu's threat of war, and, knowing that his fleet might have no better success than had those of Kublai, he had to accept the situation. He at least started the land off to a long period of material prosperity. The population, estimated at 65,000,000 in his day, rose to 150,000,000 before the dynasty fell. The country's sea and land frontier suffered frequently from raids during these 2½ centuries, but the interior remained relatively undisturbed throughout.

A crisis over the succession disturbed the peace after Chu's death, but in 1402 a grandson was eliminated and a son (Chu Ti) came to the throne (then at Nanking) behind a seasoned army to reign under the title Yung-lo (1403–24). Besides the problem of gaining allegiance from a people irate over his bloody march from Peking to the Yangtze, and from the scholars disturbed over his unfilial act in upsetting his nephew, whom his father had made emperor, Chu Ti had constantly to repel the restless chiefs of Outer Mongolia and the Japanese marauders on the coast. His interest in the navy, as keen as his father's had been, led to the equipping and dispatching of well-armed "treasure boats" with attendant supply ships nearly halfway around the world. Six expeditions went out from Chinese ports during his reign, and one afterward (1433), to countries of the South Seas, Annam, Ceylon, the near east and Africa. The ships were armed with cannon, and forced the payment of tribute when necessary. A prince in Sumatra and a king of Ceylon, both of whom gave resistance, were seized and transported to the capital. Mecca and many other states acknowledged China's might. Tribute often came in money; also imported were horses, sulfur, copper ore, timber, drugs and spices. In exchange China gave paper money (when possible), silk and porcelain. Remnants of the last still are found in faraway places, while a stele in Ceylon, inscribed in Chinese, Persian and Tamil and dated 1409, bears witness to Chinese aggressiveness and enterprise during these decades. One of this emperor's last major acts was to transfer his capital to Peking (1421) and there, on the ruins of cities put up by the Khitan, Jurchen and Mongol invaders, to construct an imperial city of his own.

The following reigns show no comparable interest in foreign adventures. The navy was reduced in strength, patrolling of the coast ceased, and merchants were discouraged from going abroad. One ill-advised monarch in 1449 permitted himself to be captured by a small detachment of Oirat (western Mongol) horsemen, a fraction of the size of his own army. A spirit of isolationism spread in court circles. The following century saw repeated encroachments on Chinese soil: the Portuguese in the south in 1521, Japanese pirates along the coast (1525–63), and Altan Khan, prince of the Ordos, in the northwest after 1542. Certain Muslims, allied to coreligionists in central Asia, also caused frequent trouble, especially in Kansu and Shensi. A serious threat was an attempted invasion by Japanese armies via Korea; these nearly reached China's northeast border during the final decade, being checked in 1598 partly by Chinese arms and partly by lack of supplies from the home islands. By this time China's economic strain was becoming evident, imperial leadership was relaxed, and morale at the capital and in the field deteriorated. When the Manchus rose in strength north of the Great Wall they were able to expel the Chinese from the basin of the Liao (1621) and eventually take Peking away from a bandit chief who had just broken through the city's gates after ravaging much of the west.

In spite of generally inept emperors, the Ming was a period of marked accomplishment. The Grand canal was deepened and improved; the Great Wall was repaired; and most of the city walls, paved highways, bridges, palace and temple structures that stand today were erected by architects of the Ming. Beautiful paintings and porcelains date from this period, as do excellent textiles, rugs and furniture. There was craftsmanship of the highest order in bookmaking, and encyclopaedic works appeared in a variety of fields, such as military science, technology and medicine, in addition to the huge *Yung-lo ta tien* in 11,095 volumes. Reprinting of many ancient books preserved what otherwise might have disappeared irrevocably. Fiction and drama continued to delight and distract the multitudes. In philosophy the dispute between Chu Hsi and Lu Chiu-yüan, his contemporary of the 12th century, blossomed again between the followers of Chu and the great disciple of Lu, Wang Shou-jen (1472–1529), who insisted that the moral judgments of a man should spring from his own intuition. Academies sprang up in many parts of the country, especially in the south, encouraging freedom of expression within the Confucian tradition. The province of Kiangsi alone had 241 academies by the mid-16th century. The members of one academy in Kiangsu dared challenge the eunuch-ridden court, with death the end result for many of them. There was no dearth of literate and able men.

Into this atmosphere appeared a small and dedicated group of Roman Catholic missionaries, led by Matteo Ricci (*q.v.*), who, in addition to their work of evangelization, undertook to introduce western culture. Their influence was immediate and consequential, leading to useful advances in many fields. For the first time in history western and eastern science began to flow in one channel. The discovery of the Americas brought not only knowledge of a wholly new world to the Chinese but also new crops that were added rapidly to their farms (maize, sweet potato, peanuts, tobacco), a new coin (the Spanish peso, minted in Central or South America) and a new disease (syphilis). Under less blind and venal leadership at the court China might have gone on to great advances, but with rebellions in the west, ending in the seizure of Peking, and a fresh and hardy foe to the north, the dynasty of the Ming came to an end. (*See* also MING.)

4. Ch'ing (1644–1912).—With the consent of a Chinese general who was blocking the passes of the Great Wall, the Manchus poured through Shan-hai-kuan to aid him in ejecting the bandit foe from Peking. This done they saw no reason to retire, and within a year had pushed south and driven the retreating Ming survivors from Nanking. Though they now had all north China to the Yangtze, this was only the beginning of a prolonged struggle. Ming princes and their supporters continued to resist not only on the mainland but also on Formosa, where Cheng Ch'eng-kung (called Koxinga [*q.v.*] by contemporary Europeans) finally based himself (1661–62) by driving out the Dutch. Not till 1683 was the Cheng insurrection crushed on the island and across the straits in Fukien. Meanwhile a revolt of three high Chinese officials appointed to govern the southland broke out in 1674 and lasted to 1681.

The Manchus at last were in control. To make their domination clear to all they imposed the partly shaven head and queue on every man. Chinese and Manchus together staffed the principal offices of administration at the capital, but frequently Chinese alone governed the provinces. At important cities throughout the provinces were stationed guardsmen drawn from the eight Manchu banners or divisions. The first Manchu emperor to reign at Peking was little more than a figurehead. With the second, however, the Ch'ing came into its own. Reigning under the title K'ang-hsi (born 1654; reigned 1661–1722), he launched a period of achievement scarcely equaled before, certainly not afterward. Of all the reigning monarchs of the time—Aurangzeb in India, Peter the Great in Russia, Louis XIV in France—K'ang-hsi was the most enlightened.

Peace, beginning in 1683, made possible careful administration and judicious control. Foreign adventurers were repressed. The Portuguese were allowed to remain in Macao but were not permitted elsewhere. The Russians pushing out across Siberia challenged the Manchus in their northern homeland, but in the treaty of Nerchinsk (1689) agreed to desist from argument by force. An agent of the tsars and a branch of the Greek Orthodox Church were allowed to settle in Peking. The Mongols in 1691 accepted junior status. Tibet, disturbed because of the Manchu forced selection of a dalai lama, was invaded in 1720 by imperial armies and compelled to allow the stationing of Manchu garrisons. Of all foreigners those most tolerated at the court were members of the Society of Jesus. They were men of scholarship, well versed in both the Chinese and Manchu languages, who introduced the emperor to certain branches of European learning. They performed numerous services as well, assisting as interpreters in state business involving Europeans, preparing elaborate maps, establishing the calendar, serving in the bureau of astronomy and even curing the emperor of malaria with cinchona bark newly procured from members of their order in South America. A shadow came over these friendly relations with the church when papal and imperial authority clashed over the Chinese name for God and the acceptability of Chinese rites (the so-called rites controversy). With the Chinese literati the emperor was always the patron, promoting compilations of books dealing with painting, literary expression, poetry and finally the whole field of knowledge—an encyclopaedia actually published a few years after K'ang-hsi's death. A dictionary named after his reign, the *K'ang-hsi tzu-tien,* is still standard in its field. Scholarship independent of the throne also flourished, and at Ching-te-chen (Kingtehchen) was inaugurated another period of superb porcelain manufacture.

The reign of the following emperor, who came to the throne by questionable means, lacked in distinction, being occupied largely with keeping the Mongols and others in the west at bay or under control. His successor, however, known under the reign title of Ch'ien-lung (1736–96), continued in the tradition of his grandfather. The empire's boundaries were pushed to their farthest limit, to the Ili valley and Kashgar (1755 and 1759). Korea and Annam remained as vassal states. Tibet, Burma and Nepal were invaded severally (1751, 1765–69, 1792). In spite of these military successes abroad and an extended era of peace at home there were signs of growing dissatisfaction. The Pai-lien chiao (or White Lotus society) in Shantung (1774), the Muslims in Kansu (1780s), the native population in Formosa (1786–87) and the Miao tribes in Kweichow (1795–97) all broke out in rebellions, which were put down often ruthlessly. An accumulated reserve in the national treasury, amounting to over 70,000,000 taels as of 1781, was dissipated by the end of the reign. The emperor, who besides his skill in administration was genuinely interested in learning and scholarship and eager to leave behind him a monumental literary compilation that would outshine all others, ordered to that end the dispatch to the capital of all rare books in public and private possession (1772–81). This action brought to light over 2,600 works critical of his dynasty and of its predecessors from the north. Such criticism he found intolerable. Over 2,300 were listed for total suppression, and the rest for partial deletion of a few lines or paragraphs. A number of scholars suffered the extreme penalty; the rest limited themselves to works of textual criticism, local histories, commentaries on the Confucian canon and on the earlier histories. The imperial compilation when completed (seven copies in manuscript only) was nonetheless an important as well as gigantic work, its catalogue *raisonné* (which did appear in print) being a necessary tool for every scholar. The emperor, when well along in age, allowed one corrupt guardsman, Ho-shen, to win his confidence and corrupt the civil service. Not until after the emperor's death in 1799 was Ho-shen put down and his vast and illegally derived fortune confiscated.

E. 19TH CENTURY AND REVOLUTION

The dynasty from this point on deteriorated swiftly. Revolts broke out in the years 1796–1804 and again in 1813. The trade in Indian opium, the sale of which was forbidden in 1729 and importation in 1800, grew alarmingly after 1820, with both foreign and Chinese connivance. By this time French, Dutch, British and U.S. ships were to be found in Macao harbour and carrying their goods up the Hsi Chiang to Canton, where the supercargoes would buy tea, silk and cotton goods in exchange for specie and opium. The purchase of the latter meant an unfavourable trade balance.

Foreign tradesmen, eager only to buy and sell on their own terms and turn a quick profit, were irked by various restrictions—the necessity of dealing solely with an officially designated group of merchants (the Co-hong; *q.v.*), the absence of fixed tariff charges, the exactions of venal officials, the unwillingness of the Manchus to permit official intercourse on the basis of equality, the prohibition against a Chinese teaching a foreigner the language, the subjection of the foreigner to Chinese laws and courts. The Russians received slightly better treatment than did the other foreigners, perhaps because they had long had contact with the peoples of Asia and the Manchus and Chinese understood better how to deal with them. Their second treaty with the Manchus (that of Kyakhta, 1727) provided for trade, diplomatic intercourse and the extradition of criminals. The western Europeans wanted even more favourable terms. Portuguese, Dutch and British embassies traveled to Peking (notably those of the British in 1793 and 1816, led respectively by Lord Macartney and Lord Amherst), but to no avail. The Chinese, and in turn the Manchus, had never been accustomed to dealing with other governments on the basis of equality and regarded all foreign envoys as bearers of tribute.

1. First War With Great Britain and First Group of Foreign Treaties (1839–44).—Such a condition of affairs could not endure. The industrial revolution had inaugurated a period of renewed expansion of the west, and it desired admission to China to market the products of its factories and to obtain raw materials. This was also the period of the important clipper ship trade between the United States and China.

Pressure first came from Great Britain. On demand from British merchants, the monopoly of the China trade by the English East India company was abolished (1834), and friction between the English and Chinese increased. Lord Napier was appointed the first "superintendent" of British trade in Canton (1834), but Chinese officials looked upon him as merely a head merchant and refused to deal with him as an equal. Lord Napier died while still in this anomalous position, and his successors were unable to effect any improvement in the situation. Armed conflict was all but inevitable. British merchants were insisting upon more privileges than the Chinese were willing to concede, and British and Chinese ideas of international intercourse were fundamentally at variance—the one government being accustomed to a family of equal nations, the other knowing only an empire and subject peoples. Conceptions of law differed, the Chinese, with their emphasis on group responsibility, holding the entire British community liable for the misdemeanour of any of its members and the British contending that upon the individual and not the community should be placed the responsibility for misdeeds.

The conflict reached its climax over the question of the importation of opium. This had long been prohibited by the Manchu government, but foreign merchants brought it in ever-increasing quantities and corrupt Chinese and Manchu officials connived in the trade. After many futile attempts at enforcement, Peking at last took vigorous action and dispatched a special commissioner, Lin Tse-hsü, to stamp out the trade. Lin arrived at Canton in 1839 and promptly set about his task. Foreign merchants were compelled to surrender their stocks of opium for destruction, and pressure was put upon them to give bond not to engage further in the importation of the drug. The British objected to what seemed to them highhanded measures, and in Nov. 1839 hostilities broke out. The Chinese were repeatedly defeated. The war dragged out until 1842, however, for the British contented themselves largely with attacks on centres south of the Yangtze, and their victories alternated with unsuccessful attempts at negotiation. Finally, when Chen-chiang—at the intersection of the Yangtze and the Grand canal—was taken and Peking's communications with the south were threatened, the imperial authorities were frightened into concessions, and on Aug. 29, 1842, the treaty of Nanking was signed.

This document provided for the cession of the island of Hong Kong to Great Britain, for the opening to foreign residence and commerce of five ports (Canton, Amoy, Foochow, Ningpo and Shanghai), for liberty to appoint consuls at each port, for communication between British and Chinese officials of the same rank on the basis of equality, for an indemnity to the British, for the abolition of the Co-hong and for a "fair and regular tariff." In 1843 regulations for trade were agreed upon and published, and a supplementary treaty was signed that fixed the tariff rates, assured to the British most-favoured-nation treatment and contained the beginnings of extraterritoriality.

Other western nations took advantage of China's defeat. The U.S. sent a commissioner, Caleb Cushing, who negotiated a treaty that conceded, in general, the same commercial privileges to Americans which had been granted to the British and that, among other things, removed U.S. citizens engaged in the opium traffic from the protection of their government, elaborated extraterritoriality and provided for the revision of the treaty at the end of 12 years. In 1844 the French obtained a treaty that had much the same provisions for trade and official intercourse as were guaranteed by the British and U.S. documents. At the instance of the French, imperial edicts were issued providing for the toleration of Catholic Christianity and for the restoration of the church property that had been sequestered in the persecutions of the previous century. In the next few years the Belgians and the Swedes were also given treaties.

2. Second Foreign War and Second Group of Treaties (1856–60).—The years between 1842 and 1846 were in effect a period of troubled truce. The treaties of 1842 and 1844 were satisfactory neither to foreigners nor to Chinese. From the standpoint of the foreigner they did not grant enough. No provision was made for travel in the interior, for residence in places other than the five open ports or for direct diplomatic intercourse through representatives resident in Peking. The Chinese, on the other hand, believed that the treaties conceded too much, and, since they had been extracted by force, the authorities were not disposed to abide by them any more than they were compelled to do. The Chinese were no further inclined than formerly to treat western "barbarians" as equals. Clashes were frequent. Moreover, the British treaties said nothing about opium, and the traffic in the drug continued, a constant source of friction.

While the Americans, the British and the French were demanding that revision of the treaties which had been promised in the documents of 1844, war between the British and the Chinese broke out over a comparatively minor incident—as is often the case in times of international tension—the violation by the Chinese of a British flag and the arrest of the crew, all Chinese, on a Chinese-owned but British-registered craft, the lorcha "Arrow" (Oct. 8, 1856). The French, then closely associated with the British through the Crimean War, found in the judicial murder of a Roman Catholic missionary in Kwangsi (Feb. 29, 1856) an occasion for joining in the conflict.

The two powers did not at first press the war, for they were just emerging from the struggle in the Crimea; also, difficulties with Persia in 1856–57, and the Indian mutiny, which blazed out in 1857, engrossed the attention of the British. Late in 1857, however, the British and French took Canton, and in the following year their squadrons went north to Tientsin, thence to threaten Peking into submission. The Taku forts, commanding the entrance to Tientsin, were captured, and to save the capital the Chinese granted the desired treaties. The Russian and U.S. representatives, although not in the war, were on hand to profit by the French and British successes and also obtained treaties. The Russians obtained all the Chinese territory north of the Amur.

The treaties of Tientsin (1858) in general contained the following provisions: (1) the tariff was modified, and by the fixing of a rate for opium the importation of that drug was legalized; (2) the residence in Peking of diplomatic representatives of the powers was promised; (3) foreigners were to be permitted to travel in the interior; (4) the activities of Christian missionaries were sanctioned, and Christians, both foreign and Chinese, were guaranteed freedom in the practice of their faith; (5) foreign merchant vessels were allowed on the Yangtze; (6) several additional ports were opened to foreign residence and trade, including Chefoo and Ying-k'ou in the north, one on Hainan, two on Formosa and four on the Yangtze; (7) extraterritoriality was further elaborated; (8) regulations for trade, including the collection of customs, were developed; and (9) indemnities were promised.

When, in 1859, the envoys came to complete the ratification of the treaties and to take up their residence in Peking, they found the road by Tientsin blocked. The Chinese, moreover, proposed the reconsideration of the treaties. The British and French attempted to force their way past the Taku forts and were repulsed. The two powers accordingly renewed the war and in 1860 fought their way through Tientsin to Peking. Peking was captured, the emperor fled to Ch'eng-te, and the British, in retaliation for the violation of a flag of truce and the death of some of its bearers, set fire to such of the summer palace as had escaped marauding Chinese troops. Both French and British joined in looting it. The Chinese were now constrained to sign conventions by which they agreed to observe the treaties of 1858, to pay an additional indemnity, to open Tientsin to trade and to permit—more definitely than agreed upon in 1858—the permanent residence of foreign ministers in Peking. The British were ceded the Kowloon promontory opposite Hong Kong, and through the French was obtained treaty sanction for what had been promised earlier, the restoration of confiscated Catholic Church property. In the Chinese, although not in the official (French), text of the French convention was also permission for French missionaries to lease or buy land and build houses in the interior. The Russians, still fishing in troubled waters, obtained a modification of their frontier by which the territory east of the Ussuri was awarded to them. This territory had a long stretch of coast that included the site of Vladivostok.

The treaties of 1842–44 and 1858–60 defined the legal basis on which intercourse between the occident and China was to be conducted. They were later modified in details, but until 1943 in their main outlines they were the basis of the legal status of foreigners in China.

While at the time they seemed to solve a troublesome situation, they weakened Chinese sovereignty and threatened the existence of the state—partly by removing foreigners from Chinese jurisdiction, partly by their regulation of the tariff and partly by making Christian communities *imperia in imperio*.

3. T'ai P'ing Rebellion and Other Revolts.—The Manchu government was confronted by serious internal problems in addition to the problem of occidentals. By 1800 the population was twice as large as it had been at the beginning of the Ch'ing. Agriculture, industry and commerce had not been able to expand with equal rapidity. There were frequent revolutionary outbreaks following the attempt by the followers of one secret society to seize Peking in 1813.

In south China, particularly in Kwangtung, a number of additional factors stimulated disorder. The Hakka, an ethnic group which had migrated centuries before from north China and settled in Kwangtung and Kwangsi, were in frequent conflict with the longer-established local population, and when economic troubles grew these conflicts increased. Secret societies with an anti-Manchu purpose were strong in south China. The illegal opium trade, carried on by smugglers, encouraged gangsterism and piracy, which became linked with the underground secret societies. After about 1820 opium was beginning to drain silver from China, which disturbed the economy, particularly that of Kwangtung. The first Anglo-Chinese war was a blow to the prestige of the Manchu dynasty. It also broke the government's naval power and weakened its ability to maintain order in Kwangtung against the league of pirates, gangsters and secret societies. During the 1840s in Kwangtung and Kwangsi the people suffered severe famines. Banditry increased; disorder was spreading. Conditions—both general and specific—made an uprising almost inevitable. The outcome was the T'ai P'ing rebellion, one of several that shook the imperial structure to its foundations.

During the T'ai P'ing rebellion the imperial government, in desperate straits for revenue, resorted to likin (internal transit taxes on commerce) and, the crisis once past, continued it. During the rebellion, too, as a convenience for the imperial authorities, was begun the system of collecting the maritime customs through the agency of foreigners. This expedient was first adopted in Shanghai but proved so acceptable to both Chinese and foreigners that it was extended to other ports. The imperial maritime customs service so developed was placed in 1863 under the direction of Robert Hart, and through his genius was officered by an able foreign staff and became not only a dependable source of revenue but an agency for the charting and lighting of the coasts and the inauguration of a postal system.

Other rebellions threatened the power of the Manchus, especially in Shensi, Kansu and Sinkiang, but these were all suppressed. The Manchu dynasty, indeed, for the moment took on a new lease of life. Able Chinese came to its support. The empress dowager, Tz'u-hsi, who had had the good fortune to bear the heir of Hsien-feng, ruled as coregent during the minority of her son, the emperor T'ung-chih—and was dominant not only during his boyhood but after her nominal retirement (1889). Unscrupulous but vigorous, she probably prolonged the life of the dynasty.

4. Increasing Foreign Pressure (1860–94).—The years between 1860 and 1894 were marked by no major crises in China's foreign relations, and Chinese life and culture went on nearly unaltered by the presence of the westerner. Pressure was steadily accumulating, however, occasional minor clashes occurred, and the stage was being set for revolutionary changes.

From time to time new ports were opened, and through these and those previously available foreign commerce was growing. As before 1860, the British continued to lead. In the treaty ports foreign colonies arose, and in some of them special districts were set aside, usually either as "concessions" or "settlements" (some of them dated from before 1860), which, as a development of extraterritoriality, were under the administration of the foreigners, through the consuls, and some of them with a council elected by the foreign taxpayers.

Christian missionaries, both Roman Catholic and Protestant, rapidly increased in number. The first Protestant missionary, Robert Morrison, of the London Missionary society, arrived in 1807, and under the impulse of the vigorous new life of Protestantism in Europe and the United States during the ensuing century representatives of many societies followed—British, American and European. Protestant missionaries emphasized the translation and distribution of the Scriptures and of religious and secular literature, preaching, schools, medical relief and the formation of churches. They were largely responsible for China's first contacts with western education and medical science.

Roman Catholics reinforced their missionary staffs, emphasizing the winning of converts and the care of children in orphanages. By 1890 Protestant Chinese numbered about 50,000 and Roman Catholic Chinese about 500,000.

The growing pressure of the west began slowly to take effect. Before 1895 no startling changes in the structure of Chinese life occurred, but here and there were indications that China would not remain as it had been. In the first place, it somewhat grudgingly began to enter into the diplomatic life of the world. In 1866 a Manchu was sent to Europe with Robert Hart to observe and report. In 1867 Anson Burlingame, who was retiring as United States minister in Peking, was asked to head a mission to present China's case to the governments of the west. Burlingame went first to the United States and there negotiated a treaty (1868) which among other things promised respect for the territorial integrity of China and freedom of immigration of Chinese labourers to the United States and reciprocal rights of residence and travel. From Great Britain and France the mission obtained assurances that pressure would not be applied inconsistent with the independence and safety of China. In 1870, after visiting several courts, and while in St. Petersburg, Burlingame died and his colleagues returned to China. The mission was much criticized, especially for Burlingame's optimistic speeches, but—with the exception of a much earlier one to Russia (1733)—it was China's first formal embassy to that west with which it must henceforth deal.

Before 1880 resident envoys had been appointed to most of the leading capitals of the world. In 1873 and again in the early 1890s the foreign envoys in Peking were given audience by the emperor, but always with a subtle suggestion that they were considered as coming from tributary states. Not until 1894 were they received on the basis of full equality.

In the 1870s the Chinese government sent several scores of youths to the United States to be educated, but in 1881 they were recalled. Two government schools were founded to train men for diplomatic service. By 1895 telegraph lines and a few miles of railway were built, and some attempts were made to reorganize China's naval and military forces and to construct coast defenses according to western models.

5. Chinese-Japanese War and Beginning of Rapid Change.—China could not hope long to remain semi-isolated. The occident was continuing to expand, Japan, at China's very doors, was rapidly adopting and adapting western culture, and China must sooner or later adjust itself to the new world.

The beginning of rapid change was brought by war with Japan. Korea had long been in an ill-defined position of vassalage to China, which Japan refused to recognize. The two nations came to blows over the dispatch of troops by both to put down an insurrection in Korea. War was declared Aug. 1, 1894, and China was quickly and overwhelmingly defeated. By March 1895 the Japanese had successfully invaded Shantung and Manchuria, had captured Wei-hai-wei and Port Arthur, fortified posts which commanded the sea approaches to Peking, and the Chinese sued for peace. By the resulting treaty (of Shimonoseki) China recognized the independence of Korea, ceded to Japan Formosa, the adjoining Pescadores Islands and the Liaotung peninsula (in Manchuria), agreed to pay an indemnity of 200,000,000 taels, opened four more ports to trade and promised a satisfactory treaty of commerce. Russia was not disposed to see Japan make gains which would threaten Russian ambitions in the far east, and, backed by its ally, France, and by Germany—which professed fear of the "yellow peril"—protested against the cession of the Liaotung territory. Japan had no other recourse but submission, and the retrocession to China was made in return for a face-saving increase in the indemnity. The war had demonstrated the utter failure of Chinese attempts at "self-strengthening" during the past three decades. Its "modern armies" had proved incapable of defending the country and its western-style navy had been destroyed (*see* also CHINESE-JAPANESE WAR).

The victory of Japan was the signal for a scramble among the powers for leases, concessions and special privileges. The weakness of the Manchu dynasty had been unmistakably disclosed and for a few years it looked as though the powers, driven by earth hunger and fear of one another, would partition it. Russian, French, British and German bankers angrily contested for shares in the loans through which China was to pay the Japanese indemnity. In 1895 Russia obtained permission to carry the Trans-Siberian railway directly across Manchuria instead of by the longer all-Russian route of the Amur and Ussuri. France secured a "rectification" of the frontier in the Mekong valley and railway and mining privileges in China. Great Britain, alarmed, demanded and received concessions on the Burmese frontier. Rumours were soon afloat (1896) of further grants to Russia in Manchuria and of a promise to that same power of a lease on Kiaochow bay (Chiao-chou Wan) in Shantung. Russia, too, extended its influence in Korea. In Nov. 1897 German forces seized Tsingtao, giving as an excuse the murder of German missionaries in Shantung, and the following March that port and land controlling Kiaochow bay were leased to Germany for 99 years, and railway and mining concessions in Shantung were assured. Russia made the German seizure of Tsingtao the signal for the occupation of Port Arthur and Dairen, and in March 1898 a portion of the Liaotung peninsula which included these two ports was leased to Russia for 25 years. Within a few weeks France was given a 99-year lease to Kuang-chou Wan in Kwangtung, and Great Britain acquired Wei-hai-wei "for so long a period as Port Arthur shall remain in the occupation of Russia." Great Britain also acquired a 99-year lease on an additional portion of the Kowloon promontory, opposite Hong Kong.

Concurrently with the seizure of these leaseholds, the powers delimited "spheres of interest," by which they meant by implication, prior rights to provide capital for the development of mines and railways, and the promise of nonalienation of territory to another power. In case China should be partitioned, spheres of interest might become formal annexations. In 1897 France secured from China a "declaration of nonalienation" of Hainan to any third power. In 1898 Great Britain obtained a similar declaration for the provinces adjoining the Yangtze, France for the provinces bordering on Tongking and Japan a promise that none of Fukien would be alienated to any power whatsoever. Germany laid claim to Shantung as its sphere and Russia the territory north of the Great Wall. In 1899 Russia and Great Britain agreed not to interfere in each other's preserves. Great Britain, too, exacted from China a promise that the inspector-general of the maritime customs should be of British nationality, at least so long as the trade of Great Britain exceeded that of any other country.

Still another form of the struggle over the country was the competition for the privilege of providing capital for railways. The details of the story are extremely complicated, but in general the results were that Russia acquired a monopoly on railway building in Manchuria; Belgian financiers—behind whom France and Russia were suspected to stand—provided the money for the road from Peking to Hankow; Germans furnished the capital for lines in Shantung and for the northern section of the road from Tientsin to P'u-k'ou (on the Yangtze, opposite Nanking), Britons for the southern half of the road and the line from Shanghai to Nanking, and France was granted concessions for railways in its sphere of interest—Kwangtung, Kwangsi and Yünnan. A U.S. syndicate was given the concession for a road from Hankow to Canton, but the Belgians later acquired a controlling interest in the company and the Chinese, irritated, bought back the grant. The French got from the Russo-Chinese bank the contract for a road connecting T'ai-yüan with the Peking-Hankow line, and a Franco-Belgian syndicate the contract for a line from K'ai-feng to Lo-yang. Mining concessions also were obtained by various foreign groups.

6. Attempts to Prevent Disruption.—To prevent the threatened disruption of China three major and widely different efforts were made. One was by the United States. In the autumn of 1899, John Hay, the U.S. secretary of state, asked from England, France, Russia, Germany, Japan and Italy assurances that within their respective spheres of interest they would not interfere with any treaty port or vested interest, that no preferential harbour dues or railway charges would be given their subjects and that the Chinese government should collect the customs duties and only according to the Chinese tariffs. This "open-door policy" was not, strictly speaking, new but was founded upon the most-favoured-nation clauses. Nor was it entirely disinterested. The United States held aloof, to be sure, from the scramble for leases and concessions, but this was partly because the United States was too engrossed in developing the virgin resources of its own land to engage in ventures abroad. On its acquisition of Hawaii and the Philippines, however, the United States had awakened to a livelier interest in eastern Asia, and did not wish doors to be slammed in the faces of its merchants and bankers. All the powers assented to the U.S. note, although Russia did so with slight reservations.

The other major efforts to save China were by the Chinese themselves. After the war with Japan clubs sprang up advocating "reform"—organization on the occidental pattern. That, so the members urged, had been the secret of Japan's victory. The great viceroy Chang Chih-tung came out with a widely read pamphlet, *Learn*, urging reform, although without the abandonment of the best of China's heritage. Some of the extremists, notably the brilliant but erratic K'ang Yu-wei and his disciple Liang Ch'i-ch'ao, a master of Chinese style, obtained the ear of the emperor, and for a little more than three months in the summer of 1898 edict after edict poured forth from Peking ordering some of the changes which the radicals desired. Compared with what was to happen in the next 25 years, these were moderate enough, but at the time they seemed revolutionary.

The civil service examinations were to be reformed; new schools with western as well as Chinese subjects were to be founded; western military methods and equipment were to be introduced and steps taken looking toward a national army based on conscription; reforms in the courts of law were projected; a government bureau to translate foreign works and a ministry of arts, commerce and agriculture were to be established; patent and copyright laws were to be introduced and rewards offered to authors and inventors; annual budgets of receipts and expenditure were sanctioned; and many sinecure offices were abolished.

Skilled statesmen might have succeeded in carrying through these reforms without provoking a major crisis, but the young emperor knew little of the world of men outside his palace walls, and his radical advisers had little or no experience in government. The inevitable storm, therefore, was intensified, and in Sept. 1898 the empress dowager suddenly intervened and inaugurated a third effort to save China—by a return to the conservative *status quo*. The *coup d'état* was precipitated by the emperor's plan to thwart the reactionaries by placing restrictions on the empress dowager and executing her most loyal henchman, Jung-lu. Information seems to have come to Jung-lu through Yüan Shih-k'ai, and Tz'u-hsi acted promptly. On Sept. 22, 1898, she reassumed the reins of government. She kept the emperor a virtual prisoner and but for the powers might have had him assassinated. As many reformers as could be apprehended were executed, and most of the reform decrees were annulled. Tz'u-hsi attempted to restore the government as it had been and to strengthen it to resist foreign encroachments.

7. Boxer Uprising (1900).—On the heels of the conservative reaction, and in part as a consequence of it, came a blind attempt, largely popular but sanctioned by the extremists, to oust the foreigner once and for all. In 1898 and 1899 unrest was widespread, induced partly by the talk of reform, partly by the aggressions of the powers and partly by the vigorous reaction led by the empress dowager. The government, in an attempt to provide for the national defense against foreign aggression, ordered the revival of the village trainbands or militia and put the plan into effect first in the northeastern provinces. Into these trainbands came many of the local rowdies, and here and there disorderly secret societies affiliated with them. The members practised rites which they believed would make them invulnerable to bullets and came to be known to foreigners as "Boxers"—a loose translation of the Chinese name for the bands, I Ho T'uan or I Ho Ch'üan, "Righteous Harmony Bands" or "Righteous Harmony Fists."

One of the favourite mottoes of the Boxers was "Protect the country, destroy the foreigner." By the autumn of 1899 the Boxers were beginning to persecute Chinese Christians—as "secondary foreign devils"—especially in Shantung, where the antiforeign Yü Hsien was governor. The powers, alarmed, brought pressure, and, while they obtained the recall of Yü Hsien, he was soon appointed to the governorship of Shansi and unrest increased. An English missionary was murdered the last day of 1899, and by the following June the attacks on Chinese Christians became more frequent and foreigners were in grave danger.

In early June 1900 an unsuccessful attempt of the powers to throw additional troops into Peking aggravated the situation, and when, on June 17, foreigners seized the Taku forts to open the way to Tientsin and Peking, the storm broke. Against the counsel of saner heads, the empress dowager ordered all foreigners to be killed. The German minister was murdered, and the other foreign ministers and their staffs, missionaries and hundreds of Chinese Christians were besieged in the legation quarter and in the Catholic cathedral in Peking. Scores of Roman Catholic and Protestant missionaries and thousands of Chinese Christians were done to death, principally in Hopeh, Shansi and Manchuria. The powers declared that they were not waging war on China but were simply seeking to rescue their nationals and to suppress the Boxers. The viceroys in the Yangtze valley and the south opposed Boxerism and accordingly remained neutral and endeavoured to repress antiforeign outbreaks within their jurisdiction. That attitude was taken also by high officials in most of the west and north. The disorders, therefore, were confined chiefly to the northeast. An international force captured Peking on Aug. 14, 1900, the court fled to Sian, and the foreign troops proceeded to loot the capital and then to relieve scattered groups of missionaries and Christians who had been standing siege and to disperse the Boxer remnants.

Although the powers had not declared war on China, they deemed a formal settlement necessary to exact reparation and to guard against a recurrence of the outbreak. After negotiations, which were prolonged by disagreements among the victors, in Sept. 1901 a protocol was finally signed.

This document provided for the punishment, by China, of some of the officials held chiefly responsible; for memorial monuments for some of the murdered foreigners; for formal missions of apology to Berlin for the death of the German minister; for the suspension for five years of civil service examinations in towns where foreigners had been killed or mishandled; for the prohibition for at least two years of the importation of arms and ammunition; for an indemnity of 450,000,000 taels, to be paid in 39 years and to be secured by the revenues of the imperial maritime customs; for the fortification and policing by foreigners of the legation quarter, the razing of the Taku forts and the maintenance by foreign troops of communication between Peking and the sea; for edicts against antiforeign agitation; for the amendment of the existing commercial treaties; and for transforming the foreign office (Tsungli Yamen) into the chief of the ministries of state, under the name of the Wai Wu Pu.

8. To the Overthrow of the Manchus (1900–11).—The Boxer year inaugurated momentous changes. The empire was clearly at the mercy of the powers, and foreigners acted as though they were living in a conquered country. With the exception of Manchuria, encroachments on Chinese sovereignty were less marked than in 1898 and 1899. The Russians continued their aggressions. The disorders of 1900 had spread to Manchuria, and thither Russia quickly dispatched large bodies of troops, ostensibly to protect its subjects and investments. The Russian forces ruthlessly suppressed all opposition and occupied much of the three provinces. Late in 1900 an agreement between China and Russia promised the latter extensive control in southern Manchuria and was modified only on protest from the other powers. Both Great Britain and Japan were alarmed, the former because of its general fear of Russia in the east and the latter because of the threat to Korea, where Russian machinations were increasing. In defense against the common foe, the Anglo-Japanese alliance was formed (Jan. 30, 1902). Russia, subjected to pressure from these two powers and the United States, promised to respect the commercial rights of all nations, and agreed with China (1902) gradually to withdraw Russian troops from Manchuria. However, Russia found pretexts for delays and sought from China, in return for evacuation, compensations that would have strengthened its hold on the debated territory.

Great Britain, the United States and Japan sought to check Russia. Japan was especially concerned and strove by direct negotiations with St. Petersburg to obtain recognition of its interests in Korea and the promised evacuation of Russian troops from Manchuria. Russia was obdurate and Japan had recourse to arms (Feb. 1904). In the ensuing months the Japanese captured Port Arthur, drove the Russians out of southern Manchuria and destroyed the Russian fleets. In 1905 Pres. Theodore Roosevelt proffered his good offices, hostilities were suspended, and by the resulting treaty of Portsmouth (Sept. 5, 1905) Russia recognized Japan's interest in Korea; transferred to Japan Russian rights in the Liaotung peninsula; ceded to Japan the southern section of the Manchurian railway and the southern half of Sakhalin. Both powers agreed to withdraw their troops from Manchuria; to use the railways in Manchuria, except those in the Liaotung peninsula, only for economic and industrial and not for strategic purposes; and not to obstruct "measures common to all countries which China may take for the development of the commerce and industry of Manchuria."

The war merely substituted Japan for Russia in southern Manchuria, and the former was no more scrupulous in respecting China's rights than was the latter. Many Japanese contended, indeed, that having spent blood and treasure for Manchuria they had better rights there than the Chinese. By the annexation of Korea (1910) Japan moved its boundary to the southeastern edge of Manchuria and strengthened its interests in Kirin and Liaoning, the southern two of the three provinces.

The suppression of the Boxer outbreak by the powers and the subsequent war between Japan and Russia seriously weakened China. The governmental machinery, which had worked fairly well as long as China had not been in intimate touch with nations as powerful as itself, proved inadequate to meet the strain imposed by the coming of the occident. The Manchus would have to show unusual ability if they were to save their throne, and the Chinese if they were to avoid anarchy.

After 1900 and especially after 1905 both Chinese and Manchus set about the reorganization of the country. Even the most conservative could not fail to read the signs of the times, and the empress dowager, doubtless reluctantly and with many misgivings, attempted to direct the reform which she could no longer avert. In 1902 the court returned to Peking and the empress dowager set herself to win the friendship of the foreigners, addressing herself especially to the ladies of the legations.

Much more important was the sanction she gave to decrees that sought to aid and to regulate the introduction of western civilization.

In 1902 orders were issued to remodel public instruction by the creation of new schools and by the introduction of western subjects in the curriculum. In Sept. 1905 a decree was promulgated abolishing that most characteristic feature of the old educational system, the civil service examination. Partly as a result of these orders and partly in consequence of the general movement for reform, schools teaching Chinese and western subjects sprang up by the thousands. The old examination stalls were razed and on some of the sites rose buildings dedicated to the new learning. Many temples were converted for educational purposes. By the end of 1910 there were 35,198 government schools with 875,760 pupils. Protestant mission institutions, once the unpopular representatives of a new learning, were now thronged and new ones were opened. Thousands of students flocked to Japan, there to study in modern schools, and hundreds went to Europe and the United States. When in 1908 the United States announced its purpose to return a portion of its share of the Boxer indemnity, the sums remitted were set aside for scholarships to enable Chinese to study in the United States. With the new schools came a flood of literature treating of western ideas, and publishing houses, notably the Commercial Press, arose to give it circulation.

With educational reform went efforts to put the country in a better state of defense. The foreign drilling of the northern army continued; throughout the country troops were trained in the new ways, greater honours were paid to military officers, and in 1906 steps were taken toward the creation of a national force as contrasted with the older provincial forces.

In 1910 slavery was abolished, but since that institution was never so prominent in China as in parts of the occident the step did not entail marked revolution. Vigorous efforts were made to stamp out the opium trade, an imperial edict of Sept. 1906 inaugurating the campaign. The British government, under whose protection much of the foreign trade in the drug was carried on, in 1907 agreed to reduce the importation concurrently with the progressive abolishment of the domestic growth of the poppy, at a rate which would extinguish the trade in ten years. The restriction on poppy growing proved so much more rapid than was anticipated that in 1911 Great Britain agreed to the complete exclusion of the foreign drug from the provinces where the culture had ceased.

Governmental reorganization also was undertaken. In 1902 a commission on juridical reform was established and in 1905 reported, recommending the modification of the laws. As a beginning, torture, except in criminal cases, and certain cruel forms of punishment were ordered to be abolished. The reorganization of laws and judiciary was not sufficiently thoroughgoing, however, to cause the powers to dispense with extraterritoriality. The reform of the currency was discussed, but nothing effective was accomplished, and with the appearance of new coins the previous confusion became worse confounded.

Most important of all the governmental reforms was the attempt to introduce a constitution with representative assemblies. In 1905 a commission was sent abroad to study constitutional methods, and on its return in 1906 a promise was made to introduce a parliamentary form of government. That same year, as a preliminary, changes were made in the organization of the central administrative boards in Peking.

In Aug. 1908 an edict promised the convocation of parliament in nine years, but the death of the emperor and of the empress dowager in November of that year brought postponement. The new emperor, P'u-i, a nephew of the childless Kuang-hsü, was an infant of two and one-half years, and his father, Prince Ch'un, was appointed regent. The new reign was given the title of Hsüan-t'ung. Shortly after its beginning the regency was deprived of the support of one of the strongest Chinese by the forcible retirement of Yüan Shih-k'ai, as a punishment, so rumour had it, for his alleged betrayal of the regent's brother, the late emperor, in 1898.

Constitutional reform was delayed only by the change in rulers, and that briefly. In 1909 provincial assemblies met, chosen by a limited electorate, and in Oct. 1910 the national assembly convened, half of it elected and half appointed by the throne. The national assembly demanded the right to legislate, but for the time could gain merely the promise of the convocation of a parliament with legislative powers in 1913 rather than in 1917.

Along with changes in education and government went other sweeping alterations in the nation's life. Several of the railways authorized before 1900 were constructed, bringing great modifications in transportation. Foreign shipping increased on the coastal waters and the Yangtze, telegraph lines were extended, and the business of the post office multiplied. Foreign commerce more than doubled in the decade after 1901, and foreign merchandise penetrated to the remotest hamlets. The numbers of missionaries rapidly increased, and both the Catholic and Protestant communities showed a phenomenal growth.

After 1900 a more radical movement looking toward overthrow of the Manchu dynasty began to gain strength among Chinese abroad and to penetrate secretly into the empire. Revolutionary leaders found recruits among the thousands of Chinese students studying in Japan. On their return to China many of these students secured positions of influence in education, journalism and the army. Magazines preaching revolution as well as those urging reform were printed in Japan and smuggled into China.

Merchants overseas contributed funds. Anti-Manchu secret societies in south and west China were rejuvenated. Several short-lived uprisings occurred. Sun Yat-sen and Huang Hsing were but two of many revolutionary leaders.

9. End of the Ch'ing.—In 1912 the rising tide of change swept aside the Manchus. Ever since the conquest in the 17th century most of the Manchus had lived in comparative idleness, supposedly a standing army of occupation, but in reality inefficient pensionaries. All through the 19th century the dynasty had been declining, and in the death of the empress dowager it lost its last able leader. In 1911 the emperor was an infant and the regency utterly incompetent to guide the nation through the stormy waters ahead. The unsuccessful contests with foreign powers had shaken not only the dynasty but the entire machinery of government. The ferment of new ideas was already weakening the ancient wineskins, and only strong and wise leadership could prevent loss to both. Under the circumstances almost any incident might have toppled the Manchus off the throne.

The chain of events immediately leading to the revolution began with the signing (April 5, 1911), with a four-power group of foreign bankers, of the Hukwang railway loan agreement for the construction of roads in central China. The Peking government decided to take over from a local company a line in Szechwan, on which construction had been barely begun, and to apply part of the loan to its completion. The sum offered did not meet the demands of the stockholders, and in Sept. 1911 the dissatisfaction boiled over into open revolt. On Oct. 10, in consequence of the uncovering of a plot in Hankow which had little or no connection with the Szechwan episode, a mutiny broke out among the troops in Wu-ch'ang, and this is regarded as the formal beginning of the revolution. The mutineers soon captured the Wu-ch'ang mint and the arsenal at Wu-ch'ang, and city after city declared against the Manchus. The regent, panic-stricken, granted the assembly's demand for the immediate adoption of a constitution, and urged Yüan Shih-k'ai to come out of retirement and save the dynasty. Yüan, after much hesitation, accepted on his own terms, and at the end of October took the field at the head of the northern armies. In November he was made premier.

Had Yüan acted vigorously he might have suppressed the uprising and so have delayed the inevitable. He dallied, however, and by the end of the year 14 provinces had declared against the Manchus, in several cities Manchu garrisons had been massacred, the regent had been forced out of office, a provisional republican government had been set up at Nanking, and the archrevolutionist Sun Yat-sen had returned from abroad and had been elected president.

In December Yüan agreed to an armistice and entered upon negotiations with the republicans. On Feb. 12, 1912, the boy emperor was made to abdicate the throne in a proclamation that transferred the government to the people's representatives, declared that the constitution should thenceforth be republican and gave Yüan Shih-k'ai full powers to organize a provisional government. The Nanking authorities agreed that the emperor was to retain his title for life and to receive a large pension. To unify the country, Sun Yat-sen resigned the presidency and Yüan was chosen in his place. Li Yüan-hung, who had come into prominence in Wu-ch'ang in the initial stages of the rebellion, was elected vice-president. A provisional constitution was promulgated in March 1912 by the Nanking parliament, and in April the government was transferred to Peking.

See also CH'ING.

F. THE REPUBLIC

The republic, established with such startling rapidity and comparative ease, was destined to witness the progressive collapse of national unity and orderly government. The causes for this chaos were, in the main, three. In the first place, traditional processes were being repeated. The demise of every dynasty had been followed by civil strife, in which rival military chieftains struggled for the throne. The disorder usually lasted for decades, and once, after the downfall of the Han dynasty, was prolonged for nearly four centuries.

The peaceful transfer of power to Yüan Shih-k'ai under the guise of a republic for a time mitigated the struggle and even seemed to have averted it. Yüan, however, did not prove strong enough to hold the country together. The country was broken up into ever-smaller fragments, most of them ruled by military chieftains. After Yüan's death (1916) the political map was seldom the same two years in succession.

In the second place, the chaos was accentuated by new ideas from the west. The governmental machinery which on the whole had worked better over a longer period than any other ever devised for so numerous a people was being abandoned. It was ill-adapted to the new conditions, and theoretical radicals, imbued with occidental ideas, and militarists tended to ignore it or to modify it more greatly than at any time since the Han. Such thoroughgoing political experimentation meant chaos, and new institutions were not quickly evolved for so enormous a section of mankind.

In the third place, the disorder was increased by the interference of foreigners. Japan was vitally concerned in the fate of its huge neighbour. The Japanese population was steadily increasing, no adequate relief could be had through emigration, and Japan's only recourse was to add to its income by engaging in industry and commerce. If it were to do this, it must have access to raw materials, including coal and iron, and to markets. For these it most naturally looked to the adjoining continent and especially to China. Japan's life depended, therefore, upon keeping open the trade with China, and it is not surprising that it sought to control portions of the republic and at times meddled in Chinese politics. To Japan were added other powers, especially the Soviet Union. Beginning about 1922, but especially after 1925, Russian Communists sought to extend their influence into China and to foment the kind of revolution that had been achieved at home.

It must be noted, however, that activities of foreigners helped to bring union as well as disunion. Resentment against the foreigner was the one issue on which the vocal elements of the nation could unite; railways and telegraph lines—both of foreign origin—helped to bind the country together, and the foreign-controlled customs service and the foreign-organized postal system were the only governmental agencies that continued to function over all the country.

1. Under Yüan Shih-k'ai.—For four years Yüan Shih-k'ai was able to delay the further disintegration of China. He faced no easy task. The radicals, who in Aug. 1912 took the party name of Kuomintang, regarded him with suspicion, and, obtaining a majority in the parliament that assembled in 1913 under the provisional constitution of 1912, demanded a type of government in which the legislature should be supreme and the president a figurehead. Rival military leaders were beginning to appear, and grave financial difficulties faced a government whose fiscal machinery, already decrepit, had been disturbed by the revolution. The confidence of the powers, moreover, was not yet given the new regime.

In the face of all these difficulties Yüan for a time achieved marked success and gradually restored in the provinces the authority of the central government. In April 1913, after prolonged negotiations, he concluded a "reorganization" loan with a financial group representing Great Britain, France, Russia, Germany and Japan. The loan, a large one, was secured by a lien on Chinese revenues, chiefly on the income from the salt monopoly—now put under foreign supervision. His financial position and the moral support of the powers thus assured, Yüan proceeded to defy the members of the Kuomintang. The latter had sought to block the loan and saw in its conclusion grave danger to themselves. They continued obstructionist policies, and, as Yüan still prevailed, in the summer of 1913 some of them, including Sun Yat-sen and Huang Hsing, declared a "punitive" expedition against him and for a while held Nanking. Yüan promptly put down the rebellion, and, after obtaining the ratification of the articles of the "permanent" constitution which had to do with choosing the president, and being elected under them (Oct. 1913), he outlawed the Kuomintang (Nov. 1913) and unseated its members of parliament. A few weeks later he disbanded what remained of parliament, replacing it with an administrative council selected by himself. In March 1914 the provincial assemblies were dissolved. A new constitution, framed by a body controlled by Yüan, was promulgated in May 1914. The president's power was greatly strengthened, his term was lengthened to ten years, and he might be rechosen by the council of state or control the election of his successor. In 1914 Yüan performed the imperial ceremonies in the Temple of Heaven at the winter solstice. He seemed to be winning against the opposition and in 1915 prepared to take the further step of having himself formally chosen and proclaimed emperor.

However, opposition developed both within China and among various foreign powers, particularly Japan, which was supported by its wartime allies Great Britain, France and Russia. A rebellion broke out in Yünnan and spread to other provinces of the south. The Kuomintang established a rival government at Canton. Opposition was so formidable that Yüan rescinded the monarchy in March 1916; on June 6 he died. (*See* also YÜAN SHIH-K'AI.)

With Yüan removed, the country appeared quickly to unite. Li Yüan-hung, unopposed, succeeded to the presidency; Tuan

Ch'i-jui, appointed by Yüan in the last few weeks of his life, continued as premier and brought to the support of the new government some of the northern military chiefs. The parliament of 1913, reassembling, brought back to Peking many of the Kuomintang. The government seemed to be further strengthened by the election to the vice-presidency of Feng Kuo-chang, dominant in the lower part of the Yangtze valley.

The very strength of the new government however, was its weakness, for it was made up of elements that were fundamentally discordant and that any crisis might set at loggerheads. This crisis was to grow out of international reactions in which China was inextricably involved.

2. Foreign Relations (1911–17).—The revolution did not immediately bring marked change in China's foreign relations. Tibet and Outer Mongolia, at best never very firmly attached to the empire, took the opportunity afforded by the shift in governments to effect their virtual independence, and Great Britain in the former case and Russia in the latter were not slow to attempt to extend their influence over territories that abutted so directly upon their own. China recognized the autonomy of Outer Mongolia in return for the acknowledgement of Chinese suzerainty, but it was less pliant in yielding to British ambitions in Tibet. On the whole, the powers made little objection to the establishment of the republic.

The outbreak of World War I, however, brought serious difficulties. With Europe absorbed in internecine strife, Japan saw a golden opportunity to extend its power in China. The Anglo-Japanese alliance afforded it a welcome excuse for seeking to eliminate Germany from the far east. Accordingly, in Aug. 1914 Japan dispatched an expedition to Shantung and, with the co-operation of a small British force, captured Tsingtao and the other German possessions in the province.

This was only a beginning. In Jan. 1915 Japan presented 21 demands that, if accepted, would strip China of its suzerain power and hand over to Japan railway, mining and other rights in Shantung, thus placing the Japanese in complete dominance. Japan attempted to keep the demands secret, but they became known and a wave of indignation swept over China; criticism also was expressed publicly and vigorously in Great Britain and the United States. The Japanese were constrained to make important concessions, but they had the upper hand; they presented an ultimatum to which China, helpless, had to submit. Early in 1917 Japan made secret arrangements with Great Britain, France and Italy whereby those powers assured their support of Japanese demands at the peace conference for the former German holdings in Shantung.

As World War I progressed, pressure was brought upon China to enter the struggle on the side of the Allies. In Feb. 1917 the United States invited the Chinese government to follow its example in protesting against Germany's submarine campaign and severing diplomatic relations, and the Franco-Japanese secret notes of March 1, 1917, promised Japanese support to the effort to induce China to take the step. On Feb. 9 the Chinese foreign office sent warning to Germany and on March 14 broke off diplomatic intercourse. The question whether China should actually declare war precipitated a contest among the principal contenders for control of the government. The step was taken on Aug. 14, 1917, when China formally declared war on Germany.

The country had already begun to disintegrate politically. The Kuomintang members of the dismissed parliament denounced the Peking government as illegal, and, under the leadership of Sun Yat-sen, in Sept. 1917 organized a provisional government, which they declared to be the only constitutional one in China. The powers did not grant it recognition, however, and it maintained a precarious existence, usually with headquarters at Canton. In the north Tuan Ch'i-jui and his supporters, the so-called Anfu group, were for several years in the ascendant.

3. World War I and the Peace Conference.—In the meantime World War I was drawing to a close. China's internal discord and financial straits were such that the country could take no active part in the struggle, although recruiting of about 175,000 Chinese citizens for labour battalions was permitted.

China gained slightly by its entry into the war. It took over the German and Austrian concessions in the ports, canceled the unpaid portions of the Boxer indemnities due its enemies and was permitted to suspend payments on the sums due to the Allies. China was assured a seat at the peace conference.

In contrast with these gains, however, was an increased control by Japan. In Nov. 1917 the United States, in an effort to adjust its difficulties with Japan, entered upon the Lansing-Ishii agreement (terminated March 30, 1923), by which it recognized that because of "territorial propinquity . . . Japan had special interests in China," and so seemed to have delivered China over to Japan. The Anfu clique around Tuan Ch'i-jui concluded agreements with Japan for the construction of railways in Shantung, Manchuria and Mongolia (Sept. 1918) and borrowed extensively from the Japanese on the security—some of it extremely dubious—of railways, mines, forests, telegraphs, taxes and bonds.

To the peace conference that terminated the war the Chinese sent an able delegation representing, by a strange but characteristic anomaly, both the Peking and the Canton governments. The delegation asked not only for the restoration to China of the former German properties in Shantung but also for the cancellation of spheres of influence; withdrawal of foreign troops, post offices and wireless and telegraphic communications; abolition of consular jurisdiction; tariff autonomy; relinquishment of leased territories; and restoration of foreign concessions and settlements. China was doomed to disappointment. The U.S. delegation favoured the restoration of the Shantung properties, but against it were the agreements of 1917 between Japan and the European Allies. By the treaty of Versailles, therefore, Japan was confirmed in the possession of its holdings in Shantung. The remaining questions were held not to come within the purview of the conference.

When news of the Versailles settlement reached China there was immediate widespread protest. On May 4, 1919, students in Peking began a demonstration against the pro-Japanese government. This patriotic movement spread rapidly to other cities and won the support of other groups in the population. The Peking government had to instruct the Paris delegation to refuse to sign the treaty with Germany. A very effective nationwide boycott against Japanese goods was also instituted by patriotic groups. This patriotic outburst, known as the May 4 movement, had wide ramifications. It developed under the leadership of western-trained professors and their university students into a broad movement for reform and rejuvenation of Chinese life in all aspects.

China was not to emerge from the war without some gains, however. It obtained membership in the League of Nations by signing the treaty with Austria, for that document did not contain the objectionable Shantung clauses, and in its separate treaty with Germany the German share of the Boxer indemnity and German extraterritorial privileges were canceled. A significant breach had been made in the wall of foreign "rights" in China.

4. Washington Conference (1921–22).—After the war the U.S. continued its active participation in Chinese affairs by bringing about (1920) a financial consortium whose purpose was to assume international control of all further foreign loans to China and so to prevent the granting of special privileges to individual nations.

In 1921 and 1922, moreover, the United States called the Washington conference, and China again had the opportunity to lay its case before the world and to ask for the elimination of the special privileges that foreigners enjoyed within its borders. Not all the agreements and treaties that resulted from the conference affected China, but the Chinese question loomed larger than any other except possibly that of disarmament. The most important actions, in so far as they concerned China, were as follows:

1. The treaty limiting naval armaments and fortifications confirmed Japan in the domination of the northeastern coast of Asia. No sea power could now hope easily to penetrate by force through the islands to the coast of China, as the United States and Great Britain found during World War II.
2. Nine powers agreed by treaty to respect the sovereignty, independence and territorial and administrative integrity of China, to give China opportunity to develop a stable government, to maintain the

principle of equal opportunity in China for the commerce and industry of all nations and to refrain from taking advantage of conditions in China to seek special privileges that would abridge the rights of subjects or citizens of friendly states.

3. The customs schedule of duties was within four months to be raised to an effective 5%, and provision was made for the convening of a special tariff conference and for the periodical readjustment of the customs tariff.

4. A board of reference was to be established in China to which questions connected with the enforcement of the "open door" and equal railway rates could be referred.

5. A resolution expressed the sympathy of the powers with China's desire to see removed "immediately or as soon as circumstances will permit existing limitations upon China's political, jurisdictional and administrative freedom," and provided for the early establishment of a commission to inquire into the practice of extraterritoriality in China and the progress in judicial reforms.

6. On Jan. 1, 1923, foreign postal agencies in China were to be abolished.

Several other resolutions expressed the good intentions of the powers toward China. (*See* also WASHINGTON, TREATIES OF; WASHINGTON CONFERENCE.)

The Washington conference also afforded Japan and China an opportunity to come to an understanding over the Shantung question. Following the signing of the treaty of Versailles, Japan had made attempts to adjust the dispute, but always on conditions that had been rejected by the Chinese. Now, however, Japan adopted a much more conciliatory attitude, and an agreement was reached whereby the former German holdings in Shantung were to be returned to China. However, the Japanese retained a share in some mines in the province and large commercial interests and landholdings in Tsingtao.

Several of the promises made to China at Washington were carried out. The foreign post offices were discontinued at the designated time. A special conference on the tariff convened in Peking in Oct. 1925 and, going beyond the assurances previously given, permitted the consideration of the entire question of tariff autonomy. Because of the disintegration of the Chinese government, the gathering broke up before a treaty was framed, but the foreign delegates agreed to the removal of tariff restrictions and consented to the putting into effect of the Chinese national tariff law on Jan. 1, 1929. The Chinese for their part promised to enforce the national tariff law and to abolish likin, long obnoxious to foreigners, on the same date.

Japan, moreover, continued conciliatory. While it declined to accede to the Chinese demand, made in 1923, for the abrogation of the agreements of 1915, until 1931 it entered upon no new marked aggression.

The powers also seemed about to remit the unpaid portions of the Boxer indemnity. The United States acted finally in May 1924, and Great Britain, France, Japan and the Soviet Union took preliminary steps looking toward the same end. All plans for remission, however, called for the allocation of the funds to educational or other cultural projects.

5. Domestic Politics.—While China was making progress toward regaining the special privileges that had been wrested from it by the powers, internally its government was rapidly disintegrating.

At the close of World War I Hsü Shih-ch'ang was in the presidency and Tuan Ch'i-jui was in control. A separate government was maintained at Canton, largely by members of the Kuomintang, under the leadership of Sun Yat-sen. For a time Sun was ousted from Canton by a Kwangsi faction, but he was restored and in April 1921 was elected "president of the Chinese republic" by such members of the parliament of 1913 as could be got together. However, Sun secured only a precarious foothold in Canton and a part of Kwangtung. Most of southern China was a medley of petty factions and quarreling war lords.

Conditions were little better in the north. In 1920 the outstanding leaders were Wu P'ei-fu, his titular superior Ts'ao K'un, and Chang Tso-lin, the master of wealthy Manchuria. In the summer of 1920 these three united to drive Tuan and the Anfu leaders out of power. Wu P'ei-fu and Chang Tso-lin could not long co-operate, and in 1922 Wu defeated the latter and drove him back into Manchuria.

Wu now took steps which he hoped would unify the country. Hsü Shih-ch'ang resigned the presidency, Li Yüan-hung was reinstated in that office, and the parliament of 1913 was recalled to Peking. Thus the last officers around whom the entire country had seemed to unite were reinstated.

Hopes for a unified China proved illusory. Funds were insufficient, cabinets unstable, parliament venal and militarists intransigent. The disintegration that had set in after the death of Yüan Shih-k'ai became complete. China was torn by rival military factions that year after year launched campaigns against each other, conscripted troops, levied burdensome taxes and disrupted the economy.

6. Nationalism and Communism.—During the early years after World War I two interrelated developments of great significance occurred: the rise of nationalism and the emergence of the Chinese Communist movement. The Communist party was founded by a group of intellectuals, some of them leaders in the May 4 movement, who had turned to Marxism for a possible solution to China's weakness and political instability. With the help of an adviser from the Comintern, the party was organized in July 1921, though there were then only a few score members. The party devoted itself at first to organizing labourers and publishing propaganda journals. In Moscow the Communist international at its second congress in July-Aug. 1920 had adopted a strategy with respect to colonial peoples that called in the first place for co-operation between Communists and other parties in movements for national liberation. Applied to China, this strategy was interpreted to require an entente between the Communist party and the Kuomintang. It took several years for Comintern agents to convince both parties of the desirability of this program. By the summer of 1923, however, the details had been worked out and the U.S.S.R. had promised help to Sun Yat-sen, who was attempting to establish a government in Canton.

In Sept. 1923 Mikhail M. Grusenberg, better known as Mikhail Borodin (*q.v.*), arrived in Canton and soon became Sun Yat-sen's adviser in a program of reorganizing the Kuomintang into a strong, disciplined and centralized party. Communists were to be admitted to the Kuomintang as individuals and to assist in an attempt to reunite the country and free it of foreign encroachments. Russian advisers, money and arms flowed into Canton to aid in the creation of a Nationalist army. After Sun's death on March 12, 1925, his party glorified him as a national hero and made his Three Principles of the People—nationalism, democracy and livelihood—a bible.

In the latter part of 1925 the Nationalist movement was directed sharply against Great Britain, the occasion being a sequence of clashes between British authorities and Chinese in Shanghai and Canton during which many Chinese were killed. Hong Kong was tied up for months by boycott and widespread strikes. Patriotic students flocked to the Kuomintang and many into the Communist party as well. Communist members of the Kuomintang were particularly active in the anti-imperialist movement and in organizing labourers and poor peasants to demand better economic conditions. The movement at Canton under the leadership of Borodin and some of Sun's more radical lieutenants veered increasingly to the left. In the meantime the new Nationalist army was consolidating the power of the Kuomintang in Kwangtung.

Not all leaders of the Nationalist party approved of the Communists, but some hoped to use them to achieve Nationalist aims. The Communists likewise hoped to use the Kuomintang. Great tension existed within the coalition.

In the summer of 1926 the Nationalist armies, led by Chiang Kai-shek, began a triumphant march northward, and by winter they had driven Wu P'ei-fu into Honan and practically eliminated him, were in possession of the Wu-han cities—Hankow, Wu-ch'ang and Han-yang—and the Kuomintang had moved its capital to Hankow.

The victories had been achieved as much by skilful propaganda as by force of arms. Wherever the Nationalist forces came, trained agitators directed popular sentiment against the treaties and foreign merchants and against Christian schools, churches and hospitals as imperialistic. Kuomintang agitators also organized labourers and peasants to make exorbitant demands of employers and landlords, and in some places, notably Hunan and Hupeh, a reign of terror followed in which many of the propertied class were dispossessed and even executed.

Educated Chinese, weary of the long civil strife and smarting over China's feeble position among the nations, hailed the advance of the Kuomintang, which continued with amazing rapidity. By March 1927 the Chinese had taken over the British concessions in Hankow and Chiu-chiang; British and U.S. merchants and missionaries were being evacuated from much of the Nationalist territory; Sun Ch'üan-fang, recently strongly entrenched in Chekiang and Kiangsu, was in full flight, his armies a disorganized rabble; and only strong forces of foreign marines kept the Nationalist armies out of the foreign settlements in Shanghai. The northern military chiefs, alarmed, had put themselves under the direction of Chang Tso-lin to stem, if possible, the oncoming flood.

The radicalism of the Communists during the northern expedition inevitably produced a reaction. Merchants, landlords, army officers and many other groups who found themselves menaced offered support to conservative leaders in the Kuomintang if they would rid the party of its radical wing. With victory in sight, tension between right and left grew sharper. Chiang Kai-shek became the centre of the anti-Communist movement. In March 1927 Nationalist troops, entering Nanking, looted foreign dwellings, robbed foreigners and killed several of them, until further loss of foreign lives was prevented by the fire of British and U.S. gunboats in the Yangtze river. One effect of this incident was to widen the breach within the Kuomintang.

In the Chinese section of Shanghai, labour unions under leadership of the left wing had risen in a general strike, disarmed police and driven out some of the northern troops. On April 12, shortly after the Nationalist army arrived in Shanghai, Chiang Kai-shek instituted a bloody purge to stamp out the Communists and leftist Kuomintang elements in the city. The purge quickly spread to other regions under control of conservative military commanders. Chiang then set up a government in Nanking as a rival to the one in Hankow. The irreconcilable cleft between Communists and Nationalists dates from this period.

The Nationalist advance was halted by these internal dissensions, and the party continued to divide. By autumn 1927 the anti-Communist reaction was under way, Borodin and other Soviet advisers were evicted from Hankow, and in many places Chinese Communists were being hunted down and executed.

In 1928 the Nationalists, reorganized under moderate and conservative leaders and with headquarters at Nanking, began a new northward advance. Chiang Kai-shek led, in co-operation with Feng Yü-hsiang and Yen Hsi-shan. A serious clash with Japanese troops occurred in May in Tsinan, and a partial reoccupation of Shantung by Japan followed. In spite of this, however, the Nationalists pushed on and in June entered Peking. Chang Tso-lin was killed by a bomb as he was retiring into Manchuria, and his son, Chang Hsüeh-liang, succeeded to the command of his forces. Because of Japanese opposition, Manchuria did not formally join the Nationalists, but Chang Hsüeh-liang was given a place on the chief council of the Nanking government. The major armed opposition to their rule having been eliminated, the Nationalists moved the capital from Peking (now renamed Peiping, "Northern Peace") to Nanking and in October set up an administration reorganized to conform to Sun Yat-sen's program, with Chiang Kai-shek as the ranking official.

7. Domestic Events (1928–37).—In domestic politics the years 1928–37 were stormy, but, on the whole, progress toward a more stable regime was made. Throughout the period the most prominent figure in the central government was Chiang Kai-shek. So vigorous a man inevitably had his enemies, but he retained his control of the army and accordingly continued the dominant leader. More serious was the recalcitrancy of the south and west. Only slowly, and then largely because of the necessity of presenting a common front against the Japanese, did Kwangtung, Kwangsi, Yünnan, Kweichow and Szechwan fall into line with Nanking.

The greatest domestic menace to Chiang Kai-shek and the Kuomintang was the Communist movement. After the purges of mid-1927 the Communist party turned to armed force to overthrow its rival. Only gradually was it able to create armed bands of peasants and deserting soldiers, seize control of inaccessible bits of territory and begin to create soviet districts. It appealed to tenant farmers, landless labourers and others upon whom the existing rural order bore most heavily. Terrorism was widespread, and persons of property were dealt with cruelly. In essence the movement depended on peasant revolt. By 1930 the Communist army had become a sizable force and Soviet regions covered large areas in Kiangsi, Fukien, Hunan and Hupeh.

The Nanking government launched five campaigns between Dec. 1930 and Oct. 1933 in an attempt to destroy the Communist army and capture the Soviet bases. Finally by Oct. 1934 the main Communist forces were driven out of their chief base in southern Kiangsi. They executed a long retreat, marching and fighting through most of the southern and western provinces of China, arriving in north Shensi one year later. In the meantime Japan had seized Manchuria and was seeking to detach north China (*see* below). The Communists skilfully employed the rising patriotic sentiment to blunt the Nationalist attacks against themselves, urging an end of civil war and a united front of all parties and armies against Japan. This program appealed especially to the Manchurian troops of Chang Hsüeh-liang who were being used to fight the Communists in north Shensi. When Chiang Kai-shek went late in 1936 to Sian to push the campaign, he was seized by Chang Hsüeh-liang, who demanded the end of the civil war against the Communists, a reorganization of the government with more toleration for the opposition and, above all, a united front against Japan.

Although Chiang Kai-shek was released without publicly acceding and Chang Hsüeh-liang was technically punished, in effect the dramatic incident was the precursor to the easing of the war against the Communists and to the eventual co-operation of the latter in the defense against Japan.

In many ways advances were being registered by the Nationalist government: officials of modern training were being introduced; education throughout the country was undergoing improvement at all levels; public health measures to cope with contagious disease were being widely adopted; one post-office administration, one customs service and one system of coinage extended throughout the country. Painfully and with occasional lapses China was advancing toward unification and a better and more stable government.

The improvement in internal order must not be exaggerated, however. Much of it depended precariously upon the life of one man, Chiang Kai-shek. Dissension among leaders had not been eliminated. Over several provinces even of China proper Nanking exercised no effective control. In the outlying dependencies, only in Sinkiang, in portions of Inner Mongolia and here and there on the borders of Tibet did Nanking exert even a shadow of power. The world-wide financial depression brought embarrassment, especially beginning in 1934 with a rise in the price of silver and, accordingly, a fall in other price levels. In the autumn of 1935 the government felt itself forced to nationalize all the silver and to go officially on a managed currency. Yet nearly every year witnessed some gains. Even those provinces that did not tolerate the interference of Nanking in their internal affairs usually permitted the Nationalist government to speak for them in relations with other nations.

For more than two years after 1928 China seemed to be making progress toward emancipation from the "unequal treaties." In 1929 the British returned to Chinese administration their concession in Chen-chiang and the next year their concession in Amoy. In 1929 Belgium consented to the cancellation of its concession in Tientsin. In 1928 and 1929 nearly all the western powers and in 1930 Japan formally assented to the resumption by China of its tariff autonomy. On Feb. 1, 1929, accordingly, the Chinese government put into effect a schedule of duties determined by itself. Moreover, effective Chinese control over the customs administration increased.

China also seemed to be making headway toward the abolition of extraterritoriality. Several of the smaller powers assented to the jurisdiction of Chinese laws and courts over their citizens. In July 1928 the Nanking government announced that all "unequal treaties . . . which have already expired shall *ipso facto* be abrogated" and that it would take immediate steps to end those "unequal treaties which have not yet expired and conclude new treaties." A number of the powers against which China adopted specific measures protested. Eventually several assented, but only on certain conditions. However, Great Britain, Japan, France and the United States, together with some of the smaller countries, held out. In Dec. 1929 Nanking announced that extraterritoriality would come to an end on Jan. 1, 1930, but postponed putting the order into effect pending suitable provision for the trial of cases involving foreigners. The needed regulations were framed and were announced to be operative on Jan. 1, 1932. Before that day arrived, however, events in Manchuria precluded carrying out the plan.

For several years after 1927 the relations of Nanking with Moscow were much of the time either strained or decidedly unfriendly. The Nanking government had been established in an anti-Communist reaction and could scarcely be expected to look upon the U.S.S.R. with cordiality. The joint operation by Russians and Chinese of the Chinese Eastern railway, in Manchuria, made for irritation. In 1929, indeed, the Chinese dismissed and arrested the Soviet officials associated with the railway. In Jan. 1930 a Russian invasion forced the Chinese to assent to the restoration to the Soviet Union of its former share in the control of the line. The U.S.S.R., moreover, had Outer Mongolia in its orbit and appeared to threaten the remnants of Chinese authority in Sinkiang. By the end of 1932, however, Russo-Chinese relations became much more friendly, especially since both nations found common cause in their apprehension of Japan.

8. Japanese Aggression.—It was from Japan, as has been suggested, that the greatest external menace arose to the territorial integrity and independence of China. Since the Washington conference the attitude of the Japanese government toward China had usually been one of moderation and restraint.

In Manchuria, however, a serious conflict was developing. There the Chinese were especially restive under the privileges held by the Japanese. Chinese formed the vast majority of the population, and the legal title of the region was held by China, yet Japan controlled much of south Manchuria through its railways and its leasehold on the Liaotung peninsula, and in other ways compromised Chinese sovereignty. The Chinese began building a series of railroads that would in part encircle the Japanese lines, debouch at Hulutao, a port which the Chinese were developing, and make them partially independent of the Japanese. Chang Hsüeh-liang, the ruler of Manchuria, was disposed more and more to ally himself with Nanking and to sympathize with the Kuomintang and its desire to rid China of foreign control. The Japanese, on the other hand, had large investments in Manchuria.

In the summer of 1931 the friction expressed itself in minor incidents. Those in control of the main body of Japanese forces in Manchuria believed that the time had passed for temporizing and compromise, and on the night of Sept. 18–19, 1931, alleging that Chinese had blown up part of the track of the South Manchuria railway near the city, seized Mukden.

In the next few weeks the Japanese occupied other cities in Manchuria and demolished Chang Hsüeh-liang's power north of the Great Wall. Having destroyed the only effective Chinese rule in Manchuria, the Japanese, compelled to preserve order to protect their own interests and not disposed to annex the region outright, stimulated native leaders, largely Chinese, to set up local governments. Early in 1932 these were organized, with Japanese direction, into a new state called Manchoukuo, which on Feb. 18, 1932, declared its independence and called to its head P'u-i, the last Manchu emperor of China. Later in the year Japan accorded Manchoukuo official recognition and entered into a defensive alliance with it.

Nanking, unable to offer effective armed resistance to Japan, presented its case to the League of Nations, which attempted to induce Japan to withdraw its troops to the zone of the South Manchuria railway, and in time appointed a commission, headed by Lord Lytton, to investigate. The commission's report, made in the autumn of 1932, in the main found Japan to be at fault and proposed a procedure for settling the dispute that would preserve China's sovereignty. On Feb. 24, 1933, the assembly of the League took action against Japan, recommending a method of effecting an adjustment that Japan would not accept. Soon thereafter Japan announced its resignation from the League.

The United States, at times acting in close co-operation with the League, attempted to induce Japan to keep the peace and declined to recognize Manchoukuo. The U.S.S.R., while deeply interested, was not disposed to go to war to keep Japan out of the Russian sphere of influence in northern Manchuria.

The Chinese, powerless to oppose effective military resistance, had a weapon in the boycott, which they invoked at great cost to Japanese trade. The Japanese objected, friction became acute and fighting broke out in Jan. 1932 at Shanghai; in the ensuing warfare Japanese forces laid waste a large portion of the city. The Chinese offered a much sturdier defense than had been expected, but eventually were driven back. Due in part to the good offices of the League, fighting ceased in March 1932.

Chinese anti-Japanese activities continued in Manchuria, largely through irregulars. Chang Hsüeh-liang, for a time with his headquarters at nearby Peiping (Peking), was a source of irritation. The Japanese, too, wished to add the province of Jehol (now Ch'eng-te) to Manchoukuo. In Jan.–Feb. 1933, Manchoukuoan-Japanese forces occupied Jehol, and Chang Hsüeh-liang, his prestige badly damaged, soon resigned and left for Europe. When he returned, it was to a post in Hupeh and then in Shensi. In April 1933 the Japanese, annoyed by raids from south of Jehol, advanced within the Great Wall. The Chinese were forced to withdraw and on May 31 Nanking found it advisable to enter into a truce, setting up a demilitarized zone south of the Great Wall, in the northeastern part of the province of Hopeh. Strangely enough, however, in all this time war was not officially declared and regular diplomatic relations were maintained between the two governments.

The truce of May 1933 established a modus vivendi that was in effect a treaty of peace and that tacitly (although not explicitly) acquiesced in the Japanese occupation of Manchuria. The articulate among the Chinese, however, remained unreconciled to the existence of Manchoukuo. Moreover, for a number of years only two foreign powers besides Japan (Italy and El Salvador) formally recognized the new state.

Japan, however, persevered in consolidating its position in Manchoukuo. It acted against banditry and entered upon a vast program of railway building that opened up more of the land and connected it with Korea. In 1934 P'u-i was officially crowned monarch of the new state (*see* also MANCHURIA).

After long negotiations, moreover, Japan obtained the sale of the Russian interest in the Chinese Eastern railway and thus eliminated the last legal trace of the former Russian sphere of influence.

Japan was not content with confining its control of China to regions north of the Great Wall. In the spring of 1934 a pronouncement from Tokyo in effect declared all China to be a Japanese preserve in which no power could take important action without the consent of the island empire. In 1935, moreover, Japanese forced the withdrawal from Hopeh and Chahar of any officials and armed forces and the disbanding of any organization that might prove unfriendly to Japan. The provinces of Hopeh and Chahar passed partly into Japanese control, and Suiyüan, Shansi and Shantung were threatened. Chiang Kai-shek dared not offer open opposition.

In July 1937 what proved to be a life and death struggle broke out between China and Japan. The opening incident was a minor clash between Chinese and Japanese troops not far from Peiping on the night of July 7. The conflict soon ceased to be localized. The Japanese came to feel that since Chiang Kai-shek and the Nationalist government would not yield to their wishes they must be eliminated. To the Japanese, the rising tide of nationalism in China, directed, as much of it was, against them, had become intolerable.

9. Chinese-Japanese War (1937–45).—The war, which remained undeclared until Dec. 9, 1941, may be divided into three phases—a period of rapid Japanese advance until the end of 1938, a period of virtual stalemate until 1944, and the final period when United Nations counterattacks, principally in the Pacific and on Japan's home islands, brought about Japan's surrender.

In July 1937 practically all Chinese regional military and political groups rallied to support the Nationalist government and Chiang Kai-shek in their decision to oppose Japan by every means. The Communists, who had urged a united front against Japan since 1935, pledged their support and put their armies nominally under command of the government. From a strictly military point of view, however, Japan was so much better prepared than China that its armies achieved rapid initial success.

Within the course of two years Japan obtained possession of most of the ports, of the majority of the chief cities as far west as Hankow and of the larger part of the railways. Peiping and Tientsin were occupied in July 1937. After fierce fighting, the Chinese armies were driven out of the Shanghai area by the middle of Nov. 1937. Nanking fell in mid-Dec. 1937. The capital was moved west to Hankow. The Japanese followed and took that city in Oct. 1938. In the same month, the Chinese lost Canton. The Japanese pressed northward and westward from Peiping along the railway lines into Shansi and Inner Mongolia. They dominated Shantung. They took possession of the Peiping-Hankow, Tientsin-P'u-k'ou and Lung-hai railways and of the lines in the lower part of the Yangtze valley. They had complete command of the sea. Always superior in the air, before many months they had all but destroyed the Chinese air force and bombed Chinese cities at will. The loss of life, particularly to Chinese, both soldiers and civilians, was enormous.

Yet the Chinese did not yield and the war was prolonged far beyond Japan's expectations. Chiang Kai-shek moved his capital to Chungking, in Szechwan, at the western end of the Yangtze gorges. Much of China's leadership migrated to the far west, to Szechwan and Yünnan. Unoccupied China prepared for prolonged resistance. In occupied China, Japan was unsuccessful in inducing many Chinese of standing to take office in the governments that it endeavoured to set up. Even there Japan's control was confined to the cities and the railway lines; outside these it was challenged, often successfully, by guerrilla bands that professed allegiance to the Nationalist government. The Communist regime was particularly successful in using guerrilla methods to resist Japan. The rapid Japanese advances broke down the established patterns of politico-military control. Communist troops and organizers moved into the vast rural areas behind Japanese lines. They organized village self-defense units, created local governments and expanded their own armies, the 8th route army operating in the mountains and plains of north China and the new 4th army in the lower Yangtze valley.

During the stalemate phase of the war, beginning in 1939, Japan tried to subdue Chinese resistance by blockade. China's main seaports were occupied, from the south to the north. In at least one, Foochow, the occupation was only intermittent, but in most of them it was continuous. When, in 1940, France fell to the Germans, Japan took the occasion to advance in French Indochina and block the railroad that led from the coast to K'un-ming (Yünnanfu) and the crude highways from the Indochinese coast to the interior. For a time Japan induced the British to close the road that led from Burma to K'un-ming in Yünnan. After a time the British reopened the road (*see* BURMA ROAD).

Then, following years of increasing tension, came the sudden outbreak of war between the United States and Great Britain on the one hand and Japan on the other. The Japanese, taking advantage of their preparedness and of their favourable geographic position, quickly made themselves dominant on the coasts of east Asia. Their capture of Hong Kong and of Burma in 1942 shut doors by which goods had moved in and out of unoccupied China. The only routes that now remained to connect the Chinese with their friends abroad were the long and poorly constructed roads across Sinkiang and the air passage from Assam. Through the venality of Japanese officials and the skill of blockade runners, some goods trickled through the Japanese lines along the coast.

During the war China was divided into three regions—Nationalist China under control of the government, Communist China and the regions occupied by Japan. Each was pitted against the other two.

Nationalist China had serious economic and social problems. The relatively backward western provinces, with almost no modern industry or transport facilities, were strained to support the huge armies and the government. The region was crowded with refugees and some of its cities were bombed. The shortage of manufactured goods and the costs of war brought on inflation, which was intensified by the government's fiscal policy and which caused great hardship and encouraged hoarding, speculation and graft. The army, unable to take the offensive against the superior Japanese forces, steadily deteriorated. In the schools and colleges a shortage of books and equipment, malnutrition and attempted regimentation by the government all had a deteriorating effect.

The government, too, was deeply affected by the war. It had lost its industrial and financial base in east China and the flower of its armies. The strong public support it had enjoyed during the early years of resistance waned and turned to apathy or hostility. The government was blamed for the ills of inflation, corruption and heavy taxation. When the Communists began to reappear as rivals rather than subordinates, the Nationalist government retaliated with repressive measures, which it applied also to other groups. Essentially an authoritarian regime, it tended to become more repressive and less efficient as the war dragged on. Yet with all these difficulties, the Chinese under Chiang Kai-shek's leadership refused to surrender or negotiate with Japan.

The scattered areas controlled by the Communist party and its armies grew during the war until near the end they covered large parts of north and east China (*see* below, *Chinese Communist Party*). In these "border regions" and "liberated areas" the regime was, by nearly unanimous report, popular with the people. This was partly the result of economic and social reforms, which improved the conditions of the peasantry, and partly the result of the system of local government, which encouraged wide participation of the public through mass organizations even though control was held firmly by the party. The army was also popular because of its good discipline and close relations with the common people upon whom it depended for existence.

During the stalemate period relations between the Nationalists and the Communists were embittered by many military clashes for which each side blamed the other. The Communists did everything possible to strengthen themselves, while the Nationalist government tried to keep them confined by blockade and other means. In effect the civil war was merely submerged, after 1938, in the larger war with Japan.

In the occupied regions Japan tried to win support and lessen its military burden by setting up a puppet regime at Nanking (1940). To head this, it obtained Wang Ching-wei, once an intimate companion of Sun Yat-sen, who professed to be carrying on the latter's tradition. Japan also went through the motions of restoring to Chinese administration the French concession and the international settlement in Shanghai, which it had taken over after the attack on Pearl Harbor.

Yet Japan was no more successful than it had been before in inducing many Chinese of ability and integrity to serve in these administrations. Obviously, too, no important step could be taken by these regimes without the approval of the Japanese authorities.

In the last phase of the war, from early 1944 to Aug. 1945, some help was beginning to come to China from the outside, chiefly from the United States. War matériel was being flown from India, and Chinese pilots and mechanics were being trained. Japanese strongholds were bombed by U.S. and Chinese planes. The United States also was training and equipping in India Chinese forces that had taken refuge there after the fall of Burma. Yet the main theatre of war was far from China, whose armies by then were too debilitated to play an important part in the final campaigns.

The Nationalist government had been seriously undermined by seven years of war and inflation, while Communist strength had grown. As Japan withdrew divisions to fight in the Pacific islands, the Communist armies were able to move in and organize more "liberated areas." The danger of fratricidal war after Japan's defeat became obvious. The U.S. government was drawn into China's domestic crisis since the United States provided the main external supports—financial, military and diplomatic—for the Nationalist government and since the U.S. wished China to take a place as a stabilizing influence in the far east after the war. In various ways United States representatives in China tried to bring about a reconciliation between the Kuomintang and the Communists. A fundamental difficulty—besides the bitter distrust and intransigence of both Chinese parties—lay in the United States' position of trying to mediate between them while supporting one side, the Nationalists, as the government of China.

G. CHINA AFTER WORLD WAR II

1. Civil War.—Within five years of the victory over Japan the Nationalist government had been driven from the mainland by the Communists, who then became masters of the country. Japan's defeat set off a struggle for control of occupied China, from Manchuria in the north to Canton in the south. Nationalist troops, transported by the U.S. army air force and navy, were able to take over key cities and most railway lines in east and north China. But Communist troops, moving out from their guerrilla bases, occupied much of the hinterland in the north and in Manchuria. The stage was set for renewal of civil war.

For more than a year the U.S. government attempted, through its ambassador, Patrick J. Hurley, and then through Gen. George C. Marshall, to mediate and prevent this conflict. During Jan. and Feb. 1946 it appeared that agreements laying the basis for peace had been reached. On Jan. 10 the Nationalists and Communists concluded a cease-fire agreement to be administered by a tripartite committee (Kuomintang, Communists and the United States) which would send out truce teams to stop conflicts that arose. A Political Consultation conference representing all parties, meeting Jan. 10–31, worked out plans for an interim coalition government to function until a new constitution should be adopted by a representative national assembly. On Feb. 25, 1946, a military reorganization plan worked out with the help of General Marshall, to merge and consolidate the hostile armies, was agreed upon by representatives of the government and of the Communist party. Within a few months, however, these agreements were undone. During all of 1946 the U.S. government, acting through General Marshall and his aides, strove for peace. The hostility, ambition and distrust of both Chinese parties made peace impossible.

The civil war lasted from 1946 to 1950. In that period the great strategic advantage of the Nationalists was reversed. During 1946 and early 1947 they succeeded in taking most of the railways and in recapturing important cities in the north. As Soviet troops withdrew from Manchuria the Nationalists sent in their best armies to try to hold the vital railways and industrial centres. But they were overextended. Communist forces, retrained and reequipped with Japanese arms, gradually shifted from guerrilla warfare to large offensive campaigns. In 1948 they destroyed the Nationalist armies in Manchuria and won impressive victories in north China. By the end of the year the Nationalist government was in desperate straits: its armies were disintegrating; inflation was destroying the economy; the Kuomintang was torn by factional strife; and the public was withdrawing its support.

In 1948 the Communists began a southward march. They captured Nanking, the Nationalist capital, on April 24, 1949; the substitute capital of Canton, on Oct. 15; then Chungking, the wartime capital to which the government had returned for final refuge, on Nov. 30. On Dec. 8, 1949, T'ai-pei in Formosa was declared to be the Nationalist capital.

2. Formation of the People's Republic.—During 1949 the Communists laid the foundation for a national government. In September the Chinese People's Political Consultative conference, a body having the appearance of a constitutional convention, met in Peiping to establish a new government. The conference included representatives of many parties, professions, organizations and ethnic minorities, but their selection was determined by the Communist party, which dominated the gathering. The climax of its meetings was the announcement of the formation of the People's Republic of China on Oct. 1, 1949. The Central People's government of the People's Republic of China was established at Peking (renamed by the conference). While having the appearance of a coalition government, it was essentially a Communist dictatorship.

Government was only one of the agencies employed by the Communist leaders to control the country and carry out their policies. Other agencies included the party itself, numerous mass organizations and the armed forces. The Communist party, a highly centralized and strongly disciplined organization, had from 6,000,000 to 7,000,000 members at the time when the People's Republic was formed. Its central committee, or a smaller group within it, determined party policy, carried out by a network of regional, provincial, municipal and lesser committees. The party structure paralleled and party officials controlled each level of the government, of the army and of the mass organizations. The rank-and-file members provided the motive force for carrying out the party's will in factories, villages, street associations and army units throughout the country. After coming to power the party established many types of mass organizations and extended those it had previously created. Associations of peasants, youths, women and labourers enrolled millions or scores of millions of members. Every profession and occupation was organized. Each of these bodies served as an agency to mobilize support for the regime and its programs. At the same time they provided the Chinese people with greater opportunity for participation in government, particularly local government, than they had ever before known.

The party, through the government, established a monopoly of all organs of information—radio, press, motion pictures, etc.—and the entire educational system. All coercive bodies such as the army, the police and the courts came under its control. The government did not hesitate to use terror, including widespread executions and forced labour, to eliminate or control potential opponents. It was through these means that the new regime, with a large measure of popular support, was able to unify the country more completely than any other had done since the height of Manchu power.

3. Foreign Relations.—In foreign policy the regime was firmly in the world Communist camp. The government was quickly recognized by the Soviet Union and its satellite countries. A treaty of friendship, alliance and mutual assistance between the People's Republic of China and the Soviet Union was signed in Moscow on Feb. 14, 1950. By the terms of a supplementary agreement, the U.S.S.R. promised to transfer to the People's Republic of China before the end of 1952 all its rights in the Chinese Ch'ang-ch'un railways (the former Chinese Eastern and South Manchuria railways) and to withdraw its troops from Port Arthur and turn over the naval base to China's control; Dairen was also to be returned. The U.S.S.R. also extended a five-year credit amounting to U.S. $300,000,000. Subsequent treaties and agreements bound the two countries closely together. Communist China's entry into the Korean conflict toward the end of 1950 tightened this alliance and tended to isolated China from the non-Communist world.

But the course of mainland China's relations with the U.S.S.R. has not always run smoothly. During the summer of 1960 strain began to appear when some leaders of the two countries were openly critical of each other and when the U.S.S.R. withdrew most of its technicians from China. In the autumn of 1961 China sided with Albania in its struggle with the Soviet Union, and even lent Albania money and diverted wheat shipments (sorely needed by the Chinese people themselves) to Albanian harbours. For several years China's foreign trade had shifted from Japan and the west to the Soviet Union and its satellites, but in this area, too, signs of change appeared. In 1961 alone the Peking government purchased 6,000,000 tons of grain from Canada, Australia and France.

The non-Communist governments of the world were divided over the issue whether to recognize the new Chinese government or continue to deal with the Nationalist government on Formosa. Burma, India, Pakistan, Indonesia, Sweden, Denmark, Finland and Switzerland quickly established relations with the new government. Great Britain and certain other countries offered recognition, but the Communist regime made no effort until 1954 to establish relations. In that year Peking and London exchanged chargés d'affaires with diplomatic status and China agreed to formalize its relations with Norway and the Netherlands. Diplomatic relations between China and Yugoslavia were established in Jan. 1955, five years after Yugoslavia had offered recognition to Peking. A series of agreements on greater trade and closer relations were concluded between the People's Republic of China and Indonesia, Burma, Vietnam (North), North Korea and Outer Mongolia in 1955 and relations also were established with Afghanistan and Nepal. Relations also were established with a number of the newer countries in Africa, and in Latin America Cuba became an outspoken ally. These understandings resulted in China's making grants and loans to Burma, North Vietnam and Guinea, supplying Ghana with machinery, and aiding Morocco in the planting of tea.

The question of which Chinese government should represent China in the United Nations also was a matter of controversy. On this issue, the United States supported the Nationalist government position, and in March 1956 the secretary of state, John Foster Dulles, declared that the United States had consistently recognized and supported the government of the Republic of China as the only government of China. In July of the same year, the U.S. congress declared in a resolution that it was unequivocally against the seating of Communist China in the United Nations.

India and the U.S.S.R. continued to introduce resolutions at sessions of the United Nations general assembly calling for the admission of the People's Republic of China. The proposals were defeated, however, by votes of 42–12 in 1955 and 48–27 (with 6 abstentions) in 1957. In 1958 a U.S. proposal to exclude any proposals for a change in the representation of China for another year was passed by a vote of 44–28 with 9 abstentions. In 1959 the vote was 44–29 with 9 abstentions. When a resolution was introduced in 1960 it was defeated by a vote of 42–34 with 22 abstentions. By that time, however, the United States realized that the number of votes it could count on was dwindling. The U.S. delegate in 1961 backed a New Zealand-sponsored resolution to consider China's membership "an important question." The African delegates agreed to vote against Communist China's becoming a member provided that the U.S. would agree to the entry of Outer Mongolia and Mauritania. This the U.S. was willing to do, and, with some difficulty, persuaded the Nationalist Chinese delegate not to veto the proposal in the Security council.

Tibet was brought back under Chinese control through a military campaign beginning in Oct. 1950 and through negotiations during April and May of 1951. The Central People's government promised Tibet "national regional autonomy under the unified leadership of the Central People's Government" but assumed control of the country's defense, communications and external relations. The agreement was signed on May 23, 1951, in Peking and was ratified by the dalai lama in October. In a treaty between India and China signed April 29, 1954, India recognized China's full sovereignty over Tibet and gave up certain privileges previously acquired there by Great Britain. One position India clung to, however, was the maintenance of the line drawn by Sir Arthur Henry McMahon early in the 20th century, indicating the boundary of India in the north. This boundary, agreed to by representatives of Tibet and British India in 1914, apparently was accepted also by the Chinese government; certainly it was not at any time protested. When therefore the Chinese Communists, late in 1959, started over the highways constructed to the borders of Bhutan, Sikkim, Nepal and Kashmir, to cross the line and dispose their armed forces at strategic points within the line, the Indians protested, and Prime Minister Jawaharlal Nehru refused to have any dealings with the Chinese premier, Chou En-lai, until the troops had been withdrawn.

Relations between India and China dropped to a new low as a result of the border dispute. On Feb. 24, 1961, India issued a white paper condemning China as an aggressor and accusing the Chinese of occupying 50,000 sq.mi. of Indian territory in the border area. Though India still favoured the admission of Communist China to the United Nations, Indian newspapers left no doubt that the country had lost much of its enthusiasm for the Chinese regime. The Indian government also was tried by events occurring in Tibet in 1959, when the Chinese began to suppress harshly the restlessness among the people and by so doing caused thousands of Tibetans, the dalai lama among them, to flee for refuge into India. The panchen lama was summoned to Peking and made titular head of the Tibetan state. (*See* also TIBET.)

The ruthlessness of Chinese Communist actions in Tibet and their significance for other states in Asia were not lost on the peoples of other border areas and beyond. Resettlement of many Communist Chinese in China's peripheral areas was observed. About 2,000,000 were settled in the decade 1950–60 in Inner Mongolia, Ningsia, and Sinkiang. In 1959–60 over 10,000 were sent into Yünnan province, the beginning of a migration that was expected to relocate 100,000 people. An anti-Chinese attitude was observed in Indonesia, Malaya, Burma and Pakistan after the conference of Asian and African nations held at Bandung in 1955.

4. Domestic Reforms.—After winning control of the country, the Communist regime launched a series of nationwide reforms that attempted to refashion nearly every aspect of Chinese life. Of fundamental significance was the land redistribution program, which undertook to expropriate the land of all landlords and "opponents of the state" and distribute it to farm labourers, tenants and poorer peasants. Within a few years, throughout a territory larger than Europe, ownership of land was redistributed and landlords were eliminated as an economic class. This was only the first step toward collectivization. Other intermediate stages were mutual-aid teams and agricultural co-operatives, which were gradually developed throughout the land. Marketing and distribution of most of the products of Chinese agriculture was brought under co-operatives and state trading companies. These and other measures were designed to increase the nation's agricultural output and place it at the service of the state for its program of economic development.

China's economic development was planned and controlled by the state. The first several years after 1949 were devoted to rehabilitation and to establishing the mechanism of economic controls. Communication facilities were restored, inflation was halted, and state banking and state trading companies were established. The war in Korea prevented much new capital construction except of railways and flood-control systems, but in 1953 the government launched the first five-year plan and announced a "high tide of construction" to transform China from an agricultural to an industrial country.

In 1955 a food shortage on the mainland was reportedly acute, partly because of floods and droughts. The decision to re-examine the five-year plan and to tighten the food ration reflected these conditions and, in an attempt to increase food production and reduce the number of city dwellers who must be fed, the government took steps in July to send large sections of the population in Shanghai and other large cities back to their native villages to take up farming. By the latter 1950s the agricultural economy was largely collectivized and industry and commerce were almost completely transformed into enterprises jointly owned and operated by the government.

Despite these facts and Peking's claim of achievement in accelerated socialization, there were, in 1957, repeated official and unofficial reports of food shortage, further reduction of cotton-cloth ration, student unrest, peasant revolts and severe punishment against "counterrevolutionary gangs." At the eighth Chinese Communist party congress in Sept. 1956, Premier Chou En-lai had reported that because of floods and drought and difficulties encountered in the process of socialization the targets for some industrial and agricultural production would not be attained at the end of the five-year plan in 1957. An outline for a second five-year plan (1958–62) was adopted by the party congress, proposing a 50% increase in national income through a rise of 100% in industrial output and 35% in agricultural production, as compared with the lower rates of increase of 90% and 23%, respectively, under the first five-year plan. The new plan, among other things, called for a long-range effort to surpass Great Britain in the output of steel and coal within 15 years.

The new plan's first year, the first year of the "great leap forward," was made notable by establishment of the people's communes. In spite of setbacks due to mistakes and floods and other forces beyond its control, the government continued to announce gains in production. In 1959 only grain production failed to reach its quota, though the total actually exceeded the 1958 figure by 8%. Steel production rose from 8,000,000 metric tons in 1958 to 13,350,000 in 1959. Pig iron production, at 20,500,000 metric tons represented an increase of 115% over 1958, though some of this may have been of poor quality because it was produced in temporary furnaces and converters. Coal production was 347,800,000 metric tons, exceeding 1958 production by 29%. Crude oil production remained small; in 1959 it was 25,900,000 barrels, a little more than three days' production in the United States. Cotton output for 1959 was 2,410,000 metric tons, an increase of 14.76% over 1958, and the mills turned out 8,250,000 bales of cotton yarn, 35% more than in 1958. Electricity rose 51%; cement 32%; timber 18%; chemical fertilizer 64%; machine tools 40%; paper 31%; sugar 26%; and salt 6%.

Late in 1960 government news sources began to report that various natural disasters plaguing the country during that year had, according to the *Red Flag* magazine, "not only affected the fulfillment of our agricultural plan for 1960 to a great extent but also inevitably created certain unfavourable conditions for the production of both heavy and light industries." The natural calamities that had visited the agricultural regions included drought (affecting almost every province except Tibet and Sinkiang), typhoons and floods (20 provinces), insects, pests, plant diseases, hailstorms and frost. Western observers speculated that the seriousness of the disasters might have been exaggerated in an effort to account for a decrease in production that had come about because of the commune system, which had met with widespread discontent, sabotage and resistance that reached their climax in 1960. The result, in any case, was famine, and food grains had to be imported.

The Communist regime actively extended education, which was brought completely under state control. Schools and colleges operated by western missionaries were confiscated. In the revised system emphasis was laid upon expanded educational facilities, ideological uniformity and technical training. A central purpose of the new system was to bring education within the reach of all workers and peasants, one device being the use of simplified characters, together with a phonetic system based on the western (and Russian) alphabet (*see* above, *The People*). Mass education to eliminate illiteracy was pushed vigorously. The government stated that in the year 1958 alone 100,000,000 persons among the young and middle-aged learned to read, so that the striking figure of 80% literacy was reached. In 1960, according to reports of the government, 86,400,000 children were enrolled in primary schools, while 8,520,000 were attending middle school, and around 660,000 (not including research students) young people were in institutions of college grade. Teachers were retrained through "ideological remolding campaigns," and new textbooks, much influenced by Soviet books, were produced. Secondary and higher education became increasingly technical in order to train engineers, agronomists, medical personnel and technicians; nearly 1,500,000 students were enrolled in technical schools in 1958. All students spent part of their time in manual labour. Carefully selected students were sent annually to the U.S.S.R. for special training.

The emancipation of women from their inferior position in the old society was announced as another aim of the Communist regime, carrying forward a movement that had been developing during the first decades of the 20th century. Legislation strengthened women's rights in property ownership, employment and health insurance. The marriage law promulgated in May 1950 made child marriage and concubinage illegal, and stressed the right of young women to choose their own husbands. Women were given franchise equal to that of men. At the same time, however, like their sisters in the U.S.S.R., they were also required to work as hard.

During 1953–54, elections were held throughout China for "people's congresses" at village, county, municipal, provincial and national levels. To prepare for elections a population count was made as of June 30, 1953 (see *Population*, below). On Sept. 20, 1954, the new national people's congress adopted a constitution of the People's Republic of China, the first constitution since China came under Communist control. In April 1959 Mao Tse-tung resigned from the chairmanship of the congress, being succeeded by Liu Shao-ch'i. Mao continued as chairman of the party's central committee and of the Politburo, while Chou En-lai served as premier and Chu Teh as chairman of the standing committee of the national people's congress.

5. Nationalist Government on Formosa.—The Nationalist government meanwhile maintained itself on Formosa, which had reverted to Chinese control upon Japan's surrender in Aug. 1945. When the island became the government's last refuge late in 1949 it was necessary thoroughly to reform the inefficient, "carpetbag" administration that had operated there during most of the civil war period. The Kuomintang party was reorganized with a view to its revitalization. The government bureaucracy superimposed upon the provincial administration was reduced and rationalized. The armed forces that had fled from the mainland were reorganized and, with help from a United States military mission and large U.S. financial grants, were revived into a more effective fighting force to defend the island and, according to Nationalist hopes, to lead in a reconquest of the mainland. In these efforts to establish a secure base Chiang Kai-shek took the lead as head of Kuomintang, president of the republic and commander in chief of the armed forces. His power within the regime became absolute.

An attempt was made to provide Formosa with an efficient administration having due regard for the welfare of the people. This was necessary in order to restore confidence in the Nationalist government both at home and abroad. Elections in 1950–51 for magistrates, mayors and councils introduced a measure of local self-government. Similar elections were repeated periodically; in 1957, 83% of over 4,250,000 voters participated. The councils, however, were given only advisory, not legislative, power.

In the civil service the proportion of Formosans, especially in higher positions, was increased. The former Japanese educational system was completely reorganized and extended so that more than 93% of children of elementary school age were in schools by 1957. In 1959 there were 22 institutions of higher learning (including 7 universities) as compared with 6 in 1949. Twelve Chinese institutions of higher learning overseas (11 in Hong Kong and one in the Philippines) were approved by the ministry of education. The Chinese language completely superseded Japanese throughout the school systems.

The island's economy was soon brought back to the productive levels of the prewar Japanese administration, and in every known instance improved. During the years 1949–53 the Nationalist government peacefully carried out a land reform program including reduction of land rents to 37.5% of the yield, sale of land to cultivators and government purchase of land and resale to tenant cultivators. As a result 5,800,000 ac. of land were transferred to tenants, and the percentage of Formosan farm land cultivated by owners increased from 50.5% to 75.4%. With the help of the Joint Commission on Rural Reconstruction, composed of Chinese and Americans, significant improvements were made in irrigation, cropping methods, animal husbandry, organizing of farmers' associations and agricultural extension. In Oct. 1959, at the conclusion of 14 years of occupation, the Nationalist government reported that the industrial production index had risen ten times, and the number of workers nine times, from 23,000 to 207,000. The textile industry rose from 20,000 spindles to more than 240,000. Steel output rose from almost nothing to 227,000 metric tons; cement from 78,000 metric tons to the neighbourhood of 1,000,000. The number of factories increased from 5,600 in 1951 to 12,100 eight years later. Privately owned plants rose from 2,300 in 1945 to 19,315 in 1959. Many new industries emerged: motor vehicles, diesel engines, machinery, electric appliances, glass, timber processing and synthetic products. Formosa's exports in 1959 totaled about U.S. $160,000,000, of which sugar and rice accounted for U.S. $77,000,000. The island's government launched one four-year economic development plan in 1953 and another in 1957. It came close to or exceeded its goal in every respect, in spite of devastating storms and the distractions of military defense.

The chief problem was the support of the armed forces of the

Nationalist government, numbering some 600,000 men, and a constant influx of refugees from the mainland. Only with extensive economic aid from the United States was that possible. (*See* also Formosa.)

On April 28, 1952, the Nationalist government on Formosa and the government of Japan signed a separate peace officially ending the war which had begun in fact on July 7, 1937.

6. Conflict Between the Two Chinese Governments.—The two Chinese political regimes—Nationalist and Communist—which had been at war most of the time since 1927, confronted each other across the Formosan strait in a continuation of the contest for support of the Chinese people and the nations of the world. In Sept. 1954 Peking increased its attacks on the islands lying in the strait between Formosa and mainland China and nominally under the control of the Nationalist government. Heavy air attacks on the Ta-ch'en Islands in Feb. 1955 led to their abandonment by the Nationalist government. The islands of Quemoy and Matsu also were harassed by artillery fire, and beginning on Aug. 23, 1958, they were subjected to a heavy and sustained bombardment for several weeks. The U.S. 7th fleet during this period convoyed Nationalist supply ships to Quemoy, bringing forth charges that the U.S. fleet had violated territorial waters, and denials from the United States. Thereafter the attacks were resumed, but the Nationalist forces, supported by the United States, held fast, and an inconclusive series of engagements continued. The Communists kept up a nuisance shelling of the offshore islands on odd-numbered days, though the bombardment became massive only on June 17 and 19, 1960, when Pres. Dwight D. Eisenhower made a state visit to Formosa. There was little damage to the heavily fortified defense works and casualties were few. *See* also Far East: Relations With the West. (K. S. L.; C. M. W.; L. C. G.)

VI. POPULATION

The prolonged uncertainty, especially among western scholars, about the total size of China's population was finally resolved by the census taken by the government in 1953. It was generally accepted outside China as an accurate head count, conducted with care and precision between July 1953 and March 1954 but referring to June 1953. It gave a total mainland population, including Manchuria (called simply the Northeast after 1949), Inner Mongolia, Tibet and Sinkiang, but excluding Formosa, of 582,603,417. Inner Mongolia accounted for 7,338,000 of this total, Tibet for 1,273,969 and Sinkiang for 4,873,608.

Figures released by the statistical bureau in 1957 placed the total mainland population at 646,530,000 (excluding Formosa), including Inner Mongolia (9,200,000), Tibet (1,270,000) and Sinkiang (5,640,000).

Earlier estimates, by Chinese and westerners, of the country's total population had ranged from as little as 250,000,000 to as much as 600,000,000. The huge population of China is very unevenly distributed, however; most of it is concentrated in the following regions:

1. The central portion of the north China plain around the convergence of the provinces of Hopeh, Shantung and Honan and a section of the valley of the tributary Wei river.
2. The triangular tract of the Yangtze delta with its apex at Nanking.
3. A relatively narrow coastal belt extending southward from the mouth of the Yangtze through Chekiang, Fukien and Kwangtung to the Hsi Chiang or Canton delta, where it widens considerably.
4. The central (Hupeh) basin with the Wu-han cities (Hankow, Han-yang, Wu-ch'ang) as its node and extending up the radial valleys converging on it (Han, Siang, Kan, etc.).
5. The Red basin of Szechwan, isolated far in the west beyond the Yangtze gorges.

The northern belt of maximum population is essentially one of peasant farmers, depending upon the land; large manufacturing cities are only beginning to grow up in the western sections, apart from established eastern centres such as Tientsin. In the Yangtze delta, the coastal zone and the Canton delta, agriculture greatly predominates, but in addition there are old and new industries and active river and maritime commerce. Despite cold-war limitations on maritime trade, Shanghai retained its place as by far the largest city and manufacturing centre. New centres are growing rapidly in the west, southwest and northwest, but the coastal plain, the plain of eastern north China, and the middle and lower Yangtze valley still contain the bulk of China's people.

Outside these regions, population is dense only in isolated valleys or small basins. In the provinces of the loess plateau (Shensi and Shansi) the density is moderate and the population fairly evenly distributed. The same may be said of the south China plateau as a whole. In both, well-peopled valleys contrast with sparsely occupied highlands.

The southwestern provinces (Kweichow, Yünnan and Kwangsi), Kansu, the provinces of Inner Mongolia in the northwest and the Manchurian provinces in the northeast all have distinctly low densities. The possibility of lessening the pressure of population depends upon developing industries and new agricultural techniques, internal migration and gradual changes in reproduction patterns.

1. Migration.—The Chinese throughout their history have been a colonizing people, but movement from congested and overpeopled regions to sparsely occupied areas was constantly held in check by the great reluctance, for reasons connected with their social philosophy, to leave their ancestral homes. This is least true of southeast China. There has long been a stream of Chinese emigrants from Fukien and Kwangtung, with their densely peopled coasts, to the rich peninsulas and islands to the south, where they helped to develop the far eastern tropics.

In Malaya Chinese form approximately one-half the total population. In the Philippines, in Java and many other parts of Indonesia, in Thailand (Siam), in Indochina and in Burma their vigour, frugality and tenacity make them a prosperous and progres-

Table I.—*Provincial Areas and Populations*

Political subdivision	Area† (sq.mi.)	Population 1953 census*		Area‡ (sq.mi.)	Population 1957 estimate§	
		Total	Density per sq.mi.		Total	Density per sq.mi.
Total	3,691,502	582,603,417	157.8	3,691,502	646,530,000	175.1
MUNICIPALITIES						
Peking	1,750	2,768,149	1,581.8	3,386	4,010,000	1,184.3
Shanghai	270	6,204,417	22,979.3	772	6,900,000	8,937.8
Tientsin‖	888	2,693,831	3,033.6	—	—	—
PROVINCES						
Anhwei	54,015	30,633,407	567.1	54,015	33,560,000	621.3
Chekiang	39,305	22,865,747	581.8	39,305	25,280,000	643.2
Fukien	47,529	13,142,721	276.5	47,529	14,650,000	308.2
Heilungkiang	178,996	11,897,309	66.5	178,996	14,860,000	83.0
Honan	64,479	44,214,594	685.7	64,479	48,670,000	754.8
Hopeh	82,227	37,886,020	460.7	81,479	44,720,000	548.9
Hunan	81,274	33,226,954	408.8	81,274	36,220,000	445.7
Hupeh	72,394	27,789,693	383.9	72,394	30,790,000	425.3
Kansu	167,143	12,928,102	77.3	137,104	12,800,000	93.4
Kiangsi	63,629	16,772,865	263.6	63,629	18,610,000	292.5
Kiangsu	41,429	40,963,000	988.8	40,927	45,230,000	1,105.1
Kirin	72,201	11,290,073	156.4	72,201	12,550,000	173.8
Kwangtung	89,344	36,740,000	411.2	89,344	37,960,000	424.9
Kweichow	67,181	15,037,310	223.8	67,181	16,890,000	251.4
Liaoning	58,301	20,566,000	352.8	58,301	24,090,000	413.2
Shansi	60,656	14,314,485	236.0	60,656	15,960,000	263.1
Shantung	59,189	48,876,548	825.8	59,189	54,030,000	912.8
Shensi	75,598	15,881,281	210.1	75,598	18,130,000	239.8
Szechwan	219,691	65,685,063	299.0	219,691	72,160,000	328.5
Tsinghai	278,378	1,676,534	6.0	278,378	2,050,000	7.4
Yünnan	168,417	17,472,737	103.7	168,417	19,100,000	113.4
AUTONOMOUS REGIONS						
Inner Mongolia	454,633	7,338,000	16.1	454,633	9,200,000	20.2
Kwangsi Chuang¶	85,096	17,591,000	206.7	85,096	19,390,000	227.9
Ningsia Hui♀	—	—	—	30,039	1,810,000	60.3
Sinkiang Uighur	635,829	4,873,608	7.7	635,829	5,640,000	8.9
Tibet	471,660	1,273,969	2.7	471,660	1,270,000	2.7

†1955 reorganized area. *1953 census adjusted to 1955 reorganized area. Census based on registered population, plus estimate of 8,397,477 persons living in areas where local registration not established. ‡1958 reorganized area. §1957 estimate adjusted to 1958 reorganization. ‖In Nov. 1958 Tientsin lost its status as an independent municipality and was placed under the jurisdiction of Hopeh province. ¶Prior to 1957, Kwangsi province. ♀Prior to Oct. 1958, part of Kansu province.

sive commercial element. These same qualities often constitute a menace to the economic prospects of the less commercially minded local peoples. Resentment and discrimination against the Chinese in these countries of southeast Asia where they form such a critically important group have become political issues, especially when the national loyalties of the Chinese may be ambiguous.

The peoples of the congested districts of the north in Shantung, Hopeh and Honan were until relatively recently somewhat less adventurous. The rich grasslands of Manchuria beyond the Great Wall became available for agricultural settlement only under the Manchu dynasty, and economic development was very slow until after the Russo-Japanese War of 1904–05. With the rapid development of railways and new industries, Manchuria became a very attractive field. North China, on the other hand, was devastated by famines and the ravages of civil war. The almost intolerable conditions of life in many districts so weakened old prejudices that a tremendous mass movement toward Manchuria set in, no longer a mainly seasonal migration of males but rather a movement of entire families. The increase of population in Manchuria in the four years 1923–27 was estimated at 2,000,000 and the exodus from north China during the summer of 1928 at 40,000 a week. During the period of Japanese control of Manchuria, migration was slow but steady. After the area came under control of the Communist regime, it was developed as an agricultural-industrial base, and migration, particularly of skilled workers and technicians, was encouraged.

To this field of colonization in the north must be added the adjacent districts of Inner Mongolia on the Chinese side of the Gobi desert, with very considerable pastoral possibilities which the Peking-Pao-t'ou-Lan-chou railway made accessible. However, this is a marginal region in which the small and fluctuating rainfall makes settlement and livelihood precarious. In spite of climatic limitations, northern China has thus had a "land of promise" along its whole northern border, but except for some sections of Manchuria this has nearly reached the saturation point. The Communist regime attempted by a drastic reorganization of the society and economy to solve the fundamental problem of overpopulation, but a generation at least will be necessary to assess the results. If no slowing occurs in growth rates, China should have 1,000,000,000 people well before the end of the 20th century; it is doubtful that total production can match such an increase.

2. Demographic Characteristics.—In the years after the 1953 census, the population of China was reported to be increasing at a rate of 2% a year. This rate of natural increase was based on birth and death rates derived from a sample survey of 30,000,000 persons, or about 5% of the total population. The survey showed births at a rate of 37 and deaths at 17 per 1,000 population.

The 1953 census showed the Chinese population to be a rather young one. The census reported 15.6% of the total population under 4 years of age, 25.5% between 4 and 17 years, and 58.9% 18 years and over. China thus had a much larger proportion of its population in the younger ages than, for example, the United States, where in 1953 the age group of 18 and over included 67.4% of the population.

The 1953 census reported that men outnumbered women by 107.5 to 100. This situation contrasts sharply with that in the United States, where at the same period (1953) there were only 98.9 males per 100 females. Chinese population counts have traditionally disclosed a predominance of men over women, partly explained by the former practice of undercounting girl babies in population registers.

3. Urban Population.—According to the 1953 census, 13.3% of the country's population, or 77,257,282 persons, were classified as urban. At the time of the census, more than 1,600 places in China were listed in the urban category. The great majority of these were small market towns, engaging in trade and handicrafts. There were only 103 (121 in 1957) cities with a population of more than 100,000 each, a relatively small number for a country as large as China. However, these large cities alone accounted for 63% of the country's total urban population. Among the large cities, 9 had a population of more than 1,000,000 (14 in 1957), 16 had a population from 500,000 to 1,000,000 (20 in 1957), and 78 (90) had a population of 100,000 to 500,000 (*see* Table II).

TABLE II.—*Cities of More Than 500,000 Population*

City	Province	Population	
		(1953)	(1957)
Shanghai*	(independent of Kiangsu)	6,204,417	6,900,000
Peking*	(independent of Hopeh)	2,768,119	4,010,000
Tientsin	Hopeh	2,693,831	3,220,000
Mukden	Liaoning	2,299,900	2,411,000
Wu-han	Hupeh	1,427,300	2,146,000
Chungking	Szechwan	1,772,500	2,121,000
Canton	Kwangtung	1,598,900	1,840,000
Harbin	Heilungkiang	1,163,000	1,552,000
Lushun-Talien*	Liaoning	766,400	1,508,000
Nanking	Kiangsu	1,091,600	1,419,000
Sian	Shensi	787,300	1,310,000
Tsingtao	Shantung	916,800	1,121,000
Ch'eng-tu	Szechwan	856,700	1,107,000
T'ai-yüan	Shansi	720,700	1,021,000
Fu-shun	Liaoning	678,600	985,000
Ch'ang-ch'un	Kirin	855,200	975,000
K'un-ming	Yünnan	698,900	880,000
Tsinan	Shantung	680,100	862,000
Tzu-po	Shantung	184,200	806,000
An-shan	Liaoning	548,900	805,000
T'ang-shan	Hopeh	693,300	800,000
Hangchow	Chekiang	696,600	784,000
Chengchow	Honan	594,700	766,000
Ch'ang-sha	Hunan	650,600	703,000
Lan-chou	Kansu	397,400	699,000
Suchow	Kiangsu	373,200	676,000
Tsitsihar	Heilungkiang	344,700	668,000
Soochow	Kiangsu	474,000	633,000
Foochow	Fukien	553,000	616,000
Wusih	Kiangsu	581,500	613,000
Shihkiachwang	Hopeh	373,400	598,000
Kirin	Kirin	435,400	568,000
Nan-ch'ang	Kiangsi	398,200	508,000
Kuei-yang	Kweichow	270,900	504,000

*Municipality.

Urban population as a whole rose by 40% in China between 1950 and 1953 as a result of renewed industrial activity in the cities under the Chinese Communist regime. Urban increases were most marked in cities where industrial development progressed. At the same time cities were being built around industrial construction sites and newly developed mines.

The urbanization trend in China continued at a rapid pace after the 1953 census as the Communist regime intensified its efforts to convert China into a powerful industrial nation. By 1956 the country's urban population was estimated to have risen to 89,150,000, or 14.2% of the national total. By late 1957, Shanghai's population had risen to an estimated 6,900,000; that of Peking to 4,010,000 (largely as a result of territorial expansion of the city limits), and that of Tientsin to 3,220,000. (T. Sd.)

VII. ADMINISTRATION AND SOCIAL CONDITIONS

A. Chinese Communist Party

1. Party Development.—The Chinese Communist party (C.C.P.) was formally established at the first National Party congress in Shanghai, July 1, 1921. National Party congresses were held thereafter at irregular intervals: Shanghai (1922), Canton (1923), Shanghai (1925), Wu-han (1927), Moscow (1928), Yenan (1945) and Peking (1956, 1958). Between 1921 and the early 1960s the C.C.P. increased from 57 to nearly 18,000,000 members, becoming the world's largest Communist party. During the first united front with the Kuomintang, during the 1920s, C.C.P. members were admitted to membership in the Kuomintang, but the party retained full organizational and programmatic independence during the second united front during the Japanese war period (1937–45). The C.C.P. controlled the Chinese soviet republic in Kiangsi and Fukien provinces (1931–34) and the Shensi-Kansu-Ningsia border area government (1936–45), in addition to large guerrilla areas within the Japanese lines. It achieved national power on Oct. 1, 1949, by a process of territorial expansion from large rural base areas that remained under its control after the cessation of hostilities in World War II.

Under the successive leaderships of Ch'en Tu-hsiu, Li Li-san and Ch'en Shao-yü, between 1921 and 1935, the C.C.P. was torn by internal and factional differences over such questions as: relations with non-Communist elements, relations with the Soviet Union and the Communist international, political-military strategy and tactics, and a number of ideological issues, such as the respective roles of the urban proletariat and rural peasantry in the revolutionary process. An extraordinary party conference at Tsunyi (Kweichow province) in Jan. 1935, during the course of the march from south to northwest China, established the leadership of Mao Tse-tung (*q.v.*). Party dissidents were disciplined by Mao Tse-tung and his principal lieutenant, Liu Shao-ch'i; and the *cheng-feng* or rectification movement of 1942–43 had the effect of consolidating Mao's leadership and of establishing his interpretations of Marxism-Leninism as the basic ideological guide for the party's subsequent revolutionary action.

The revised party constitution of Sept. 26, 1956, defined the C.C.P. as "the vanguard of the Chinese working class, the highest form of its class organization," and set forth the principal objectives of party policy with respect to social revolution and reconstruction, economic development, relations to other classes and minority groups, and foreign affairs. It declared that "the C.C.P. takes Marxism-Leninism as its guide to action"; that it "adheres to the Marxist-Leninist world outlook of dialectical and historical materialism"; and that it "upholds the principle of integrating the universal truths of Marxism-Leninism with the actual practice of China's revolutionary struggle." These and other party pronouncements emphasized the principle of the "continuing revolution," by which the party was wholly committed to "the achievement of socialism and communism in China." The C.C.P. has its own constitutional and administrative systems, which are rigorously distinguished from those of the state, and it looks upon the state apparatus as but one of the several forms of organization available to it for attaining its objectives.

2. Organization and Structure.—In accordance with the principle of "democratic centralism," the capstone of the C.C.P. hierarchical structure is the National Party congress, a body formally endowed with plenary authority to control the constitution, organization and policies of the party. Members of the congress are indirectly elected by party congresses of lower levels for five-year terms. The party constitution of 1956 stipulated that the congress should normally hold annual sessions within the five-year term of its election, in sharp contrast to the previous practice of convening single-session national congresses on an *ad hoc* basis. Congress sessions are of short duration, and in practice are almost entirely concerned with endorsing proposals laid before them in the name of the central committee.

The National Party congress elects a central committee of about 100 members to exercise full authority over party affairs in the long intervals between its sessions. In turn, the central committee elects the principal functionaries of the national party organization: a chairman, five vice-chairmen, a secretary-general, a Political bureau, a standing committee of the Political bureau, a secretariat and a Central Control commission. The number of members of the collegial organs varies at the discretion of the central committee. During intervals between the prescribed semiannual plenary sessions of the central committee, which are actually convoked less regularly, its powers and functions devolve upon the Political bureau and its standing committee, which issue orders and directives in the name of the central committee. The latter organs comprise the core of the party leadership.

Under direction of the Political bureau and secretariat, the continuing apparatus of the central committee consists of administrative departments, each normally headed by a central committee member, which exercise policy and staff functions connected with the formulation and enforcement of party programs, the internal business of the party and liaison and direction of lower-level party organizations and committees. The most active departments of the central committee have been the organization department, finance department, united front work department, rural work department, industrial and communications work department, propaganda department, social affairs department, women's department, youth department and military affairs committee. Parallel activities, with more limited scope, are maintained by analogous departments of provincial and local party committees.

Membership in the C.C.P. is open to persons above the age of 18 who are qualified and willing to perform the duties prescribed in the party constitution, to accept party discipline and "to place the interests of the Party and the State . . . above their personal interests" (party constitution, art. 2). The new member is admitted to a one-year probationary status by a local party branch. Once qualified for regular status, the member may voluntarily withdraw or, as a disciplinary measure, may be reduced to probationary status or expelled. The Communist Youth league (formerly the New Democratic Youth league), the junior organization directly controlled by the C.C.P., maintains at all levels an organizational apparatus paralleling that of the party, and is the principal source of recruitment for new party members. At the time of the eighth party congress (1956) the party membership was identified, by social status, as follows: workers, 14%; peasants, 69.1%; intellectuals, 11.7%; others, 5.2%. About 10% of the party members are women.

The C.C.P. also controls and directs nonparty mass organizations, which are considered as the party's principal links with the masses and serve as "transmission belts" for party policies, and whose "activists" may become candidates for party membership. Such organizations include the All-China Federation of Trade Unions, All-China Federation of Democratic Women, All-China Democratic Youth, All-China Federation of Industry and Commerce, Sino-Soviet Friendship association, All-China Federation of Literature and Arts, All-China Student federation, and others. Their total membership exceeds 100,000,000, and many of them maintain active affiliations with such international Communist organizations as the World Federation of Trade Unions, World Federation of Democratic Women, International Student union, and others.

3. Party Control of Government.—In C.C.P. doctrine, the party assumes the role of leadership in transforming ownership of the means of production, in establishing the socialist society and in preparing for the transition to Communism. In principle, the party anticipates the "elimination of classes, state authority and party" (Mao Tse-tung, June 30, 1949). During the pre-Communist phase, it considers the "state institutions of people's democratic dictatorship and its laws" as "superstructure" which plays a role in socialist transformation (Mao Tse-tung, Feb. 27, 1957) necessarily subordinate to the transformations it assists the leading party to achieve. Consequently, the C.C.P. exercises complete control over the government, directly or indirectly formulating its policies.

Several channels for controlling the government are available to the C.C.P.:

1. Although party membership is not prerequisite to employment by the state, the most responsible governmental personnel at all levels are invariably important members of the party hierarchy. The party constitution stipulates that three or more party members of the leading bodies of state organs or people's organizations should form a "leading party members' group," with responsibilities for assuring that policies and actions of the leading bodies conform to the policy decisions of the party.

2. The state constitution itself acknowledges the leadership role of the C.C.P. within "a broad people's democratic united front," and incorporates a statement of the directions of state policy corresponding to the party's objectives.

3. Basic constituent and legislative acts, such as the state constitution of Sept. 20, 1954, are preliminarily drafted within the party apparatus before submission for formal action by an appropriate constituent or legislative body of the state.

4. From time to time, the party central committee joins with the state council, or its ministries, to issue joint orders, directives or regulations equally applicable within the party and state hierarchies.

5. The indirect system used in electing members of people's congresses and governments at different levels of the state apparatus permits the C.C.P. to maintain strong electoral control, indirectly, over party and nonparty officeholders.

6. Through its propaganda department, the party directly employs and controls all media of mass communications (press, publications, radio) and cultural and educational facilities, to stimulate broad mass support for policies it seeks to popularize.

7. Through its united front work department, the party exerts leadership over all "democratic parties and groups," ensuring their conformance with party policies.

As a consequence of full utilization of such means of control, the actions and pronouncements of the party take priority over state actions and enactments as expressions of the principal directions of public policy. Jurisdictional debate does not occur, and certain "rightists" who in 1957 voiced objection to the "party empire" were purged from public life. In sum, the party employs the state apparatus to carry out party policies considered appropriate for governmental action, but at its option it may employ mass organizations and other nongovernmental agencies, or act directly. Thus, the sweeping program for the establishment of people's communes in 1958 was completed entirely under direct party leadership, without authorizing legislation or subsequent official confirmation by state authorities.

B. State Constitution and Administration

1. Constitution.—The constitution of the People's Republic of China (abbreviated hereafter C.P.R.), adopted by the first national people's congress on Sept. 20, 1954, supplanted the organic laws of the Chinese People's Political Consultative conference of Sept. 1949 as the basic constituent instrument of the C.P.R. The state constitution consists of a programmatic preamble and 106 operative articles grouped in four chapters.

Ch. i (art. 1–20), "General Principles," defines the C.P.R. as "a people's democratic state led by the working class and based on the alliance of workers and peasants," and sets forth the basic policies for "the gradual abolition of exploitation and the building of a socialist society." Ch. ii (art. 21–84), "The State Structure," defines the organs of state administration, including the national people's congress and its standing committee, the office of chairman, the state council, local people's congresses and government councils, the special regimes for autonomous areas, and the people's courts and people's procuratorates; ch. ii was implemented, in detail, by a special series of organic laws. Ch. iii (art. 84–103), "Fundamental Rights and Duties of Citizens," and ch. iv (art. 104–106), "National Flag, National Emblem and Capital," complete the document.

The constitution entered into force immediately upon its adoption. The national people's congress may amend the constitution at any time by a two-thirds majority vote. Broad powers to interpret the constitution were subsequently assigned by the congress to its standing committee. The supreme people's court, which is politically responsible to the congress and reports to it, has none of the functions of a constitutional court.

2. Central Government.—The governmental system of the C.P.R. is based on the unitary principle. The national people's congress, "the highest organ of state authority," exercises complete legal control over provinces, national autonomy areas and local governments and administrations. All state organs observe the principle of "democratic centralism," which nominally renders people's congresses (and government councils elected by them) responsible to the lower-level congresses that elect them ("democracy") but which actually permits higher-level congresses and their governments to prescribe mandatory policies for lower-level organs ("centralism"). Within the central government, the powers of the national people's congress nominally extend over all other organs, whose personnel are elected by the congress and are subject to recall by it. The principle of unity of power, rather than separation, governs the assignment of particular functions to the chairman of the C.P.R., the state council, the supreme people's court and the supreme people's procuratorate.

The national people's congress (1,226 members, pending the "liberation" of Formosa) is a unicameral body whose members are indirectly elected for four-year terms by people's congresses of successively lower levels. In 1959 there were 150 women deputies and 179 from national minorities. The franchise is held by all men and women aged 18 and above, "except insane persons and persons deprived by law of the right to vote" (constitution, art. 86). The latter provision has been employed during the period of voter registration to exclude "counterrevolutionaries" and politically hostile elements. The individual right to vote, however, is exercised only in elections of people's congresses at the basic levels of *hsiang* (rural township) or *ch'ü* (urban wards or precincts), where the balloting occurs secretly or by show of hands according to local practice. The ballot is cast for a slate of names equal to the number of seats allotted to the basic-level congress, which has been approved by an election committee appointed by higher authority. Deputies elected to basic-level congresses elect the members of the *hsien* (county) or municipal people's congress, who in turn elect members of provincial people's congresses. The national people's congress is elected by provincial congresses, or their equivalent, on the basis of a slate of names proposed by the higher-level national committee of the Chinese People's Political Consultative conference.

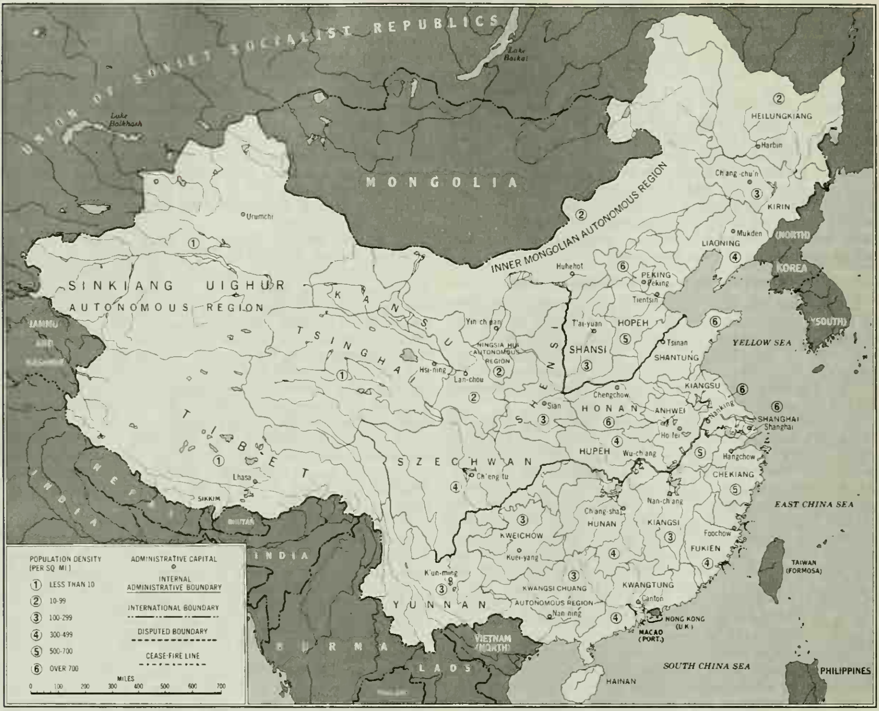
The national people's congress has formal authority over all important matters affecting the life of the nation. It approves the national economic plan, examines and approves the state budget and financial report, decides on general amnesties and on questions of war and peace and exercises such other functions and powers as the congress considers necessary. The standing committee of the national people's congress exercises the functions of the congress during the intervals between its annual sessions, and in 1959 was authorized to amend the laws enacted by the congress. The chairman of the standing committee yields precedence only to the chairman of the C.P.R. The nationalities committee of the national people's congress submits for approval to the standing committee matters concerning various nationality autonomous areas. The bills committee studies bills or draft decrees. The budget committee is responsible for examining and reviewing the budget as well as the final accounts of state expenditure.

The chairman of the C.P.R. is elected by the national people's congress for a four-year term. He performs the formal and representative functions of chief of state, commands the armed forces and presides, ex officio, at sessions of the Supreme State conference and the National Defense council. Although the constitution provides for election of a single vice-chairman, the second national people's congress in 1959 elected two vice-chairmen of the C.P.R., without regulating the order of their succession to the chairmanship.

On recommendation of the chairman, the national people's congress elects the premier of the state council; and, on his recommendation, elects the vice-premiers, ministers and chairmen of commissions. The state council is the "highest administrative organ of the state," and exercises the characteristic functions of a national administration, with broad powers for the appointment of personnel and for issuance of orders, decisions and regulations. Its precise composition and that of its organs vary frequently as changes are made in the number of ministries and commissions.

3. Local Administration.—For administrative purposes, mainland China is divided into 21 provinces, five autonomous regions and two municipalities under direct central control (*see* Table I). The provinces of ancient China have their own deep historical and cultural traditions, and provincial separatism frustrated the efforts of the Manchu dynasty and Nationalist government to modernize the country. The C.C.P. has developed explicit policies calculated to destroy provincialism, but incurs criticism by reason of the predominance of Hunanese in its higher echelons. The national autonomous regions reflect the C.C.P. policy of seeking to minimize "Great Han" nationalism and to accord cultural autonomy—but not political independence—to areas in which national minority peoples predominate (*see* also above, *The People*).

In their turn, the provinces are basically divided into approximately 175 municipalities and some 2,000 units of *hsien* (county) level, many of which also have independent traditions. At the next successive lower level, the municipalities are divided into almost 400 municipal districts, and units of *hsien* level are divided into approximately 100,000 *hsiang* (administrative villages) and *chen* (villages). People's congresses and governments are set up at each of the three indicated levels, although *hsien-* and *hsiang-*level apparatuses are relatively less complex than provincial struc-


UNION OF SOVIET SOCIALIST REPUBLICS
Lake Baikal
Lake Balkhash
MONGOLIA
HEILUNGKIANG
Harbin
Ch'ang-chu'n
KIRIN
Mukden
LIAONING
(NORTH) KOREA
(SOUTH)
INNER MONGOLIAN AUTONOMOUS REGION
Huhehot
PEKING
Peking
Tientsin
Urumchi
SINKIANG UIGHUR AUTONOMOUS REGION
KANSU
TSINGHAI
Yin-ch'uan
NINGSIA HUI AUTONOMOUS REGION
Hsi-ning
Lan-chou
T'ai-yuan
SHANSI
HOPEH
Tsinan
SHANTUNG
YELLOW SEA
SHENSI
Sian
Chengchow
HONAN
ANHWEI
Ho fei
KIANGSU
Nanking
SHANGHAI
Shanghai
JAMMU AND KASHMIR
TIBET
Lhasa
SIKKIM
NEPAL
BHUTAN
INDIA
SZECHWAN
Ch'eng tu
HUPEH
Wu-ch'ang
Hangchow
CHEKIANG
EAST CHINA SEA
Nan-ch'ang
KIANGSI
Ch'ang-sha
HUNAN
KWEICHOW
Kuei-yang
Foochow
FUKIEN
TAIWAN (FORMOSA)
K'un-ming
YUNNAN
KWANGSI CHUANG AUTONOMOUS REGION
Nan-ning
KWANGTUNG
Canton
HONG KONG (U.K.)
MACAO (PORT.)
BURMA
VIETNAM (NORTH)
LAOS
HAINAN
SOUTH CHINA SEA
PHILIPPINES
POPULATION DENSITY (PER SQ MI)
① LESS THAN 10
② 10-99
③ 100-299
④ 300-499
⑤ 500-700
⑥ OVER 700
ADMINISTRATIVE CAPITAL
INTERNAL ADMINISTRATIVE BOUNDARY
INTERNATIONAL BOUNDARY
DISPUTED BOUNDARY
CEASE-FIRE LINE
MILES
0 100 200 300 400 500 600 700

PREPARED BY CENTRAL INTELLIGENCE AGENCY, 1959

FIG. 3.—ADMINISTRATIVE UNITS OF CHINA SHOWING DEMARCATED INTERNATIONAL BOUNDARIES AND POPULATION DENSITIES, MARCH 1959

tures. Integral mergers of *hsiang* and *hsien* governments with people's communes of the same areas were prescribed late in 1958, when the traditional patterns of local administration began to collapse.

For the administrative convenience of higher-level governments, intermediate administrative combinations of subordinate areas frequently are found. *Hsien* are grouped into subprovincial administrative areas, and *hsiang* are grouped into sub-*hsien* administrative districts. Such areas and districts are, in effect, branch areas under control of the higher authority, and do not themselves have status in the system of people's congresses and governments. They permit higher-level governments to maintain closer scrutiny over governments of lower level, and permit adaptations of government policy to special local circumstances.

C. Social Revolution and Transformation

1. Socio-Political Objectives.—In *On People's Democratic Dictatorship* (June 30, 1949), Mao Tse-tung clearly defined the immediate and long-range socio-political objectives of the C.C.P. For the short range,

> Our present task is to strengthen the apparatus of the people's state, which refers mainly to the people's army, the people's police and the people's courts, for the defence of the nation and the protection of the people's interests.

As for the long-term,

> When this condition is met, China will be enabled to advance steadily, under the leadership of the working class and the Communist Party, from an agricultural to an industrial country, from a new democratic to a socialist society and communist society, to abolish classes and to achieve world communism.

By "the people," Mao explicitly meant "the working class, the peasant class, the petty bourgeoisie and the national capitalists," as distinguished from their explicit enemies, "the landlord class, the bureaucratic-capitalist class, the Kuomintang reactionaries and their henchmen." By the "people's democratic dictatorship," Mao meant the basic social integration of the four elements constituting "the people," who, "under the leadership of the working class and the Chinese Communist party," formed "their own state" to maintain dictatorship over non-co-operating social classes.

Mao's formulation reflected the class-war concepts of Marx and Engels, Lenin's "dictatorship of the proletariat" and his own interpretation of the need for "continuous revolution" under the special conditions found in China.

Mao's immediate objective of strengthening the power of the people's state was broadly achieved between 1949 and 1953, when the state army, police and courts destroyed the principal class enemies. The properties of "bureaucratic-capitalists" (*i.e.*, capitalist elements identified with the Kuomintang, especially the "four families" of Kung, Soong, Chiang and Ch'en), were confiscated and placed under direction of new economic ministries, thus providing the new regime from the beginning with a state-socialized, urban-centred industrial economy. Under the Agrarian Reform law of June 28, 1950, properties of rural landlords were confiscated and redistributed in the spirit of a political struggle to free China of "semifeudal" elements. Land reform, except in isolated minority areas, was completed by the end of 1952, and the economic power of the landlords was destroyed. The Regulations for the Suppression of Counterrevolutionaries (Feb. 20, 1951) legitimized continuing police action against other dissident elements whose "counter-revolutionary" character was ascertained from their reluctance to accept C.C.P. direction. During the same period, several nationwide campaigns (the "3-Anti," "5-Anti," "democratic reform" and others) had the effect of disciplining, indoctrinating and isolating politically the middle-class elements in private industrial and commercial circles. The "Aid-Korea, Resist-America" campaign exploited the patriotic themes of the Korean war to excite the people's loyal allegiance, and to expose class enemies as national traitors. During the same period, the network of C.C.P. controls was vastly expanded and decisive action was taken against carefully selected social and political targets.

A second phase of social policy, now in pursuit of the longer-term objective of the "transition to socialism," was initiated in 1953—the year of the first five-year plan and the Korean armistice. Following the substantial socialization of all means of economic production by 1957–58, the C.C.P. embarked upon the program of people's communes, considering these as an organizational prototype for the eventual transition to Communism. High levels of political and organizational tension were consciously sustained throughout the entire period; the masses were continually exhorted to act in a spirit of militant struggle to destroy all remaining class enemies and establish, in succession, the socialist and Communist societies. Progress toward those goals was specifically measured by successes in destroying anti-working-class elements, suppressing the theory and practice of private ownership of the means of production, and identifying and purging "rightist" elements. A great campaign against the "rightists" was waged in connection with the all-encompassing "rectification movement" of 1957–58. At the same time, the growing economic power of the state-owned sectors of the national economy was deliberately employed to overwhelm the dwindling private sectors of the economy (industrial and commercial); and, in the countryside, the massive weight of collectivized agricultural production was employed to make economic life untenable for individual landowning peasants.

2. Rural Transformation.—While the land reform movement successfully removed the landlord class, it left unsolved the technical problems of increasing agricultural productivity and did not basically alter the social status of rich, middle, poor and landless peasants. To meet these objectives, the C.C.P. central committee issued a series of directives on Dec. 15, 1951, Feb. 15, 1953, and Dec. 16, 1953, contemplating the gradual, "voluntary" creation of agricultural producers' co-operatives following a preparatory campaign for the organization of permanent and temporary mutual-aid teams. The mutual-aid teams were organizations of several rural households for the common employment of tools, farm implements, draft animals and labour power during the spring and autumn sowing and harvest seasons and in times of natural adversity, which did not affect private ownership of the peasant's land or possessions.

Thus habituated to mutual effort, the peasant was next encouraged to pool his land with that of his neighbours in a lower-level agricultural producers' co-operative, from which he derived compensation in proportion to the share of his land (retaining a theoretical right to withdraw his property from the co-operative). By the end of 1954, nearly 10,000,000 mutual-aid teams with a total membership of around 70,000,000 households had been established; there were also 115,000 co-operatives with a membership of 2,300,000 rural households. Following Mao Tse-tung's July 1955 report on agricultural co-operatives, the C.C.P. central committee on Oct. 11, 1955, directed an acceleration of the movement. Between Oct. and Dec. 1955, the number of lower-level co-operatives increased from 630,000 to 1,900,000, with a membership of 75,000,000 rural households (65% of the total). In that phase of rural transformation, the primary social target was the "rich" peasantry.

The Supreme State conference convoked by Mao in Jan. 1956 decreed a completion of the lower-level co-operative movement and an intensification of the establishment of "advanced" agricultural producers' co-operatives by merger and consolidation of lower-level co-operatives. The social target of the ensuing "high tide of socialization in the countryside" was the middle peasant class, with the objective of reducing all peasants to a common system of wages. By the end of May 1956 the basic transformation had been completed: 110,000,000 rural households (91% of the total) had been encompassed in co-operatives—75,000,000 households (62% of the total) in advanced co-operatives and 35,000,000 households (29% of the total) in lower-level co-operatives. The process of consolidating lower-level co-operatives proceeded at a rapid rate for the rest of 1956, and the end of the year 95% of all rural households had been organized into 750,000 advanced agricultural producers' co-operatives.

Model Regulations for Agricultural Producers' Co-operatives (lower-level) were issued on March 17, 1956; Model Regulations for Advanced Agricultural Producers' Co-operatives were issued on June 30, 1956. A comparison showed that members of advanced co-operatives were called upon to assign title to their lands to the co-operative, without right of recovery, and to receive thereafter compensation in the form of wages based upon their actual hours and days of labour for the co-operative. The political blow to the middle peasantry, formerly the mainstay of the countryside, was struck by the party policy of requiring advanced co-operatives to accept the membership of "small" and "landless" peasants with equal right to daily and hourly wages even though they brought no land into the collective effort.

By the end of 1956, therefore, the Chinese countryside was substantially organized into semisocialist collectives; the private ownership "guaranteed" by the Agrarian Reform law of 1950 had ceased to exist, except for small garden plots; and the new system of party-controlled co-operative management brought most of the agricultural production of the nation within the framework of the planned national economy.

Concurrently with the advanced co-operative movement, the C.C.P. brought about a co-operative organization of handicrafts and side industries, rural credit and commercial and marketing agencies. Private speculations in grain, foodstuffs and industrial products (cotton, in particular) were halted. As a consequence, nearly all agricultural processes were managed and controlled by the collectives and their co-operative satellites—from the physical reconstruction of the rural land to the application of advanced agricultural techniques, the financing of rural agriculture, the semiprocessing of agricultural products and their sale and distribution. The mass of peasants had been reduced to the common level of a rural proletariat. The processes of merging and consolidating co-operatives of all types continued through 1957–58, paving the way for the establishment of people's communes late in 1958 (*see* below).

3. Industrial and Commercial Transformations.—The Common program of 1949 had theoretically safeguarded the private property interests of industrialists and merchants untainted by "bureaucratic-capitalism" or "foreign imperialism." Gradually, through such pressures as were exerted during the "3-Anti" and "5-Anti" movements of 1951–52, private industrialists and merchants were brought under higher degrees of party, state and trade-union control of their operations. At the same time, the rapid growth of state-owned industry made private industry increasingly dependent on state allocations of raw materials and manpower, and the development of state-owned trading agencies sharply reduced the operational sphere of private commerce. Late in 1955 the C.C.P. decided to bring private industry and commerce into contractual relationships of a "joint state-private management" type; in Jan.–Feb. 1956, the overwhelming majority of private industrialists and merchants were induced to "voluntarily" accept new arrangements in which, in return for a short-term payment of "interest" on the state-appraised value of their properties, former private owners might continue to serve as salaried managers of their enterprises. Political conformity with C.C.P. objectives was enforced, and the device of joint state-private operation brought nearly all industry and commerce within the scope of the state-managed planning system. The transformation was more drastic in industry than in commerce. As a result, at the end of the first five-year plan period in 1957, less than 0.01% of Chinese industry remained in private hands, and private commercial transactions were reduced to 3% of the total internal commerce. The "national capitalists" had been eliminated as a social class by measures as effective as those employed in the elimination of private ownership in the countryside. Mao Tse-tung could therefore say, with some accuracy, that "socialist relations of production have been established" (Feb. 27, 1957). The ensuing decision of the C.C.P. was to set new targets for "socialist production" (as distinguished from former emphasis on "socialist construction"), to complete the socialization of the small remaining spheres of private economy, and to move—through people's communes—to the Communist society.

4. People's Communes.—The C.C.P. Political bureau's Resolution on the Establishment of People's Communes in Rural Areas, of Aug. 29, 1958, visualized the establishment of people's communes as "the fundamental policy to guide the peasants to accelerate socialist production, complete the building of socialism ahead of time, and carry out the gradual transition to communism." The agricultural collectives, with their average memberships of fewer than 200 households, were considered to have been outmoded by the march of events. Initially, therefore, the Political bureau directed that all collectives within a particular *hsiang*, averaging 2,000 peasant households, should be amalgamated to form larger and more comprehensive people's communes—without bar to the merger of all collectives within a *hsien*. Where the former collectives had been engaged exclusively in agricultural activities, the people's communes absorbed all other forms of co-operative activity in the communal area and became multipurpose production units embracing peasants, artisans and handicraftsmen, local merchants, students and local militia. The commune thus became the sole form of economic and social organization for large rural areas, including many consolidated *hsiang*, with responsibility for single direction of agricultural, industrial, commercial, educational, defense and other social-productive activities.

Experimental communes had been set up in Honan province early in 1958, and between May and August 1958 that province was wholly communalized while pilot communes were being established elsewhere. By Dec. 1958, 123,250,000 peasant households (99.1% of the total households) were reportedly organized into 26,578 people's communes, with average membership of 4,637 households (18,000–20,000 persons). On Sept. 30, 1958, communalization was complete in the rural areas of Hopeh, Shansi, Liaoning, Kirin, Heilungkiang, Shensi, Kansu, Tsinghai, Shantung, Anhwei, Chekiang, Honan, Hunan and Kwangtung provinces, in Kwangsi Chuang autonomous region, and the suburbs of Peking and Shanghai; more than 95% completion was reported from Kiangsu, Fukien, Hupeh and Szechwan provinces and in the Inner Mongolian autonomous region.

Such a transformation, on so vast a scale and affecting so many people, was doubtless without parallel in the history of mankind. It did not take place without opposition. During 1959–60 reports of widespread resistance to the program appeared. In July 1960 the *People's Daily* said that peasants had devastated some 10% of the total cultivated land in Shantung, Hopeh, Kiangsu, Shansi, Heilungkiang, Honan and Shensi; next month it reported that one-third of the cultivated land in Shantung was overrun with weeds because of neglect. Hog raising had been hindered by acts of sabotage; land had been carelessly harvested and thousands of tons of grain left in the fields. On Nov. 1, 1960, the *People's Daily* reported that party and government leaders had gone to the fields to supervise harvesting because of distrust of local commune leaders and peasants in general.

During the initial phases of the commune movement in 1958, drastic modifications in the regular patterns of Chinese rural life were introduced as a consequence of the extreme actions of the party's organizing cadres. A substantial retrenchment was prescribed by the central committee resolution on Some Questions Concerning the People's Communes, of Dec. 10, 1958, and subsequent actions in 1959–61 sought to restore the precommunal systems. The extreme changes in rural life observed in 1958 included the following:

1. The new communes, as productive units, were integrally merged with the governmental apparatus of the *hsiang*, district or *hsien*, becoming "the basic organization of socialist state power." The management committees of the former collectives and the people's congresses of merged *hsiang* were dissolved and replaced by a single communal people's congress and communal administrative committee for the exercise of governmental and production activity. C.C.P. organizations were reconstructed to ensure effective party leadership of the enlarged effort. The peasant, who could formerly deal face-to-face with the local political and production authorities, thereafter was obliged to deal indirectly with authorities more remote from his native village.

2. The vastly larger areas and populations of the communes led to more specialized forms of production organization. The labour power of the commune, male and female, was organized into a new hierarchy of production brigades, battalions, companies and sections (or "production teams"). The woman, "freed from household drudgery" so she could participate in economic production, might be assigned to the paddy fields; the man might be assigned to an irrigation construction project miles distant from his wife. Communal kitchens and mess halls, staffed by special teams, provided the food for workers too occupied to prepare their own; communal nurseries took charge of the children while the mother worked the fields; and systems of boarding schools were started to provide for school-age children. A profound effect was exerted in these and other ways upon the traditional relations of family members.

3. In principle, all private property of the peasant was abolished and merged into the communal holdings, but in Dec. 1958 the central committee at least temporarily relaxed the full enforcement of the policy for the personal possessions of the peasant. Where the land system of former collectives was based on the principle of collective ownership by the members, the communal land system at least partly reflected the nationalized principle of "ownership by the whole people." In many localities, however, the "production team," corresponding to the co-operative, remained the basic unit for agricultural production and continued the principle of "collective ownership"; while new activities at the communal level generated capital accumulations and investments said to reflect the principle of "ownership by the whole people." Actually, then, the communal system in the "transition period to communism" was to be characterized by a mixture of ownership systems.

4. The former system of wages by which members of collectives had been compensated was replaced by a combination of (lower) wages and "free supply" of food, clothing and other services. Ideologically, the wage-and-supply system was considered a step in the direction of the Communist principle ("to each according to his needs") and an advance over the socialist principle ("to each according to his labour")—but the central committee emphasized that the full adoption of the Communist principle, which also would require replacement of collective ownership by ownership by the whole people, would require 15, 20 or more years, and would need to await a vast increase in the total economic production of the country.

5. The face of the countryside was physically changed as the separate lands of former collectives were merged into larger fields better suited to mechanized agriculture and more advanced technology; as road nets, irrigation systems and water-impounding structures were reconstructed; and as burial mounds were leveled, new schools and nurseries constructed and many small villages removed or reconstructed.

6. Emphasis was placed on communal industrialization taking advantage of the raw materials and energy sources available to the commune, partly to enlarge the total national industrial pro-

duction, but also—by bringing industry to the countryside—to minimize the economic differentials between the rural and urban workers.

7. New state fiscal arrangements were necessitated by the loss of turnover and commercial taxes from the movement of commodities within the commune. At the same time, the communes were held responsible for maintaining their own capital construction projects, school construction and public works on the basis of their own manpower and capital surpluses, thus reducing financial subventions from the state budget for local operations. Communes were required to enter into contractual relations with higher authorities for the delivery of capital accumulations in lieu of former taxes, and pressures were exerted to increase the total payment to the state from the rural areas. Closely associated with these developments was the central government's necessary policy of devolving a large share of responsibility for economic planning and development upon the localities.

8. Communes were obliged to maintain their own schools, including "Red and technical universities," in accordance with a further policy of educational decentralization. All education was to be combined with "productive labour," to heighten socialist consciousness and to make workers of all intellectuals.

9. Heavy emphasis was placed on labour discipline to mobilize communal labour power "as in a factory or the army," but lip service was paid to the necessity for combining discipline with mass-line democratic procedures of discussion and criticism. Especially intensive labour effort and discipline were required in the autumn-winter period of 1958–59 in support of the massive communal projects of public works and capital construction and reconstruction.

The entire communal program was executed by C.C.P. leadership without specific state legislative authority. The entire development occurred with surprising rapidity, especially in view of the fact that no apparent discussion of commune policy occurred in the national party congress deliberations of May 1958, where the 12-Year National Program for Agricultural Development (1956–67) was approved in revised draft without mention of communes. Party cadres often used ruthless working methods in their haste to complete the work; as peasant complaints increased late in 1958, the party directed its cadres to respect a normal work day not exceeding 10–12 hours and to grant all rural workers two free days each month. The national people's congress was officially apprised of the communal transformation only when Premier Chou En-lai referred to the communes in a passing paragraph of his report of April 18, 1959, in which he attributed the movement to "the demands of the broad masses of peasants."

By the early 1960s, however, the system of rural people's communes was in full retreat. Successive years of decline in agricultural production (1959–61), officially attributed to natural calamities of drought and flood, were also explained by widespread resistance of the peasantry. In Aug. 1959 a "three-level system of ownership" was instituted, and rural means of production were distributed between the three levels of commune, production brigade (corresponding to the former collective) and production team (corresponding to the former lower-level co-operative), with ownership at brigade level designated as basic. By 1961, after difficulty had been experienced in reactivating peasant initiative at the collective level, measures were taken to restore the co-operative level and to protect production at that level from undue encroachment on the part of the production brigade. The functions of the commune management committee were reduced to those of general planning and supervision, and many of the nonagricultural functions of the communes were permitted to atrophy. Rights of private ownership of plots of land and other property were restored to peasants within the co-operative system, and they were encouraged to sell or barter their surplus products and the products of family handicrafts in rural fairs. A new system of wages was intended to compensate rural workers on a differential basis, according to the special skills required in different types of labour and according to the actual volume of work produced, and the system of "free supply" was largely abandoned. In principle, the system of communes survived (and could be reinvigorated at a more opportune time); in practice, however, the measures of retrenchment recognized a substantial collapse of even collective agriculture and were designed to salvage the systems of private and co-operative agriculture originally instituted in 1953–55.

The more difficult problem of creating urban communes was tentatively approached by providing some "street and block" mess halls and nurseries and by preparing urban workers to accept a new system of equal wages (with bonuses) in place of the incentive wage differential used since 1949. In some newly established industrial centres, such as the Wu-han iron and steel complex, efforts were made to employ industrial workers on part-time, small-scale garden plots in the vicinity to prepare for urban communes with agricultural components. The enlarged program of urban communes undertaken in 1959–60 placed more emphasis upon full employment of men and women in small and medium-size industrial establishments designed to replace small handicraft enterprises; in the larger cities, the new organization was based upon districts and sections rather than upon the municipality as a whole.

D. Justice

"The law of the people's state is a weapon . . . to be used to punish subversive elements of all sorts" (*People's Daily*, March 25, 1952), and "people's courts" are politically responsible to, and report to, the people's congresses which elect them at different levels. The Organic Law on the People's Courts (Sept. 21, 1954) assigns final appellate jurisdiction to a supreme people's court, which also exerts judicial control over local people's courts, intermediate people's courts and such "special people's courts" as may be appointed for specific purposes from time to time. Until it was abolished in April 1959, the ministry of justice was the principal agency concerned with the administrative assignment of judicial personnel, staff and "people's assessors," but these functions thereafter were centralized under the supreme people's court. People's courts exercise criminal and civil jurisdictions so as "to safeguard the people's democratic system, maintain public order, protect public property, protect the rights and legitimate interests of citizens and ensure the smooth progress of the Socialist construction and Socialist transformation of the country" (Organic Law, art. iii). The courts are assertedly "independent" (Organic Law, art. iv), but an official report in 1959 declared that they "work under the leadership of the (Chinese Communist) Party and the State, . . . adhere to the mass line and carry out the policy of combining judicial work with productive labour. . . ."

Public prosecutions are maintained by the supreme people's procuratorate (Organic Law of Sept. 21, 1954), under a procurator-general elected by the national people's congress. The procuratorial organization is self-contained and self-administered, and procuratorates at lower levels are controlled directly from the centre and may not be interfered with by local state organs (state constitution, 1954, art. xcvi). The supreme people's procuratorate exercises procuratorial authority over all departments of the state council and corresponding administrative organizations at lower level, and may also review the work of the people's courts. The state constitution guarantees citizens from arrest "except by decision of a people's court or with the sanction of a people's procuratorate" (art. lxxxix), but no published regulations control the absolute discretion of the procuratorates. Their essentially political character was suggested in the report of Chang Ting-cheng, procurator-general, to the national people's congress on April 24, 1959, when in a review of the work of his agency during the preceding four-year period (1955–58) he pointed out that of all arrests and indictments during that period "70.8% involved active sabotage activities, while the remaining 29.2% involved counter-revolutionaries." The ministry of public security maintains a national police organization, which is supported by rural and urban militia and the garrison forces of the People's Liberation army, and together with the procuratorates and people's courts forms the backbone of the police state apparatus.

The "six codes" of the former Kuomintang government were annulled in 1949, but no subsequent codification of criminal and civil law was promulgated. People's courts rely on "people's assessors" and informal methods of inquiry to administer "people's justice" in accordance with the mass-line policies of the C.C.P. Public hearing of cases is the rule, except in cases "involving state secrets, the private matters of the parties concerned, or crimes committed by juveniles . . ." (decision of the standing committee, national people's congress, May 8, 1956).

E. EDUCATION

During the first five-year plan period (1953–57), over-all enrollment in Chinese educational institutions at all levels reportedly increased about 33% from 54,000,000 to 71,000,000. In 1958 the total rose to nearly 100,000,000: 86,400,000 primary-school students, 8,520,000 middle-school students, upper and lower, and 660,000 in institutions of higher education and 1,470,000 in comprehensive and technical universities, normal schools, technical schools and colleges. Educational policy is generally directed by the propaganda department of the C.C.P. central committee, but the principal administration is vested in a ministry of education.

Educational policy strongly reflects the political objectives of the C.C.P. Mao Tse-tung asserted, on Feb. 27, 1957: "Not to have a correct political point of view is like having no soul . . . Our educational policy must enable everyone who gets an education to develop morally, intellectually and physically and become a cultured (*i.e.*, literate), socialist-minded worker." Following a central committee Conference on Educational Work in 1958, Lu Ting-yi declared:

> Our state is a proletarian dictatorship, a socialist state. Our education is not bourgeois, but socialist education . . . The educational policy of the Chinese Communist party has always been that education should serve the politics of the working class and be combined with productive labour; and to apply this policy, education must be led by the Communist party . . . We believe there are only two kinds of knowledge in the world. One is knowledge of the class struggle. . . . The other kind of knowledge is the knowledge of the struggle for production, that is, the knowledge men gain in their struggle against nature. . . . The philosophy of dialectical materialism provides men with a correct way of thinking.

In 1957–58 strong emphasis was placed upon compulsory "socialist education" at all school levels, and for all elements of the population, under a special curriculum prescribed by the propaganda department. Extensive indoctrination was maintained concerning the necessity for combining "redness" with "expertness"—in large part to overcome rightist and "bourgeois" tendencies in educational and intellectual circles. Especially after 1958, students and faculty in all educational institutions were required to engage in productive activity, either establishing their own factories and workshops or being assigned to work in factories, on farms and in other enterprises. As summarized by Lu Ting-yi:

> Education divorced from productive labour is bound to lead, to a degree, to the neglect of politics and of party leadership in educational work, thus divorcing education from the realities of our country and eventually causing right deviationist and doctrinaire mistakes.

The assignment of educational responsibility to the communes was designed to keep the student in the closest possible relationship to productive activity.

F. DEFENSE

The Chinese People's Liberation army (P.L.A.) is the unified organization, under a single command, of all mainland land, sea and air forces. Known as the Red army (until 1937), and as the 8th route army and new 4th army (and 18th army group) during the Japanese war (until 1945), the P.L.A. adopted the new name when the civil war resumed in 1946. The history of the P.L.A. is officially traced to the Nan-ch'ang uprising of Aug. 1, 1927; the army fought under the "8–1" red flag until 1949, and Aug. 1 is regularly celebrated as P.L.A. day. The P.L.A. developed as the armed force of the C.C.P., whose People's Revolutionary Military committee exercises continuing political control, and Mao Tse-tung's military lectures and essays of 1936–38 strongly influence its military and political doctrines. A system of political commissars, with full military status, is maintained throughout the P.L.A.; and seven of the ten marshals first appointed in 1955 were serving as regular members of the C.C.P. Political bureau in 1959.

The P.L.A. is recruited on the principle of compulsory military service (law of July 30, 1955), which requires such service of all male citizens who attain the age of 18. Women may register for medical, veterinary and other technical services. The year of the military call up runs from March 1 to the end of February, and eligible men are required to register before July 1 of the year they attain the age of 18. Basic service is for a three-year period, which is extended for noncommissioned officers. Since the total size of the P.L.A. is estimated to be about 3,000,000 officers and men, the annual call up is fewer than 1,000,000 men, perhaps only one-twentieth of all eligible men. Technical information concerning the operation of the system is carefully restricted. Demobilized servicemen are carried in a ready reserve, which is reinforced by a standby reserve of civil and Korean war veterans and the urban, rural and communal militias.

The P.L.A. officer system, adopted on Feb. 8, 1955, specifically follows the Soviet model, with four officer levels: (1) two grades of marshal: supreme marshal, marshal; (2) four grades of general officers, corresponding to: general, lieutenant general, major general, brigadier general; (3) four grades of field officers: senior colonel, colonel, lieutenant colonel, major; and (4) four grades of company officers: captain, senior first lieutenant, first lieutenant, second lieutenant. Commanding officers and political officers are assigned to specific branches of service: infantry, cavalry, artillery, armoured corps, engineers, railway corps, signal corps, technical troops, public security force, air force, navy and air defense. (Naval ranks extend from admiral of the fleet to warrant officer.) Officers in certain professional classifications have special rank designations: technical officers, quartermasters, medical officers, veterinary officers, judge advocates and administrative officers. Art. 25 of the regulations concerning officers specifies: "Selection of officers and assignment of officer duties shall be based on political quality and professional ability." During the rectification campaign of 1957–58, and as a means of advancing party concepts of the proper relations that should exist between officers and men, senior officers were temporarily detailed to company duty as enlisted men. Officers are ordinarily held accountable for maintaining a party-type mass-line association with their juniors.

The modernization of the P.L.A. took place with Soviet military advice, and weapons systems and armaments were based on Soviet models. Increasing amounts of armaments, including ships and aircraft, are produced in China. In Oct. 1964 came the long-expected announcement that China had joined the ranks of the world's nuclear powers by detonating its first atomic device.

The chairman of the C.P.R. is commander in chief of the armed forces, and is chairman of the National Defense council. Under a chief of staff, the P.L.A. maintains a general political department, a general training department, a general personnel department, a general inspectorate, a general logistics department, a finance department and special command organizations for the navy and air force. Several department heads serve concurrently as vice-ministers in the ministry of national defense, which was established in 1954; nearly all are also members of the C.C.P. central committee. The Scientific and Technological commission of the state council, constituted in 1958 and initially placed under the chairmanship of Marshal Nieh Jung-chen, is understood to have responsibility for the military applications of advanced science and technology. (H. A. S.)

VIII. THE ECONOMY

In examining the economy of China it is necessary to distinguish between plans, practices, goals and operators. There first existed two patterns, that of the Nationalists and that of the Communists. Both planned the industrialization of postwar China, and both administered portions of China during the 1940s. The Communist pattern in 1949 became that operative for mainland China, and the Communists inherited a shattered economy, initially executing many Nationalist projects. Within the Communist pattern, however, after 1949, plans, practices and goals were altered so frequently that assessment of conditions at any one time is difficult. Chinese Communist economic policy is marked by inventive expediency, skilful improvisation, willingness to depart from classical Marxist theory and a sense of timing. Chinese Communist economy by the 1960s had become a mixed and transitional economy, no longer that of the traditional orient, but neither that of the occident nor of the Soviet Union.

The economy during the 1950s went through revolutionary changes, some of them truly basic and some chiefly organizational. Though a revolution has been in progress, the Chinese economy involves such a large population that intensive operations and a large amount of human labour per production unit continue to be a primary characteristic. Intensive agriculture, handicraft manufacturing and traditional transport all expanded during the very period in which agricultural mechanization, big-factory industry and modern transport were being fitted to the economy. In the reorganization of the economy, private activity gradually but largely was eliminated, state control of primary and secondary production being relatively complete as the second five-year plan went into operation in 1958. Only in the non-Chinese areas of southwest China, in Tibet, in Inner Mongolia and in Sinkiang was state control less than complete. Though the production index increased, much of the product was either plowed back into expansion or was consumed by a growing population, so that the living level of the great majority of the population rose very little. Though party members profited from events, almost all Chinese were deprived of their private property and their freedom to operate individually, and millions of people were forced to work at public works projects under conditions amounting to slave labour. The economy of China is growing steadily, and the traditional focus on agriculture is changing, but agriculture remains dominant, with basic growth taking place in all other areas of the economy.

A. PRODUCTION

1. Agriculture.—China proper and Manchuria form a region extending through several climatic regimes from Hainan Island to the Amur river. The region long has had a complex double pattern of agriculture, to which was added a third pattern in Manchuria after 1900. In the south has been a subtropical to tropical agriculture, based on rice, silk and tea and supported by a wide range of minor crops; the use of hill terracing, water in crop growing, and double cropping on small farms has been normal. In the north was found a midlatitude to cold climate and a dry climate agriculture based on wheat, millet and kaoliang (sorghum), supported by a wide but different range of minor crops; use of water in crop growing and double cropping have been minimal. In Manchuria after 1900 there developed on larger farms a commercial agriculture based on wheat and soybeans, plus several minor crops, contributing a large foreign trade volume by utilizing the good transport network. In all three zones there have been localities in which minor crops assumed major proportions, based on climatic, soil, ecologic or cultural factors. In the Yangtze valley the two southern patterns overlapped, and the two northern patterns overlapped in south Manchuria. (For a more detailed discussion of the agricultural regions, *see* above, *Geographical Regions: Agricultural Regions.*)

Traditional Chinese agriculture was distinguished primarily by its intensity. The use of human energy was basic, leading to a high development of co-operative labour patterns both locally and regionally. Local processing and fabrication of agricultural raw materials into simple manufactured goods has given most of the agricultural population a variety of secondary handicraft skills. The subordination of animals to crops led to the subordination of animal to human energy in farming operations, this in turn keeping tools simple and farms small in size.

Chinese agriculture, as a whole, has been practised on lands held under private ownership, so that tenancy has been traditional, though varying both regionally and historically. Regional self-sufficiency in products has been traditional but not total. The Chinese seldom purposely exported agricultural produce in earlier periods, yet since before the 19th century a large annual export of agricultural products has occurred and since the establishment of the People's Republic agricultural exports have been the chief means of paying for purchases abroad.

The agricultural landscape has expanded slowly over the centuries, and the number of farm families has increased. The agricultural population long comprised about 80% of the total. Farms generally were small, and though the large amount of human labour available enabled high yields per acre, this meant a low yield per man-day and, therefore, a low per-capita income. As the population increased after the 1850s the per-capita farm area actually decreased steadily, resulting in a slow decline in the per-capita income. Though the Chinese farmer was perhaps the world's most skilled user of fertilizers, the volume available never was adequate to the need. The gradual disappearance of former Chinese monopolies (such as natural silk, tea, soybeans, pig bristles and tung oil) caused disruption and deterioration of regional sectors of agriculture, since government services to the farmer never developed.

The Communist agrarian revolution was designed to cure the ills from which rural China suffered. It consisted of the abolition of landlordism and, initially, the distribution of land to the landless peasantry to win their support, proceeding to agricultural co-operatives and thence to vast rural communes (described above under *Social Revolution and Transformation: Rural Transformation*).

Increase in yields is being sought through the extension of the cultivated area, the extension of irrigation, flood control, field drainage, disease and pest control, improved plant breeding and supply and use of chemical fertilizers.

2. Fisheries.—China has rich and varied sea and fresh-water fisheries, and a widespread pattern of pond breeding of fish to supplement the total. The whole of the China coast is a shallow-water sea-fishery zone, with tropical species important in the south and cold water forms in the north. The Shantung and Chekiang-Fukien coastal sections are leading sea-fishery areas. Prior to 1950 there were few modern facilities for handling large volumes of fish, and fishing fleets were not mechanized. Almost every stream, lake and canal in eastern and southern China produces fresh-water fish in wide variety. In the lowlands of south and eastern China the pond raising of carp and other breeds of fish is an important auxiliary occupation. In southwest, west and northwest China fresh-water fisheries are not productive in any form, and fresh fish are a rare food.

3. Forestry.—Most of China proper and Manchuria were once forested. For many centuries, however, the Chinese have prevented nature from reproducing the natural plant cover and gradually have depleted most of the forest resources. Afforestation has been practised repeatedly. Extensive forest plantings of the early 1930s were being cut for commercial timber in parts of south China during the late 1950s. Under Communist control reforestation is under way, and by the early 1960s around 7,000,000 ac. of shelter belt forests and other local forests had been planted in north China, Manchuria and other localities. Though much of this would not yield forest products for several decades, it should have more rapid results in flood control and prevention of soil erosion.

The heavily populated parts of the Yangtze valley, north China and southern Manchuria are extremely short of all kinds of wood products. Northeastern Manchuria is the only real source of large timber, with commercial lumbering one of the important industries. From the Yangtze valley southward there are scattered patches of forest, with many scattered trees found throughout the agricultural landscape. Lumbering there is small in scale and secondary to agriculture. However, south of the Yangtze river bamboos grow widely and provide a substitute for true wood products. Bamboos grow rapidly and produce large volumes of marketable material annually, so that in the 20th century there has been greater use of bamboo than of true wood products everywhere in southern China. Whereas China as a whole formerly was an exporter of wood and forest products, its supplies by the 20th century had become inadequate to its total need, and China became an importer of wood products. (*See* also above, *Physical Geography: Vegetation.*)

4. Mining.—In the early 19th century China was thought to be a tremendous mineral storehouse. By the 1930s the estimates had been revised sharply downward, as surveys revealed shortages. Surveys carried on by the Communist government, however, particularly in the outer areas of greater China, have been revising the totals upward again, both in quantity and in variety.

Coal.—Coal is China's greatest mineral resource, the country ranking fourth in world coal resources, assessed in 1954 at 445,000,000,000 tons. The coal varies in type from anthracite to lignite. Most of the reserves, and the greatest annual production, are located in north China and southern Manchuria, though coal is mined in every province (but not in Tibet). South China, however, is not well off, the coal resources being smaller and more costly to mine than those of north China and Manchuria.

The annual production of coal in 1938 was 38,900,000 tons; that of 1942 was 56,300,000 tons; that of 1954 was 79,928,000 tons; and by 1959 a production of 347,800,000 (metric) tons was said to have been reached. Communist effort centred on the two open-pit basins at Fu-sung and Fou-hsin, south Manchuria; on the Kailan mines near the port of Ch'in-huang-tao, Hopeh; the new Ta-tung area of north Shansi; and the Hwainan area of northern Anhwei, with development at other coal basins at lesser rates.

Petroleum.—Petroleum prospects for China were small and scanty in reserve until 1955, when important finds were made in Sinkiang. Manchurian oil shales, located near the major coal sources, produce oil also. Production of oil in 1944 was only 116,000 tons (minus Manchurian oil shale production), that for 1954 was 824,000 tons; by 1959 it reached 3,300,000 tons, still a small figure in comparative world terms.

Iron.—Iron ore of some sort is to be found in every province of China, but the known deposits of workable, high-grade ores formerly were scattered and rather small. New sources have been found in a number of areas in surveys conducted by the Communist government, and the program of iron and steel manufacturing is expanding rapidly. Though Chinese iron ore reserves are neither huge nor high in quality, there is sufficient ore, adequately distributed, to advance the country's industrial status, and new sources of satisfactory ore continue to be found.

Others.—China is known to possess a wide variety of other minerals in quantity adequate to its needs in the near future. The shortages in copper, aluminum-producing minerals, some ferroalloys, and other minerals critical to industrialization have come to appear less serious than they formerly did.

5. Power.—In power resources China long depended upon coal and charcoal. The programs in petroleum exploration, and those in hydroelectric power development, supplemented by thermal-electric development, were expected to yield results by the end of the second five-year plan. A long-range program of multipurpose dams in the Yellow river basin eventually will yield large power returns. The total electric power capacity in 1958 stood at 2,500,000 kw. and the government reported that 41,500,000,000 kw.hr. were generated in 1959, reaching the goal for 1962 under the second five-year plan.

6. Industry.—Manufacturing is very old in Chinese economy. In the premachine age handicraft manufacturing was carried on in countless small units organized by guilds. Handicrafts persisted into the 20th century as the prevailing method of manufacture, though some were weakened by competition with foreign machine-made goods or, in cottons, by modern factories in China itself. Factory development was mainly, although not exclusively, in the manufacture of cotton textiles. There also were established silk filatures, flour mills, match factories and some steelworks. Industrial development was retarded by civil strife and foreign wars, since both domestic and foreign capital were reluctant to invest extensively in equipment that might be destroyed by contending armies.

Before the war with Japan began in 1937, industry had been developed mainly in the lower reaches of the Yangtze valley. After 1937 industrial development made rapid progress in the interior provinces. The Japanese in Manchuria, after 1931, developed industry and the return to China of Manchuria promised an active industrial region. Its stripping by Russia during 1945 and 1946 made the process of postwar economic reorganization difficult. The first five-year plan almost amounted to an initial plan for the development of industry in China, though it did have as support many previous plans, a number of plants in going condition, many inoperative plants, mines, a skeleton transport network and a small complement of skilled labour.

Facing economic blockade from much of the world, the Communist government turned to the Soviet Union for aid. The industrial program was divided into two segments, namely modern, powered, big-factory industry, and traditional handicraft, workshop industry. Both segments are under expansion, the first designed to develop basic heavy industry and power, the second to supply consumer goods until the maturing of the modern industrial pattern. Institutional changes made by the Communist regime were in the direction of transfer of control of all industry from private hands to the state. (*See* above, *Social Revolution and Transformation: Industrial and Commercial Transformations.*)

For the first five-year plan about 3,000 industrial projects were set up, of which 694 were classified as "above norm," meaning that major state financing would be required for each, whereas the other 2,300 projects were smaller items into which the state expected to put only minimal capital investment funds. The "above norm" group was expanded to 800 prior to the completion of the first five-year plan in 1957. Some of the 800 projects were not scheduled to begin until late in the period. Forty-eight projects were planned for the already operating An-shan iron and steel complex, whereas in other cases a single project involved a complete operating complex.

As the second five-year plan began in 1958, many projects of the first plan were not yet operative, and many long-term complexes were designed for completion only by the end of the second period. Owing to changing bases of statistical reporting, the changing of base dates for production indexes, and other technical changes, the actual accomplishment is difficult to assess. Industry is growing and is turning out producer's goods that can promote further industrialization. The government reported that in 1959 steel production reached 13,350,000 tons, as compared with 8,000,000 tons in the preceding year; these figures do not include the poor product of small native-style plants. An automobile truck factory began operation in 1956, and electric generators, electric motors, machine tools and other producer's goods are actually being turned out.

Formerly most industry was concentrated near the seaboard. During the war years, 1937 to 1945, it was dispersed all over interior China proper. The locational focus of the first five-year plan lay in north China and southern Manchuria, with Shanghai and its hinterland an important auxiliary zone, but with industrial beginnings in Inner Mongolia. Later planning indicated considerable decentralization around the newer finds of mineral resources.

B. Trade and Finance

1. Trade.—Though local and regional self-sufficiency was marked in traditional China, it never was complete; interregional trade in a wide variety of products is almost as old as Chinese culture. But as the occident developed its modern passion for interregional trade China maintained its older patterns, neither developing the complicated organizational machinery nor the consuming interest in commodities that marks the modern economic history of the occident. (For the origin and nature of the system by which the foreign trade of China was organized after the middle of the 19th century, *see* above, *History: 19th Century and Revolution.*) The Chinese interest in trading, though it has grown slowly, does not yet equal that of the occident. After about 1930 Chinese interest in foreign goods shifted gradually toward raw materials, tools, machinery and other production goods. Communist trading policy is political in nature, the exports and imports of the People's Republic reflecting centralized planning and political intent rather than popular will or interest.

Domestic.—The earlier internal trade of China was made up of two types of exchange: purely private trade on a local to national basis; and movement of grains and other commodities from local areas toward government administrative centres as tax payments. The latter expression of exchange ceased in 1911, but government agricultural collection as tax payment was reinstituted by the Communist government in 1949. In Communist China domestic trade is handled by a variety of state-controlled agencies for large interregional trade, and by local co-operative organizations for purely local commodities, these latter groups engaging in both wholesale and retail trade. The volume growth of internal trade has been slow, but corresponds closely to improvements in transport. By the early 1960s internal trade was increasing rapidly as large volumes of raw materials and manufactures moved between rural areas and urban industrial centres; the very population of China requires a large amount of exchange.

Foreign.—Since the mid-19th century the foreign trade of China has grown larger with the changes in the economy. An important feature of this foreign trade has been the considerable excess of imports over exports, characteristic up to 1955, but not thereafter. There has always been some government participation in foreign trade, since early "tribute" missions operated between governments. Under the Communist government, state trading organizations took over the entire handling of foreign trade. Summary returns are not published, making a full analysis of trade since 1949 impossible.

After 1949 the direction of foreign trade shifted markedly, reflecting the altered international situation. In Dec. 1950 the United States announced the prohibition of transportation or discharge by U.S. ships or aircraft of strategic materials shipped from or transshipped through the United States to the Chinese mainland, Hong Kong and Macao. Most west European countries followed this ban to some degree until about 1955, after which date they increasingly relaxed their restrictions. Consequently China's trade with the United States ceased and that with the Soviet Union and eastern European satellites came to be dominant. Trade with the Soviet Union was only 0.4% of total trade in 1936 and 8% in 1949. Trade agreements were signed with the Soviet Union in February and April 1950. In 1950 the Soviet Union accounted for 20% of total imports and 27% of total exports; in 1951, 45% of total imports and 52% of total exports. Trade agreements were also signed with eastern European countries, among them Poland, Czechoslovakia, Hungary and eastern Germany. These countries accounted for slightly over 1% of total imports and 4% of total exports in 1950; in 1951 for 25% of total imports and 26% of total exports. Imports from the Soviet Union and eastern European countries consisted mainly of industrial raw materials and industrial machinery, equipment and parts. Exports to those countries consisted of soybeans, silk, tea, wool and agricultural by-products, which increasingly were more highly processed. From 1952 through 1958 trade with Communist countries amounted to almost 80% of China's foreign trade.

China also made trade agreements with other countries with which no large trade previously existed, and between 1953 and 1957 agreements were made with west European countries that resulted in the growth of significant trade with Europe. In most of these cases China was seeking particular raw materials, such as rubber and cotton, or such manufactured goods as machine tools, electrical equipment and chemicals. Trade agreements with Japan encountered political obstacles, but by the late 1950s China's trade with Japan was greater than that with any non-Communist country.

2. Banking and Currency.—China's traditional currency consisted of copper coins, known as "cash" to foreigners, used for small transactions only, and unminted silver bullion for larger transactions, the amounts specified by varied weight measures. Domestic banks were chiefly merchant trading houses, though these sometimes received deposits and made loans. After European trade began, Spanish and Mexican silver dollars were imported and circulated, and in the 19th century some foreign banks, chiefly British, established branches in China. After 1900 the "cash" slowly disappeared, Chinese minted silver dollars and copper coins, on a decimal system, replaced the foreign coins, but paper money, based on silver, provided the main medium of exchange. Chinese private and government western-type banks appeared, replacing the older merchant trading houses. Silver was nationalized in 1935, and paper money issued by government banks became the exchange medium. The period from 1937 to 1950 saw heavy inflation and several new paper currencies, both Nationalist and Communist.

Communist abolition of these currencies, and replacement by the *jen-min-pi*, issued only by the People's Bank of China, was complete by the end of 1951. All private banks were taken over by the end of 1952, and all government banks were reorganized to be replaced by six government banks, each of which finances different sectors of economic activity. After all banking became state controlled, several thousand branches were established throughout the country. The currency became a controlled one without specific gold or silver backing, and a compulsory savings system was developed for the accumulation of state controlled capital funds. Most of the government banks engaged in short- and medium-term loan programs to government agricultural and handicraft co-operatives and to industrial corporations. Almost annual fluctuations take place in credit, loan and investment programs, reflecting changing economic planning, rapid or slow economic development, and success or failure in loan recoveries.

3. National Finance.—Normally the Chinese imperial government's income was derived from a variety of levies, among which the land tax, duties on both foreign and domestic trade, the salt tax and "tribute" levies of commodities drawn from all over China were the chief producers of income, supplemented by a wide variety of minor taxes. Public works were largely performed by unpaid drafted labour. After about 1860 the foreign trade customs dues increased greatly but regularly were mortgaged for foreign loans. During the 1930s the salt tax produced much of the unmortgaged national income, the land taxes financed provincial governments and regional military groups. In the 1930s income, profit, corporation and other occidental-type taxes were introduced, along with more complete budgeting, accounting and auditing systems. However the Nationalist government operated partially upon the basis of foreign loans. The Communists were supported by a variety of local and regional taxation until after 1949.

Communist national finance differs from earlier patterns. After 1953 most state revenue was derived from receipts from state enterprises, the proportion of national income so derived in 1958 being estimated at 84% of the total budget, with the remaining state-controlled private enterprise yielding about 1.5%, communes yielding some 13.7%, and purely private enterprise taxation yielding only about 0.5% of the national budget. Soviet financial aid to China has been significant, but is roughly balanced by Chinese aid to such governments as Outer Mongolia, North Korea, Communist Vietnam and Nepal.

Capital formation during 1951–57 represented chiefly profits from state enterprises and compulsory savings, with domestic bond subscriptions and other sources contributing smaller proportions. The introduction of the commune simplified the problem in the sense that state control of income became almost total, as shown by the 1958 figures given above. The annual rate of capital formation is rising above 20% of annual income (in 1958 being estimated at 28%), a rate which can be enforced by the almost complete state control of the economy. The rate of investment in expansion of the economy has exceeded the rate of capital formation, producing inflationary pressures and causing cutbacks in expansion during 1957 and 1958.

The published total budgets of income and expenditures moved slowly upward until 1958, when the budget jumped from 30,000,000,000 Yuan (balanced) to 41,000,000,000 Yuan with the 1959 budget set at 52,000,000,000 Yuan. The allocation of expenditures during the first five-year plan were roughly: industry, close to 40%; agriculture, forestry and water conservancy, about 10%; transport, telecommunications and postal services, about 12%; trade, about 4%; culture, education and public health, about 15%; and defense, nearly 20%. In 1959 the allocation to industry was increased to about 50%, with a decrease in defense to about 11%.

C. Transport and Communication

For centuries the human carrier, using the shoulder pole and a peculiar bouncing gait, treading narrow paths that become step trails in the uplands, has been the chief transport agency. Royal courier trunk roads for government agents were wider and often stone-paved, but were not suitable for wheeled vehicles. In the north the wheelbarrow, the animal cart and the pack animal were supplementary, as were also, in central and south China, water navigation by boats and rafts on rivers, streams, lakes and canals. In the southwest the pack train again was supplementary, and in Tibet and most of central Asia the pack train was dominant. Along the coast the sailing junk was a dominant and highly developed agent of transport. Communication for all levels of society was chiefly by courier. Passenger traffic used all forms of transport, though the upper classes traveled chiefly by sedan chair. Not until the latter part of the 19th century did other forms of transport or communication come into use, but slowly China has adopted most of the modern devices, though the human carrier and the other traditional agencies remain much used in contemporary China. In 1949 the ricksha and the sedan chair were legally prohibited.

1. Roads.—After 1915 modern roads were constructed in various parts of China, though many areas, such as Szechwan province, were without roads until the 1930s. All forms of wheeled traffic have been growing steadily. The bicycle, the wheeled cart, automobiles, motor trucks and motor buses spread all over China proper, into Manchuria and into central Asia. By the early 1960s greater China had a total of 275,000 mi. of wide road open to wheeled vehicles, though of this only about 180,000 mi. could be termed highways open to automotive truck and bus traffic, the balance being usable by carts, bicycles and other light wheeled traffic. Of these totals, about 80% (and 90% of the automotive highways) lay in China proper and Manchuria. The claim was made, at the end of 1958, that only 54 counties out of just over 2,000 could not be reached by some kind of wide road. There are few statistics for the vehicles themselves, but the total of light wheeled vehicles of all kinds at the end of 1958 was well over 1,000,000, whereas the automotive equipment is restricted, the 1959 total being approximately 105,000.

2. Railways.—Railway construction started in 1895 (see *History* above), made fair progress during the early years of the 20th century, stopped during the civil wars of the 1920s, resumed during the 1930s and World War II, and made progress after 1950. The older lines formed a skeleton system in the Yangtze valley and north China. The Russian- and Japanese-built Manchurian lines formed a good system linking the Russian Siberian system to that of China. All railways prior to 1926 were built by foreign companies on economic concessions, giving rise to much international difficulty and becoming a sore issue to the Chinese. Since 1930 new lines have been Chinese built and controlled. Construction by the Communists has been both strategic and economic, and is aimed at spreading the rail network over the whole of greater China and at connecting to the Soviet and Vietnam systems at several points.

The total mileage of lines in 1937 was about 6,850, excluding Manchuria, and that in 1948 after the recovery of Manchuria was about 16,000, though by 1951 only about 8,750 mi. had been reopened to traffic, owing to military destruction and deterioration since 1937. New construction to the end of 1959 totaled about 4,500 mi., which, with the completion of restoration of older lines, produced a total of about 20,500 mi. of operating line, with construction in progress on a few hundred miles. The chief new construction was in north China, Mongolia, the central Asian corridor and southwest China. The only significant double trackage in 1952 was the Peking-Mukden and other Manchurian lines, but by the end of 1959 about 1,900 mi. of double-track line were in operation.

Railway rolling stock suffered severely during the war years. In 1959 there were in operation about 4,700 locomotives, 128,000 freight cars and 4,800 passenger cars, with annual additions being made. The second five-year plan, 1958–62, called for significant additions to all aspects of the railway system, in both line construction and rolling stock. The rail system is China's economic mainstay in the program of industrialization, and represents the cheapest form of inland transport available.

3. Maritime Shipping and Inland Waterways.—The fleet of motorized seagoing ships, barges and tugs available to the Communists in 1949 numbered under 350, with a tonnage of about 200,000, of which only a very few were seaworthy cargo ships, the balance of a rather large fleet either having been destroyed during the war years or taken to Formosa by the Nationalists. The fleet grew considerably, totaling by the early 1960s about 600,000 tons, in addition to a considerable tonnage of chartered British ships. Its utility is coastwise and on the lower reaches of a few rivers, except for the tug fleet, which chiefly is used on the inland waterways. The tonnage of about 300,000 native junks in 1958 was about 4,000,000, about one-third of which could work both the coastal zone and the major inland waterways, the balance being purely inland craft. Their carrying capacity was less than the tonnage would suggest, owing to their slowness. There are in the vicinity of 70,000 mi. of rivers and canals navigable to all kinds of watercraft, about two-thirds of this being limited to small craft and rafts, or to seasonal traffic. The distribution is chiefly within the Yangtze basin and south China, except for a very few navigable streams in north China and Manchuria. Waterborne traffic formerly amounted to between 10% and 15% of all freight carriage, also accounting for a significant share of the passenger movement, but in 1959 it handled about 20% of all freight moved.

At the end of the war many of the ports were in poor shape, and the navigational services largely inoperative. These subsequently were restored to their former quality, Shanghai resuming its dominant position in all forms of water movement of cargo and passengers.

4. Air Transport.—When the People's Republic was established a large number of airfields were available. With Soviet aid, equipment and personnel a civil air line was established in 1950, which became a state-controlled company in 1955 with, by then, dominantly Chinese personnel. About 20,000 mi. of passenger and freight routes are flown regularly, connecting the major Chinese cities, and linking up with Soviet air services.

5. Postal Services.—The Chinese postal service began operations in 1879, and was increasingly improved and extended over the years. All foreign powers withdrew their postal agencies from China in 1923. During the varied civil wars of the 1920s and the period of military conflict from 1937 to 1949 the postal services operated with surprising efficiency, delivering mail through military lines. During the 1920s there were maintained about 11,000 post offices and postal agencies, several hundred of which included postal savings bank facilities. The number of offices has been greatly increased under the Communist governments, reaching over 60,000 in the late 1950s.

6. Radio and Telecommunications.—Telegraph lines began to be privately built in China during the 1880s, became government controlled in 1908 and have gradually expanded to a fairly complete network covering all of greater China with a mid-1950s mileage of about 120,000 mi. of line. The telephone developed more slowly, except in urban areas, but by the late 1950s the total line mileage was close to 90,000, and trans-China long-distance service was in operation. A network of international telecommunications also was established, with centres in Peking and Shanghai connecting more than 80 countries. Radio, of course, is much younger, but has developed even more highly than either the telegraph or telephone systems. During the 1930s many private concerns and government agencies installed their own radio systems for trans-China communication. Under the Communists the radio communications have been further developed, both for message work and for general broadcasting. The broadcast network completely covers the country and, by the device of the fixed-tuning village and community centre loudspeakers, can completely blanket the country to bring almost the entire Chinese population into rapid and effective contact with central and regional officialdom.

See also references under "China" in the Index volume.

(J. E. Sr.)

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CHINA (ware): *see* CHINAWARE.

CHINA CLAY: *see* KAOLIN.

CHINA SEA, part of the Pacific ocean (*q.v.*) off the coast of China. The China sea, which has a total area of 1,377,700 sq.mi., is divided by the island of Formosa (Taiwan) into the East China sea in the north and the South China sea in the south.

East China Sea.—This portion of the China sea, called Tung Hai by the Chinese, is bounded by the China mainland in the west, Formosa in the south, the Ryukyu Islands in the southeast, and Japan’s Kyushu Island and Korea in the northeast. The East China sea, which has an area of 482,300 sq.mi., includes the Yellow sea (Huang Hai), which is an embayment between Korea and the north China mainland. The East China sea communicates through the Korea strait with the Sea of Japan, through the Formosa strait with the South China sea, and through the several straits between the Ryukyu Islands with the Philippine sea, also a section of the Pacific. Most of the East China sea is occupied by a continental shelf, on which the water depth ranges from 100 ft. in the west to 600 ft. in the east. The easternmost part adjoining the Ryukyu Islands is a deepwater trench reaching a depth of 9,126 ft.

The climate is dominated by the monsoonal system of east Asia, in which the steady cold, dry winter monsoon from the northwest alternates with a feeble, irregular, warm, moist summer monsoon from the southeast. Typhoons, which are tropical storms typical of east Asia, occur during the warm season and number three to four storms a year on the average. January temperatures over the East China sea range from 40° F. in the northwest to 60° in the southeast; July temperatures average 80°. Annual precipitation ranges from 45 in. in the west to 90 in. in the east. The eastern part of the sea is dominated by a strong warm northward current, which is a continuation of the north equatorial current of the central Pacific. The current enters the East China sea through the straits of the southern Ryukyu Islands and, flowing north, branches into a northern arm that enters the Sea of Japan through the Korea strait and a southern arm that skirts the south coast of Kyushu and becomes the Japan current (Kuroshio). In the shallower western section of the East China sea, currents shift seasonally with the monsoon, flowing southward in the winter and northward in summer. In view of the vast volume of sweet water carried by the Yangtze river, the chief inlet of the sea, its salinity, which is normally 34.5 per thousand, drops to 10 or even 5 per thousand in the vicinity of the Yangtze estuary. Water temperatures range in the winter from 45° in the northwest to 60° in the southeast; in the summer they are generally 80°. Below a depth of 5,000 ft. the water temperature is uniformly 36.5°. Tides reach 20 ft. or more along the China mainland, notably at Hangchow, but drop to 4 or 5 ft. in the Ryukyu Islands. Fishing is an important branch of the economy of China, Formosa, Japan and Korea, and their fishermen make rich catches of sardines, milkfish, tunas, sea breams, croakers and other species, as well as shellfish and seaweeds. The principal ports on the East China sea are: Foochow, Wenchow, Ningpo, Shanghai, Sinhailien, and the Yellow sea ports of Tsingtao, Tientsin, Ch'in-huang-tao and Dairen in China; Chinnamp'o and Chemulpo in Korea; Nagasaki in Japan; and Chi-lung in Formosa.

South China Sea.—This portion of the China sea, known by the Chinese as Nan Hai, with an area of about 895,400 sq.mi., is bounded by the southeast Asia mainland in the west, Borneo in the south, the Philippine islands of Palawan, Mindoro and Luzon in the east, Formosa in the northeast and the China mainland in the north. It receives several major streams of southeast Asia, such as the Hsi Chiang (West river) of southern China, the Red river of North Vietnam, the Mekong of Laos, Cambodia and South Vietnam, and the Menam Chao Phya of Thailand. The mainland shore line is fairly regular and contains only two major indentations: the Gulf of Tonkin and the Gulf of Siam. Most of the South China sea is underlain in the west and south by the continental shelf with depths of less than 500 ft. Only in the northeastern section do depths exceed 15,000 ft. Unlike the East China sea, which is devoid of islands, the South China sea is speckled with a vast number of islands and reefs. These are part of the Pratas group (Tung-sha), the Paracel (Hsi-sha Ch'ün-tao group), Macclesfield (Chung-sha bank), and the Spratly (Nan-sha group), all of which are claimed by the People's Republic of China. In the far south, the Natuna and Anambas islands are part of Indonesia.

The South China sea is subject to submarine earthquakes and volcanic eruptions that effect changes in the surface relief of the sea bottom. Like the East China sea, it is dominated by the monsoon climate with alternating seasonal winds. However, in view of its lower latitude, the South China sea has high winter temperatures, ranging from 60° in the north to 80° in the south near the equator. Annual precipitation averages 100 in. Warm-season typhoons are more common than in the East China sea, with as many as 15 occurring in August in the northern portion. Currents shift seasonally, with a predominant southward flow in the winter and a northward flow in the summer. These seasonal currents are especially strong in the western part of the sea and are counterbalanced by weaker currents moving in the opposite direction in the east. Tides reach 20 ft. in the Gulf of Tonkin. Tuna, sardines and mackerel are among the most important commercial fish in the region. The principal ports are: Hong Kong, Canton and Chan-chiang (Tsamkong) in China; Haiphong in North Vietnam, Saigon in South Vietnam; Bangkok in Thailand; and Manila in the Philippines. The South China sea is a major sea lane for all ships passing from Europe through Singapore to the far east. (T. Sd.)

CHINAWARE, a term used as early as the 17th century to describe ceramics imported into England from China. Since then, it has come to be used almost synonymously with porcelain to designate most of the finer ornamental and useful ceramic wares.

The types of chinaware discussed in this article will be confined to the translucent, vitreous ceramic wares such as American household china, American hotel (or restaurant) china and English bone china. These ceramics are made with a high first, or bisque, fire at about 1,250° C. to 1,300° C. and a second, or glaze, fire at a lower temperature, about 1,100° C. to 1,200° C., followed by decorating firings at temperatures lower than the glaze firing.

The nonvitreous, opaque earthenwares, which are often called china in a broad application of the term, are manufactured by processes similar to those used for translucent wares. However, earthenwares have different clay body formulas and lower firing temperatures and would be absorbent if left unglazed. (*See* Pottery and Porcelain; Earthenware.)

Principal Raw Materials of Chinaware.—*Clay* is the basic essential ingredient of chinaware. It is formed by the decomposition, due to weathering or pneumatolytic action, of igneous rocks such as granite, gneiss and pegmatite. This process began ages ago with the cooling of the earth's crust and is continuous, so that more clay is constantly being formed.

Ceramists define clay as hydrous silicate of alumina; *i.e.*, a substance composed largely of aluminum oxide (Al_2O_3), silicon dioxide (SiO_2) and combined water. However, pure clay is practically nonexistent in nature. All clays contain impurities, usually compounds of iron and magnesium, which sometimes must be removed, depending on the type of ware to be made.

It is possible to make some types of pottery, such as coarse earthenwares, from clay as it is found in the earth. In order to provide the attributes desired in finished chinawares, they must be made from special clays plus other ceramic materials. This mixture of clay and other substances is called the chinaware body, clay body or batch.

Kaolin, or china clay, constitutes about 40% to 50% of the chinaware body. This is the only type of clay from which a white, translucent, vitreous ceramic can be made. Kaolin is a refractory clay, which means it can be fired at high temperatures without deforming; because of this characteristic it forms the framework of the chinaware body. It is a "white burning" clay, which means it imparts whiteness to the finished ware.

The early discovery of kaolin in China enabled the Chinese to produce true porcelain from about the 9th century A.D. After kaolin was found at St. Yrieix, near Limoges, France, and also in Aue, Ger., and Cornwall, Eng., Europeans began to produce fine porcelains and chinawares. In the United States, the principal sources of kaolin are in North Carolina, Georgia and Florida.

Ball clays, which constitute about 10% to 15% of the chinaware body, are refractory clays with a high degree of plasticity, and are added to make the body more workable. They also aid in the fusing, or vitrification, thus strengthening the ware. They fire to a creamy colour and cannot be added in amounts exceeding 15% without noticeably altering the whiteness of the finished china. Ball clays are more widely found than kaolins. Devonshire and Dorset in England, and Kentucky and Tennessee in the United States are important sources.

Flint, or pure silica, is a most important ingredient of American commercial china, although it is not used in English bone china. Its addition to the batch lowers the shrinkage of the body before firing and adds hardness and strength to the fired ware. Flint is made by grinding crystalline quartz or quartzite sand to powder. It is plentiful and can be obtained easily in most parts of the world. In the United States, it is mined extensively in Illinois, West Virginia and Pennsylvania.

Feldspar is needed in chinaware to act as a flux, that is, it melts first during the firing, thus helping to dissolve the other body materials and fuse them into a vitreous mass. As the ware cools, the feldspar hardens and forms a binding element that increases the hardness and translucency of the fired ware. Feldspars, or "spars" as they are called in the industry, vary in composition. There are two general types: (1) potash spars, such as orthoclase, which contain potassium and have the theoretical formula $KAlSi_3O_8$; and (2) soda spars, such as albite, which contain sodium and have the theoretical formula $NaAlSi_3O_8$.

Commercial feldspars are mixtures of potash and soda spars and are made to order to meet the requirements of the manufacturer. A mixture having a high content of potash is used in the chinaware body. North Carolina produces a large percentage of the feldspars used in the United States.

Cornwall stone (Cornish stone), or china stone, is a unique feldspathic material found at Cornwall, Eng. It forms 20% to 30% of the body of English bone china, in which it acts as a flux. It is also used in glazes and bodies of other chinawares.

Bone ash is a calcium phosphate made by calcining (roasting) bones of cattle and grinding them to a fine powder. Some authorities consider bones of oxen best for this purpose. This material forms from about 25% to 45% of the body of English bone china, in which it acts as a flux and imparts translucency. When added in large amounts, it acts as a refractory along with the kaolin in keeping the ware from deforming during firing.

Other supplementary ingredients are added in small percentages to the body to facilitate production. Dolomite provides calcium and magnesium; bentonite increases plasticity; talc (steatite) and nepheline syenite act as fluxes.

Formulas.—A typical formula for U.S. household china body is: kaolin, 40%; ball clay, 10%; feldspar, 30%; flint, 18%; dolomite, 2%. This ware is given a bisque firing of about 1,270° C. and a glaze firing of from 1,100° to 1,200° C.

Bone china was made experimentally at several English factories, including Bow and Chelsea, as early as the mid-18th century. However, it was perfected and first marketed in quantity in England by the second Josiah Spode (1754–1827) about 1800. So successful was his venture that many other factories in north Staffordshire began to make similar ware and thus created the great English bone china industry. Spode's original bone china formula was: kaolin, 3½ parts; Cornish stone, 4 parts; bone ash, 6 parts.

Preparing the Body.—After the formula for the chinaware body has been determined, the ingredients must be thoroughly mixed, purified and processed to the form and consistency necessary for shaping the ware. The steps in this process vary with the factory and type of ware, but in general are as follows:

1. Blunging—the term used in ceramics for mixing the batch with water in a tank called a blunger.
2. Grinding—reducing the body materials to the necessary degree of fineness. This is usually done in a ball mill, a cylindrical tank lined with porcelain and containing a "charge" of flint pebbles. It is sometimes possible to mix and grind simultaneously in ball mills, thus eliminating the need for blungers.
3. Screening—passing the batch through a series of screens, usually varying in fineness from 80 to 100 meshes to the square inch, to remove coarse particles left from the grinding.
4. Magnetic separating—passing the batch over strong electromagnets to remove iron impurities that would discolour the white body of the china during firing or that appear as brown or black spots in the bisque ware.
5. Filter pressing—removing the surplus water and forming the body into soft, plastic clay slabs for storage or processing to the appropriate consistency for shaping the ware.
6. De-airing—eliminating bubbles that would cause defects in the finished ware.

The ceramic industry in the 20th century has notably accelerated the development of machinery to facilitate these operations and decrease costs. Machines have been developed that will blunge, grind, purify, filter, and de-air the chinaware body automatically and deliver it in the form of slip for casting, or soft plastic clay of the proper consistency for jiggering or pressing.

Forming the Ware.—Most useful and ornamental chinaware is produced by one of the following methods: (1) wheel throwing; (2) jiggering; (3) slip casting; or (4) pressing.

Wheel throwing is a process in which the potter, who must be highly skilled, forms the ware with his hands on a revolving disk, or wheel, mounted on a vertical shaft; the wheel may be driven by mechanical power or by the potter. This process is better suited to the making of individual pieces than to mass production. After the ware has been formed, it is allowed to dry to a "leather-hard" state, and the feet and any other unfinished parts are completed by turning (*see* below).

Jiggering, or jollying, is the mechanical adaptation of wheel throwing; it is used in chinaware factories and in many studios where mass production or duplication of the same shape is required.

Hand jiggering is done by placing a plaster of paris mold shaped like the outside of the object, such as a cup, on the jigger head (which is essentially the throwing wheel). A piece of clay of the size and shape necessary to form the object is put into this mold. As the jigger rotates, a metal template shaped like the inside of the cup and fastened to an adjustable arm is slowly lowered into the revolving mold and clay; this action gradually smooths and shapes the clay to the profile of the template and completes the forming of the object. The cup handle is applied later.

In forming shallow objects, such as plates, the mold is shaped like the inside of the plate and the template forms the foot and underside. It is possible to jigger oval shapes by using an eccentric rotating gear.

Automatic jiggering machines have made it possible for factories to produce more than 240,000 table services per day.

Slip casting, or molding, is the simplest of all the clay fabricating processes for producing more than one piece of a particular kind of ware. It is especially useful in producing pieces, such as teapots, that cannot be formed easily by other methods. In the slip casting process, the ware is formed in molds made of plaster of paris and shaped to the contour of the outside of the object.

Once the mold is ready, the clay body is mixed with water to a creamy consistency called slip; the slip is then poured into the mold until its level is at the top of the mold. The mold, being porous, rapidly absorbs the water from the slip, causing a coating of clay to form on the surface of the mold in the shape of the object desired. The thickness of the ware is determined by the length of time the slip is allowed to remain in the mold. It may be necessary to add more slip from time to time to maintain the slip level; otherwise the level will drop as the mold absorbs water from the slip. When the ware is of the desired thickness, the excess slip is poured out and the mold inverted to drain and to allow the clay to harden slightly.

As soon as the clay has hardened sufficiently, usually in about half an hour, the ware is removed from the mold and finished by trimming the mold fins, filling any holes left by air bubbles, and turning or smoothing the top and foot, if necessary. Extra parts that have been molded separately, such as handles for cups, are applied and the ware is ready for firing.

Figurines and other sculptured forms are especially adapted to casting when more than one of a kind is wanted. These are cast in several "piece molds" and the parts assembled and put together by a "repairer" while the clay is still somewhat moist.

Pressing of clay wares is done in plaster of paris molds. The clay body can be used wet, semidry or dry. In the past, automatic pressing techniques have been more generally used for tiles, bricks, electrical wares and other industrial products than for artistic wares. However, the trend in chinaware factories in the 1960s was toward increased use of the newer and faster automatic techniques, such as ram-pressing.

Turning.—Turning is the process of finishing the green (unfired) ware, after it has dried to a leather-hard or air-dried state, by shaving and paring the surface with a variety of metal tools. This technique is used to smooth and finish foot rings on wheel-thrown wares or undercut places on molded or jiggered pieces. It is usually done on the potter's wheel or jigger as the ware revolves, although a lathe can be used.

Firing the Bisque (Unglazed) Ware.—*Setting the Kiln.*—Placing the ware in the kiln in preparation for firing is called setting the kiln. This operation requires great care and specialized knowledge of packing and supporting the clay wares so that they will not warp or crack when subjected to heat. Bisque wares can be set in rings, placed in other specially designed supports called kiln furniture or bedded in silica. Some wares are packed in boxlike containers called saggers (or saggars) to prevent breakage or to avoid direct exposure to the kiln atmosphere.

Whenever conditions permit, the ware is placed on shelves made of silicon carbide and separated by posts made of the same material. This is called open setting and is preferred because it lessens weight and conserves space and heat. Silicon carbide in the early 1960s was replacing fire clay as the material for kiln furniture. especially shelves, because of its superior strength in relation to weight.

Temperature Indicators.—The temperatures inside the kiln and inside the wares are measured by pyrometers or pyrometric cones. The pyrometers show the temperature of the kiln atmosphere, while the cones indicate the temperature of the ware, which. because of its thickness, may be lower at some periods than the temperature of the kiln atmosphere. The cones are slender pyramids, about 2″ high by ½″ wide at the base, made from ceramic materials that will melt at predetermined temperatures. The 60 cones in a standard series have melting points ranging from 605° C. to 2,015° C.

Usually three cones are selected; the first melts a few degrees below the maturing temperature of the ware; the second melts at or near the maturing temperature; and the third melts a few degrees above this temperature. These cones are set in a row, with each cone at a slight angle, in a flat piece of soft clay and are then placed in the kiln so they can be observed through a peephole. When the cones begin to melt and bend, the ceramist knows that the maturing point of the firing cycle has been reached. The fire is usually cut off before the last cone deforms, and the kiln then is allowed to cool.

The Firing Process.—The soft, dull-coloured clay body is transformed to brilliant white translucent chinaware by the firing process. In the firing, the claywares are heated to the temperatures necessary to mature the body, glaze and decorations. These temperatures vary from about 600° C. for soft bisque pottery to 1,480° C. for Copenhagen porcelain, and to over 2,000° C. for high-fired industrial and scientific wares.

Kilns.—In modern ceramic practice, there are two basic types of kilns: periodic kilns and continuous or tunnel kilns.

In periodic kilns, the ware is placed in a cold kiln and the temperature is gradually raised to the degree necessary to mature the ware or glaze; the kiln then is allowed to cool and the ware is removed. These kilns are useful in studios and factories where production is not continuous.

Tunnel kilns are constructed in straight or circular form and are lined with refractory bricks. As the ware moves through the tunnel on kiln cars or movable trays, it passes through a series of zones of different temperatures, gradually increasing to the maximum temperature, and then cooling again as the ware approaches the exit. The firing cycle for bisque wares often takes several days. The glaze firing for china is usually shorter.

Glazing.—Chinaware, in common with other ceramic products, can be covered with a glassy coating called a glaze. Glazes have the same characteristics as glass, and may be shiny or matte, coloured or colourless, and transparent, translucent or opaque.

Glaze Composition.—Glazes are made from silica (one of the basic materials used in making glass) combined in most cases with either soda, lead, lime or borax, or combinations of these materials. Silica, if melted alone, will make a glass but it cannot be used as a glaze because its melting temperature (1,710° C.) is higher than the melting points of chinaware or porcelain bodies. When soda or the other metallic oxides mentioned above are added to the silica, they act as fluxes and cause the silica to melt with them at temperatures low enough so that the silica-oxide mixtures can be used as glazes for ceramic wares. A small amount of alumina has to be added to most glazes to keep them from running off the vertical surfaces of the ware.

A number of other glaze materials, such as zinc, barium and magnesia (magnesium oxide), also act as fluxes. Sometimes these substances contain more than one of the ingredients needed in the glaze. For example, commercial feldspars, the principal material for producing high-fired glazes, usually contain soda, potash, alumina and silica.

Most chinawares are glazed with a lead-borosilicate glaze, which is a mixture of lead oxide, boron oxide, silica and alumina.

Preparation.—In preparing the glaze for application, the ceramist grinds the ingredients to a powder and then mixes the powder with water. The grinding is done with flint pebbles in a ball mill.

Since glazes are usually mixed with water during their application as well as during their preparation, it is desirable to use ingredients that are insoluble in water so they will not dissolve and be lost or, if toxic, such as lead, so that they will be less injurious to the worker. When a glaze is composed of ingredients that are insoluble in water, it is called a raw glaze; its components are mixed, ground and applied without any further processing.

Soluble ingredients can be melted, under controlled conditions, with silica and other necessary components into a glass called a frit. After cooling by quenching, this frit can be ground to powder and used as an insoluble glaze ingredient. Glazes of this type are called fritted or frit glazes. Most glazes used on chinawares are fritted glazes.

Glazes can be coloured by adding metallic oxides, alone or in combination, to the glaze formula. Some oxides give more than one colour depending upon the amount used, the glaze combination and the firing conditions.

Application.—After the glaze is prepared it is applied to the ware by one of three basic methods: (1) dipping, in which the ware is immersed in the liquid glaze; (2) spraying, in which the liquid glaze is sprayed on with a spray gun as the ware revolves on a turntable under a ventilating hood; this method gives better control of glaze thickness and produces excellent results when more than one colour is used, or when shaded or stenciled pattern effects are desired; (3) painting, in which the glaze is applied to the ware with a brush; textured and other decorative effects can be produced with this method.

Firing the Glaze.—After the bisque ware or the green (unfired) ware has been coated with glaze, it is placed in the kiln and fired to the temperature necessary to melt the glaze and fuse it into an impervious coating on the ware. Glaze firing can be done either in periodic or tunnel kilns as described for the bisque firing process. It is necessary, however, to place the ware in the kiln in such a manner that the melted glaze will not fuse to other pieces or to parts of the kiln. This is accomplished by using various types of supports made from fire clay such as stilts, pins, spurs, saddles and other pieces of kiln furniture. These supports are designed to leave a minimum of marks on the finished ware. Marks from stilts can be found on the underside of the rim or foot of plates or similar pieces. They often appear as three marks or pits in the glaze where the three points of the stilt contacted the ware. If the base of the foot ring is not glazed, it can be set directly on the kiln shelf with no stilt for support. This eliminates the stilt mark but leaves a "dry foot."

Decorating the Ware.—*Underglaze decorations* are more lasting because they are protected by the glaze covering, but the colours are limited because they must be fired at the same temperature as the glaze. Many colours will "fire away" and disappear at the temperatures required for chinaware glazes. The materials used for colour pigments in underglaze designs are usually oxides of iron, cobalt or copper, which are mixed with fluxes and refractories, such as flint, to keep them from running and blurring under the glaze.

Overglaze decorations are applied on the glazed ware after it has been fired and cooled. The colours used are called enamels and are actually glazes with the ingredients so proportioned that they fuse at whatever temperatures are desired, usually at about the softening point of the glaze or slightly lower, and thus attach themselves to the glaze surface or even sink into it during the firing. These colours are usually opaque or semiopaque and are made by grinding together a glass (or frit) with small amounts of clay, tin oxide and one or more of the colouring materials. After they are applied to the ware, they are fired in the decorating kiln.

Transfer printing or decalcomania is the process by which a large proportion of commercial chinaware is decorated. Decalcomania prints, or decals, also known as transfers, are designs printed in overglaze enamel colours on a special paper that has been coated previously with a gelatinous material. When these decals are used for overglaze decoration, the ware, which has already had the bisque and glaze firings, is coated with varnish that dries to a semihard or tacky consistency. The printed side of the decalcomania paper is placed against this varnished surface and rubbed with felt or bristle rubbers until the printed colours have adhered to the varnished surface. The paper is removed by washing in water, leaving the design on the ware. The decorated ware is then fired at about 850° C. This burns away the varnish and fuses the enamel colours to the glazed surface of the ware. When decals or other transfer prints are used for underglaze decoration, the techniques must be adapted to substances and colours that can be used under the glaze.

Hand-painted decorations can be placed either over or under the glaze. The colours used are the same enamels as described above. These colours are ground to a powder and mixed with oil of turpentine, linseed oil, or similar vehicles that allow them to be painted on the surface of the ware with brushes. Combinations of hand-painted and transfer decorations are often used. The outline or other part of the decoration is put on with a transfer print, then parts of the design such as leaves, flowers, clothing or water are painted in.

Gold or gilded decoration is usually fired at a lower temperature than the enamel colours. It ranges in quality from pure gold, which must be burnished after firing, to the diluted liquid gilt decorations, which contain so little metal that they are actually lustres. Because of its low-firing temperature, pure gold decoration is very soft and will usually wear away much quicker than enamel colours.

Factory Marks.—A factory mark on chinaware is the monogram, seal or trade-mark usually found on the underside of the ware. This mark can be over or under the glaze and is usually painted or printed, although some marks are impressed or incised in the soft clay before the bisque firing. These marks are to china what hallmarks are to silver, except that china manufacturers do not have to state whether the object is porcelain, earthenware or some other ceramic body; neither do they have to state the content of the various ingredients. Incised, impressed or painted letters and numerals that occur at random are called workmen's marks and sometimes indicate a dating, or maker, in code. Usually they are without meaning unless explained in factory records, and do not help in identification.

Chinaware that has the country of origin indicated in the trademark is generally found to have been made after 1891, the year the United States began requiring that imported ceramic wares be marked with that information. But this is not an infallible rule for dating ceramics because some wares are marked with paper stickers that can be removed; also, ceramics made for use and sale outside the United States would not need to comply with this regulation.

There are a number of books that give the date and origin of factory marks. Since rare marks are often forged, it is advisable to consult museum curators or reputable dealers when identifying problem pieces.

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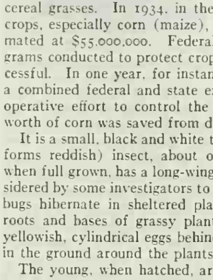
CHINCH BUG, a North American hemipterous insect (*Blissus leucopterus*) occurring in most parts of the United States, but particularly destructive to grain crops in the valleys of the Mississippi, Missouri and Ohio rivers (*see* Hemiptera). A most destructive native insect, it has frequently damaged crops to the extent of many million dollars in a single year. It was first noticed in North Carolina, at the close of the Revolutionary War, and was first described and named by Thomas Say in 1831.

Originally, the chinch bug fed upon wild grasses, but when cultivation of wheat reached its native haunts it multiplied enormously and soon became a pest of the first importance on many cereal grasses. In 1934, in the U.S. alone, the damage to grass crops, especially corn (maize), wheat, oats and barley, was estimated at $55,000,000. Federally supported and organized programs conducted to protect crops from the insects have been successful. In one year, for instance, it was estimated that through a combined federal and state expenditure of $1,212,776 in a cooperative effort to control the chinch bug, at least $25,500,000 worth of corn was saved from destruction.

It is a small, black and white to gray and white (early immature forms reddish) insect, about one-sixth of an inch long, which, when full grown, has a long-winged and a short-winged form (considered by some investigators to be a separate species). The adult bugs hibernate in sheltered places, usually clustering about the roots and bases of grassy plants. In the spring they lay their yellowish, cylindrical eggs behind the lower blades of the grain or in the ground around the plants.

The young, when hatched, are bright red in colour, and begin at once to suck the sap of the plants. They grow rather rapidly, become dark in colour and shed their skins five times, the adult being the sixth stage. By the time the majority are full grown, or even before, the wheat has become too hard to suck, or harvest begins, and they are then compelled to migrate in search of food. The cropping systems prevalent in the middle west at once offer new sources of food; corn, usually young and succulent at this time, provides an excellent host.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CHINCH BUG (BLISSUS LEUCOPTERUS), LONG-WINGED FORM

In seasons of abundance the bugs march in throngs from the wheat to the corn. The full-grown individuals do not generally take wing but walk along the ground. Occasionally, however, at this time they take wing and scatter. There is generally a second generation on corn, the adults of which appear in the autumn and fly back to their winter quarters at the roots of wild grasses or other sheltered places.

The chinch bug is most susceptible to weather conditions, and with wet weather in the late spring and toward the end of July the young are either destroyed by the water or develop an epidemic fungus disease.

In dry weather, however, they flourish. Seasons in which they occur in great numbers are rarely consecutive. Outbreaks have lasted for two or three years, but, in the same locality, years of abundance are apt to be separated. Serious damage may be obviated by proper cropping of farms, reducing the acreage of small grains and using the land for immune crops. Resistant varieties of grains have also been found.

Control measures often effective in small areas are the spraying of seriously infested crops with nicotine sulfate, and, in summer, the trapping of the crawling bugs in chemical barriers (ditches or lines of creosote, DDT, etc.) as they migrate from ripening wheat to young corn.

Bibliography.—*Farmers' Bulletin* no. 1780, U.S. Department of Agriculture; *Iowa Extension Circular* no. 213; "Insects," *1952 Yearbook of Agriculture*, U.S. Department of Agriculture. (L. O. H.; X.)

CHINCHILLA, a small rodent resembling a long-tailed rabbit but with smaller ears. The best-known and commonest member of the species, *Chinchilla laniger*, is the Chilean or coastal variety. These animals are about 14 in. long, including the hairy, tufted, 5-in. tail. The fur, about one inch long, is exceedingly soft and of a beautiful pale gray colour with dusky overtones; a black streak runs the length of the tail above and below. Rudimentary cheek pouches are present. Chilean chinchillas occur in loose communities among the rocks in the warmer foothills and valleys along the western base of the Chilean Andes. They live in burrows and are active above ground in the morning and late afternoon. At the least alarm they scamper to the safety of the burrow only to emerge, impelled by curiosity, a few moments later. They feed about sunset, sitting on their haunches and manipulating their food with the forepaws. They are vegetarians, feeding on seeds, fruits, grains, herbs and moss. Usually two litters of two young each are produced each year; gestation is about 110 days.

BY COURTESY OF THE NEW YORK ZOOLOGICAL SOCIETY

CHINCHILLA (CHINCHILLA LANIGER)

The Peruvian or royal chinchilla, which once inhabited the higher elevations of the western slopes of the Peruvian Andes, is virtually extinct because of having been hunted intensively for its fur. The Bolivian variety, which inhabits the eastern slopes and plateaus of the Andes in Bolivia and northern Argentina, is still fairly numerous.

Chinchilla fur is exceedingly valuable, the most costly being that of the rare royal chinchilla. The use of chinchilla fur dates back at least to the Incas, who also prized the animals as food. The Chilean chinchilla is raised extensively in captivity and presents no difficulties save for its sensitivity to humid conditions. The first breeding stock was introduced into the United States about 1923 and the progeny, together with a few subsequent introductions, have given rise to a flourishing industry. Little fur was being produced commercially in the early 1960s; instead, the animals were being reared primarily as breeding stock. Efforts to raise the very rare royal chinchilla at that time had not been notably successful. (*See* FUR: *Fur Farming.*)

The viscacha (*q.v.*) of South America is a related but much less valuable fur bearer. (K. R. KN.)

CHINDWIN, a river of Burma, the largest tributary of the Irrawaddy, is called Ningthi by the Manipuris. Length about 650 mi. It is formed by the junction of the Tanai, the Tawan and the Tarôn or Turông, but there is doubt as to which is the main stream. The Tanai rises on the Shwedaung-gyi peak of the Kumôn range, 12 mi. N. of Mogaung, and flows due north until it reaches the Hukawng valley, when it turns to the west and meets the Tarôn or Turông river. The last-named flows into the Hukawng valley from the north. Its sources are in the hills to the south of Sadiya, rising from 10,000 to 11,000 ft. above sea level. Below the Hukawng valley the Chindwin is interrupted at several places by falls or transverse reefs. At Haksa goods have to be transshipped from large boats to canoes. Not far below this the Uyu river comes in on the left bank at Homalin and from this point downward steamers ply for the greater part of the year. The Uyu flows through a well-cultivated valley, and during the rainy season it is navigable for a distance of 400 mi. from its mouth by steamers of light draft. Below Mawlaik the only considerable affluent of the Chindwin is the Myittha, which drains the Chin hills. The Chindwin rises considerably during the rains, but in March and April is so shallow in places that navigation is difficult even for small launches. Whirlpools, narrows and sandbanks also cause considerable trouble. The extreme outlets of the river are 22 mi. apart, the interval forming a succession of long, low, partially populated islands. The most southerly mouth of the Chindwin is, according to tradition, an artificial channel, cut by one of the kings of Pagan. It was choked up for many centuries, until in 1824 it was opened out by an exceptional flood. *See* also IRRAWADDY. (L. D. S.)

CHINESE ARCHITECTURE. The art of building in China has always been closely related to the deep feeling of the Chinese people for the perfect harmony and order which is reflected in the world of nature. The general arrangement and planning of Chinese structures were rooted in religious and philosophical ideas of long standing and the basic plans, as well as the principles of construction, have remained the same during many centuries. The principal building material was wood, and a timber-support unit of column and brackets was basic to a constructive system which limited the depth dimension of a building, its height dimension somewhat, its length dimensions not at all. The story of Chinese architecture is that of the development of this timber construction technique and its expressive elaboration in a traditional society.

Historical and cultural information about the periods mentioned in this article will be found in CHINA. BUDDHISM also gives relevant background material. The principles of architecture are treated under ARCHITECTURE. Material on Chinese religious buildings appears in TEMPLE ARCHITECTURE. The development of architecture in other areas of the orient is discussed in JAPANESE ARCHITECTURE and INDIAN ARCHITECTURE. *See* also CHINESE SCULPTURE and CHINESE PAINTING.

This article is divided into the following sectinns:

I. History
  1. Carpentry Techniques
  2. Earliest Times
  3. Chou Dynasty (1122?–256 B.C.)
  4. Ch'in and Han (221 B.C.–A.D. 221)
  5. The Six Dynasties (221–589)
  6. Sui and T'ang Dynasties (589–906)
  7. The Five Dynasties and the Sung Dynasty (907–1279)
  8. Yüan Dynasty (1280–1368)
  9. Ming and Ch'ing Dynasties (1368–1912)
II. The Pagoda
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I. HISTORY

1. Carpentry Techniques.—A Chinese building may be described as a complex of posts and beams tenoned together to support a massive roof and to define the planes of enclosing walls. Substantial columns afford the primary support and rest freely on individual foundation stones whose upper surfaces have been carved to form dowels that are socketed into the bottoms of the columns. Wall beams and tie beams are tenoned into or through the upper ends of the columns. Upon this framework rests the structure that forms the steeply sloping roof. The roof truss repeats on a smaller scale the post-and-beam construction of the main support and by means of an internal arrangement of beams establishes the curvature and slope of the roof.

Each tie beam of the main support carries a pair of short posts, placed some distance in from each end, which together hold a shorter transverse beam. Into this beam is socketed another pair of posts supporting an even shorter beam. By means of such units, each a little shorter in length than the one immediately below, a stepped truss is raised until the required height of the roof at the head of the kingpost is gained. The kingpost stands immediately below the ridge beam and in the centre of the uppermost beam of the truss. Some additional support to the roof framing may be given by extra posts placed at strategic points along the beams. Roof purlins rest on or above the heads of the posts, whose various heights may be regulated to shape the contour of the roof precisely. The deep overhang of the eaves may be supported by extending the tie beams beyond the wall columns to catch the eaves purlins situated some distance out from the walls; or the eaves may be carried by an arrangement of cantilevers, or brackets, springing from the columns or rising above them. It is this elaborate technique of eaves support that distinguishes Chinese architectural form and contributes significantly to the visual unity and variety of Chinese buildings.

In one system, the brackets are socketed into the column itself and rise in a sequence of regularly increasing lengths until the topmost and longest bracket reaches the eaves purlin. In other arrangements, the brackets extend from a capital that is socketed into the top of the column or into the wall beam at a point immediately above the column. In such a system, the capital is fitted with a longitudinal arm holding three regularly spaced bearing blocks and a transverse arm with a bearing block at its free end. Such an arrangement may be considered the standard bracketing unit basic to most Chinese bracketing systems. This basic unit may be repeated, vertically, with the transverse arm regularly increasing in length until the eaves purlin is reached. The longitudinal arm grips a wall purlin from which rises the capital block of the next bracket unit. The transverse arm supports the corresponding member of the bracket unit above.

Often, the uppermost bracket arm is a slanting lever tethered at one end in the framework of the roof and sloping toward the eaves purlin at an angle parallel to that of the common rafters. This slanting arm is braced either by the horizontal bracket arm immediately below it or by a second parallel slanting arm, shorter and slightly below. Sometimes the stay for the slanting arm is the extension of an interior beam incorporated into the bracket unit. The slanting arm also may function as a true lever, with the inner end freed from its moorings in the roof framing and giving direct support to the aisle purlin. With the wall beam as fulcrum, equivalent thrusts on either side are held in balance.

Extra supports in the wall plane may take the form of struts braced between the wall beams and wall purlins at points in-between the column axes. Sometimes the strut is a simple post; at other times, it is a double brace, looking something like an inverted V. Support to the eaves at points between the column axes comes from one or more intercolumnar bracket groupings at the same level as and often exactly like those springing from above the columns.

Since walls had no supporting function, they could be made of unsubstantial materials such as mud plaster. The roofs of buildings of the first rank invariably were sheathed in tiles. The buildings themselves were set off from the ground by means of raised platforms.

2. Earliest Times.—The earliest known dwellings in north China were pits or caves which were covered with domed-up shells of sod. A more highly developed type, square in plan, with sunken floor, smoothed and plastered walls and a central fire pit, either followed or existed alongside of the rude pit dwelling. Other simple houses were roughly arched or gabled shelters of wood and thatch and mud. Platform houses, raised shelters of poles and brush, were apparently used in warm weather and were designed to overcome the discomforts of flood and the peril of marauding animals.

The city culture of the ancient Shang capital, An-yang (1300–1028 B.C.), in Honan, developed a style of building which was already recognizably Chinese. Wood was the chief structural material. Large oblong halls were raised upon tall rammed-earth (*q.v.*) platforms. Rows of wooden columns, somewhat symmetrically disposed, supported roofs of thatch. Some important buildings were oriented toward the south. A city wall, made of rammed earth and surmounted by lookout towers, enclosed the city proper. These were some of the traits characterizing the traditional building style which was to evolve in the millenniums to follow.

3. Chou Dynasty (1122?–256 B.C.).—The ballads of the "Poetry Classic," *Shih Ching*, often extolled the princely ancestral shrines and royal palaces raised by the rulers of the Chou states. These were invariably buildings which were awesome in size, with huge raised platforms, strong supporting pillars, wide-spreading roofs and rammed-earth walls.

Architectural forms and ornament seem to have been allotted according to rank or social status, as was to be always the case in later imperial times. The *Li Chi*, a standard compendium of Chou etiquette, states that "the pillars of the Son of Heaven are red, those of the feudal princes blackish, those of high officials blue-green, and those of the other gentry yellow." A commentator to the *Ch'un Ch'iu* remarked that "the rafters of the shrine of the Son of Heaven are to be hewn, rubbed smooth, and polished with a fine stone. Those of the princes are to be hewn and rubbed only, and those of high officials merely hewn."

Architectural ornament could have been either painted or carved. Richly sculptured walls and elegant, costly carving became more and more the vogue during the later years of Chou rule. Thatch was the usual roofing material until the 8th century when tile roofs began to be used in monumental structures.

A dynastic ode of the royal house recounted the foundation of the first Chou city by the chief Tan-fu; the plan was roughly symmetrical with one set of rammed-earth ramparts around the perimeter and another girdling the palace compound. These walls were broken by lofty and strong gates. In every part of the city design, left balanced right with big and little plots methodically measured out and related to each other.

The typical Chou mansion seems to have been planned with courtyards along a dominant axis. The main building stood at the rear of the major courtyard on a high platform and was subdivided into numerous symmetrically disposed areas. Along the front was a porchlike space called the *t'ang*. Behind the *t'ang* was the main room called the *shih*; this was flanked by smaller rooms, *fang*, *hsu*, *chia*. Sometimes a second *t'ang* spread across the rear or north side. The entire building may have been contained within a rectangle or may have had projecting wings on either side.

In this plan, the central axis, though dominant, was not pronounced with the clarity of later times. The building was approached by parallel front stairs and thus maintained a left and right balance of the elements.

The Late Chou rulers were notoriously extravagant and had a passion for building lofty lookouts called *t'ai* which, when associated with parks and artificial lakes, served as talismans, designed to win strength and prosperity for the state. The *t'ai*, park and lake combination had already become a classic pattern for imperial architecture by the end of Chou. The name *t'ai* probably referred to all kinds of towers regardless of specific form or method of construction. A *t'ai* was usually an elevated platform built of rammed earth which might have been sheathed in plaster and decorated. A separate superstructure sometimes capped the platform. Other *t'ai* had wood superstructures built over rammed-earth bearing walls and incorporated actual interior spaces.

Another curious feature of Chou princely architecture was the *Ming T'ang*, a royal hall whose specific form and function still remain enshrouded in mystery. Whatever its appearance in Chou times, it was considered of magical necessity to the sovereign and fired the imaginations of imperial architects for hundreds and hundreds of years.

4. Ch'in and Han (221 B.C.–A.D. 221).—When Ch'in Shih Huang Ti subjected the lords of Chou and brought all of China under one rule, he made possible the development of a genuinely national architecture which was more grand than any that had existed before. The magnificent palaces with which he adorned the new capital, the Great Wall and the network of military highways which he had built were as remarkable as the fantastic power of his warriors and the wealth of his treasury. The varied regional styles of Chou architecture were fused into a single imperial style, which was looked upon as an impressive symbol of national greatness. Under the "First Emperor," monumental architecture was thought to be indispensable to sound government.

The Han emperors, who succeeded Shih Huang Ti, also believed that a great architecture was necessary to stable government. They considered great size and overpowering beauty as the appropriate means for inspiring awe.

Ch'ang-an (Sian), the capital of Western Han, was used for many generations and suffered much irregular expansion motivated by necessity rather than a sense for order. It nevertheless betrayed something of the customary Chinese regard for symmetry and regularity in its general layout. The walled city was surrounded by a moat. Three monumental gateways opened each face of the enclosing wall; nine major avenues running each way dominated the network of streets. There was, however, after the initial expansion, no major palace on axis and the arrangement of government offices and major places of worship was all too often haphazard.

The reign of Han Wu Ti (140–87 B.C.) saw the erection of countless pleasure palaces more sumptuous than those of the Ch'in, and a number of architectural constructions designed to establish contact with the supernatural world. In 109 B.C. the emperor had built a *Ming T'ang* on an ancient site in Shantung. This structure had a single apartment with a broad porch on four sides and a wide overhanging roof of thatch. A moat encircled the shrine precinct. Then there was a double ring of walls surmounted by wooden towers. The approach was from the southwest, the direction appropriate to the "Yellow Emperor," and the shrine precinct was called K'un-lun after the fabulous paradise mountain of Taoist myth.

The usurper Wang Mang (A.D. 8–23), who momentarily replaced the Han line in the royal seat, used architecture to establish his claim to rule. Like the sage-kings of legend, he built a succession of monuments of the sort traditionally associated with kingship: a *Ming T'ang*, a *Pi-yung* lakeside hall, a *Ling T'ai* and a ninefold ancestral shrine. All of these were overpowering in size and, therefore, quite appropriate for an emperor. Wang Mang also built the first *Ming T'ang* in the imperial capital. This was a two-story building, "round above and square below," with eight windows and nine chambers. The magical number system which determined these arrangements extended also to the participants in the rite performed there. The whole was meant to embody a particular cosmological concept. This temple was burned when Wang Mang fell from power, but one comparable to it was erected at Lo-yang in A.D. 59. Among the other architectural wonders for which Wang Mang was responsible was an important shrine to the "Yellow Emperor" which was, as usual, gigantic in size and took the form of a Greek cross in plan.

When civil war destroyed most of Ch'ang-an, the Eastern Han line that came to power did its best to repeat its beauties at the new capital in Honan. Lo-yang, however, was distinctly more regular in design. The imperial palace compound, together with its great park, occupied the rear centre of the city and the axial boulevards were clearly marked by the principal government offices.

Palaces, mansions and public edifices followed a plan which was to become routine later on. A succession of courts, each more private than the one before, were aligned along a major axis. The building blocks were assembled in the courtyards with left balanced against right and the main hall on axis at the rear. There were the inevitable front and side gates; a major gate on axis was itself a proper building with interior chambers. Sometimes galleries leading back to the main hall bordered each court.

The major hall with its platform and left and right stairs was often two storied. On the east and west sides of the hall were areas called *hsiang*, which were partitioned off from the main chamber only by light screens or curtains. A surrounding aisle completed the unit. Sometimes all of the elements were covered by a single roof; in buildings of considerable size, the *hsiang* were roofed separately and had the appearance of wings. Another architectural type current in Han times was the *hsien*, which took the form of a raised porch attached to the front of a hall.

Single-story buildings often were ceiled; buildings set apart for imperial use had their coffered ceilings embellished to symbolize the "dome of Heaven."

The official architecture was lavishly decorated. It was habitually enhanced by sculpture and painting to a degree unknown before. Human and animal caryatids, brilliant polychromy, gilding, jade and bronze ornamentation enriched all architectural surfaces and forms. (*See* CHINESE SCULPTURE.)

Han palace complexes were filled with magnificent buildings of various sorts. Park annexes, moreover, had artificial lakes and hills, were set out with fine groves and strangely shaped rocks, and were stocked with rare birds and beasts. The largest buildings, the halls of state, were grandly colossal; many of them were as large as 400 ft. by 110 ft. in plan. Next to the halls of state, the most impressive features of the Han palace compound were towers of various sorts. Most of these were like the ancient *t'ai* in form, being raised on bearing walls of rammed earth which were faced with stone for greater beauty. Gateways were marked by paired towers called *ch'ueh* which were sometimes so modified that they took the form of monumental masonry pillars flanking an entranceway. A new type of high building, the wood-framed *lou*, became popular during Han. The *lou* was sometimes only two stories high and at others soared through many levels. The *ch'ueh* of the Ch'ien-chang palace were cylindrical and were topped by bronze acroteria in the shape of phoenixes. The Cloud *t'ai* at Lo-yang, which was destroyed by fire in A.D. 185, was used as a storehouse for rare books and other objects and must have been built with rooms and a wooden superstructure. Another tower, the *t'ai* for "communication with Heaven," was distinctly magical in function and was supposed to serve as a lure for Taoist Immortals. Another tower, which was furnished with chambers decorated with paintings of Heaven and Earth, the Supreme Unity and various supernatural beings, was equipped with sacrificial utensils to allow contact with the spirits of Heaven. An entire precinct, Ming-nien, "the radiant year," was composed of 5 walled areas and 12 wood-framed *lou* towers, and clearly embodied cosmological ideas.

Under Eastern Han, Buddhism made a partial penetration of China. Its first recognized temples were probably erected by the state and took on a simple form similar to that of secular halls. A building erected in A.D. 190, however, described as a Buddha shrine, was a two-story pavilion surmounted by a finial with nine bronze disks. Inside the pavilion sat a human figure fashioned out of gilt bronze. The shrine was surrounded by galleries and, like the stupa-ghara of India, was a forerunner of the later Chinese pagoda.

The Han style survived the second collapse of the dynasty and flourished as late as the 5th century when the Tatar rulers of Northern Wei, in tribute to the Chinese past, sent architects south to Lo-yang to survey its ruins. The Tatar capital later was transferred to Lo-yang and it was rebuilt on Eastern Han lines.

5. The Six Dynasties (221–589).—This period was marked by political instability and, for a long time, official architectural commissions were carried out on a smaller scale and in the still dominant Han style.

In the early 6th century, under the Northern Wei and Liang rulers, building activity took on new vigour, motivated primarily by the new religion, Buddhism. As soon as official interest turned to the new faith, Buddhist precincts began to be "dignified" in the traditional Chinese way, with walls, high gatehouses, galleries and monumental halls. More and more, costly materials and cunning craftsmanship were invested in Buddhist establishments of impressive size. The traditional forms had been given new meaning and the monastery was in architectural style often little different from the palace. Only the pagoda, fully developed as an architectural form, was specifically Buddhist; it was the only alien element in an utterly traditional way of building.

The best examples of the Six Dynasties style in wooden architecture are found in the halls, galleries and gatehouses of the Japanese monastery of Horyuji. These are characterized by an effective simplicity and a strict symmetry about both axes. The *kondo* still reflects an ultimately Indian notion in the disposition of its interior. The altar is in the centre with its images oriented toward the four directions; all are surrounded by a processional aisle. Chinese examples of the style may be found at the rock-cut cave-temples of Tun Huang in Kansu, Yun Kang in Shansi and Lung Men in Honan.

6. Sui and T'ang Dynasties (589–906).—The reunion of China under the Sui ushered in a second imperial age whose archi-

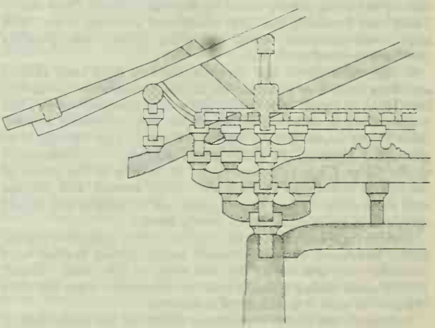


FIG. 1.—BRACKETING SYSTEM ON THE KONDO OF TOSHODAI-JI, JAPAN, T'ANG STYLE

tecture rivaled and surpassed the splendour of Han. In a tremendous burst of energy, a new capital city of Ch'ang-an was laid out, new palaces were raised and countless Buddhist temples were restored or newly founded. The new style developed rapidly, molded by new and better building techniques and a more mature aesthetic.

The Sui court placed a high premium on the science and fine art of building and heaped honours lavishly upon the skilled builders gathered in the capital. The names of four outstanding men of genius who contributed most to Sui operations have come down to us.

Yang Su was an expert designer of gigantic naval yachts who also helped to lay out the new city of Lo-yang and direct its construction. Yu-wen K'ai was an architectural historian who undertook an exhaustive study of the *Ming T'ang* prior to designing an intricate version of his own. He was also a hydraulic engineer who constructed, for the pleasure of the second Sui ruler, a rare rotating pavilion which was operated by an ingenious mechanism beneath its platform. Ho T'ai, a connoisseur of old pictures and *objets d'art*, was a most distinguished military engineer who designed an assault bridge to span rivers and, also, a demountable castrum complete with ramparts and towers which was capable of being set up overnight. He constructed a mausoleum for the dowager empress and designed the imperial insignia, robes and vehicles; he also staged the state festivals and other ceremonies. Yen Pi, a painter and calligrapher, was famous for his pleasure-palace designs and for the construction of a long canal waterway which served the Sui armies fighting in Korea. He was also commissioned to restore the Great Wall.

The T'ang dynasty continued the developments begun in Sui times and brought the empire to its full flowering. The perfect combination of talent, wealth and demand coincided with a stable and long-lived regime to allow for the refinement of building techniques and the maturing of the architectural style. T'ang design was marked by regularity and a pronounced spaciousness, and was dominated by a few massive elements. It gave an impression of great vigour and the repeated stress on the horizontal produced a feeling of solemnity and dignity.

The capital city of Ch'ang-an, laid out by the Sui and inherited and developed by the T'ang, was characteristically huge. It was bounded by the usual high ramparts and ordered by the traditional checkerboard of streets and avenues with an unprecedented regard for strict symmetry and formal order. The imperial enclosure, on axis toward the rear of the city, embraced all of the government offices as well as a lavishly laid out palace. There was a second, larger palace compound just outside the city limits to the northeast which became a favourite imperial residence and went by the name Ta-ming. Each palace was developed around an arrangement of three large halls on axis, a formula which was later often repeated. This three-part scheme was ultimately derived from the Chou ritual books which insisted that the Son of Heaven rule from three courts. It manifests at Ch'ang-an a classicistic revival of what was thought to be a very ancient form.

Buddhist architecture flourished under the early rulers of T'ang, as it had under the Sui, but after the reign of Ming Huang (Hsuan Tsung; 712–756), Taoist influence became so strong as to effect the gradual decline of Buddhist building.

Sui and T'ang temples and shrines have suffered much from the ravages of war and the action of time, and little remains to reflect the magnificence which once was theirs. However, the Todaiji monastery in Nara, Japan, built in the mid-8th century to rival and surpass the most glorious of T'ang temples, preserves for us a goodly number of the features characteristic of the T'ang imperial style. Designed to impress by reason of size, both precinct and buildings are astoundingly spacious and grand. The imposing Buddha hall, actually a throne hall in religious dress, dominates the scheme. The Chinese ideal of order is especially manifest in the doubling of the pagoda, thereby maintaining the perfect symmetry of the layout. The double-pagoda scheme may also indicate the enormous accumulation of wealth in the early days of the second empire which allowed the foundation and construction of such grandly impressive shrines.

The only wood-framed building of T'ang date still extant in China is the mid-9th century main hall of Fo-kuang-ssu on Wu-t'ai Shan. It witnesses clearly to the strength, dignity, forceful simplicity and massiveness which characterized T'ang architectural form. A concern for the impressiveness of ideal proportions and for the visual interest of plain surfaces contrasted by richly carved details is everywhere evident. Its hipped roof, dignified, stable and stressing the horizontal, was a form which was much preferred in T'ang times. The interior of the hall was axially subdivided. All spaces were covered by reticulated ceilings, the chancel being higher than the aisles. The altar images were no longer oriented toward the four directions but were assembled like an emperor flanked by courtiers.

A new type of building which became very popular in T'ang times was the *ko*, a pavilion which was lower than the pagoda, but broader, and higher than the throne hall. The *ko* pavilion was used in a number of ways. It was at times the culminating feature of a compound, placed squarely on axis; sometimes it was used in pairs which flanked the axis.

The empress Wu (late 7th century), a passionate patroness of Buddhism, was responsible for a considerable number of bizarre and colossal structures among which was a 100-ft. stone *lou*, a magnificent confection of openwork masonry. In 688 she commissioned a *Ming T'ang*, at Lo-yang, as big as any previous one and more extraordinary. It was three tall stories high; the lowest was square, each face coloured appropriately to symbolize one of the four seasons. The top two stories were polygonal and were separated by a cylindrical unit with a balcony which was supported by nine dragons. The whole structure was capped by a round cupola and topped by a huge iron phoenix. Running up the core of the building was a massive wooden shaft, symbolic of the great pillar which separates earth and heaven, according to the prevailing cosmology. She commissioned also an equally tremendous five-story tower to house a colossal Buddha image. From its third floor one could look down on the peak of the *Ming T'ang* to the south.

During the golden age of Ming Huang, pleasure seems to have been the ultimate aim. All of his commissions were characterized by costliness and ingenuity. Perhaps it was in emulation of the "warm" and "cool" apartments of Han palaces that T'ang Ming Huang had erected pleasure kiosks which were cooled by artificial rains falling on the roof and massive marble halls, large enough to include warm-water pools with miniature islands and pleasure boats. In the Ta-ming palace there was a triangular hall in which the emperor loved to feast.

This kind of ostentation and costly display was considered to be the privilege of the great in the T'ang society whose rigid building codes were ordered according to social status. It stood, however, in marked contrast to the earlier austerity affected by T'ang T'ai Tsung (627–649), who ordered that the buildings of his mountain palace should be roofed in thatch.

After the civil war of the mid-8th century, T'ang power steadily decreased. Yet the patronage of the crown, the bureaucracy and religion were secure and money was reasonably abundant. The wars and the proscription of Buddhism in 845 led to the destruction of much fine architecture. Those who followed and attempted a recovery were all the more stimulated to build on the customary grand scale. Late T'ang buildings incorporated more complicated and interrelated bracketing and increased the decorative embellishment of the structural members.

7. The Five Dynasties and the Sung Dynasty (907–1279).—The period of the Five Dynasties was much too short and chaotic to have had any lasting effect on the development of a national architecture. In those parts of China which were relatively undisturbed by political conflict and economic instability, a significant amount of expert building was undertaken. The middle coastal region, where the rich princes were still ardent patrons of Buddhism, saw the erection of many splendid buildings.

With the rise of the Sung house, the country was brought under a single rule and the diverse talents of China were once again collected at the court. Among these was an architectural genius, Yu Hao, whose treatise on carpentry proved to be both valuable and influential.

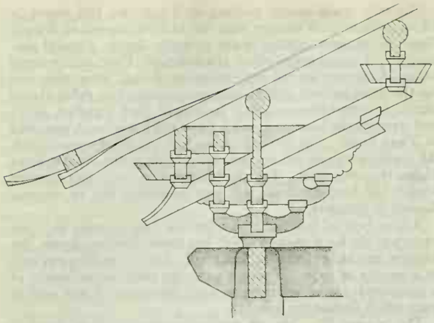


FIG. 2.—BRACKETING SYSTEM FROM THE CH'U-TZU-AN, SHAO-LIN-SSU, SUNG STYLE

The Sung sovereign had to tackle the usual job of recreating a capital city and building a palace. The Sung capital was built at Pien-ching, now K'ai-feng, Honan, on the basis of an already large T'ang city. Successive enlargements of this T'ang city were made until the appropriately imperial dimensions were realized. The city plan was manipulated until a reasonable regularity was achieved and the metropolis took on the classic formation of a square. The Sung palace was modeled directly after the T'ang examples at Lo-yang but with an even stricter adherence to symmetrical layout and precise balance of the elements. Axes were clearly marked and halls and gateways were perfectly aligned so that the whole could adequately reflect the perfect morality of the sovereign. Some of the T'ang remains, notably those buildings associated with the reinstated temple of Hsiang-kuo-ssu, set the style for the new buildings.

Sung buildings, however, were less overwhelming than those of T'ang in size and sheer vigour. The inventiveness of Sung designers was invested in the refinement of traditional forms and in the evolution of an elegant, subtle and ideal beauty. There was also a marked preference for the picturesque.

Sung taste evidently ran in the direction of high buildings; numerous accounts of the capital city testify that it was a city of towers. Pagodas, high gateways, *lou* towers and *ko* pavilions were liberally used; sometimes the upper stories of neighbouring high buildings were connected by balconies.

The Japanese pilgrim Jojin visited Pien-ching in 1072 and described the spectacle of the city in lavish terms. He mentioned the usual gold and silver ornamentation of important buildings as well as the use of jewels in architectural embellishment. A curious feature of Sung interior decoration, a scheme to be much repeated later, also came to his notice. This was the use of miniature buildings in varying degrees of relief as a form of architectural enrichment.

The great Buddha hall of the imperial Ch'an headquarters, Fu-sheng-ch'an-yuan, had a ceiling which was generously adorned with miniature treasure halls. The libraries of a number of Ch'an monasteries featured miniature pavilions as crownpieces for the book cabinets. The fascination with reduced architecture brought about the fashion of enshrining anything valuable in some kind of architectural container.

Another achievement of the Sung age with regard to architectural décor was the mastery of the art of glazing roof and floor tiles with sumptuous colour. Much of the splendour of Sung structures must have been due to the brilliant coloristic effects thus obtainable.

A manual of architectural procedure, immensely popular in its own time and happily still extant in a not-too-much-disfigured form, the *Ying-tsao Fa Shih*, was composed by a state architect, Li Chiai, and was presented to the throne in 1100. Part of the book is devoted to architectural history of a sort and a discussion of architectural terms used by the ancients. The rest of the book deals with the more practical aspects of building: the laying out of a plan, the foundation, stonework, décor, etc.

Among the many forms recommended in this manual is a platform type which in Sung times was new to architecture. The so-called *Sumeru* platform with its widely projecting cap and base and narrow waist had long been used in image pedestals. During Sung times it was widely used for stone terraces which literally enthroned whole buildings.

When the capital was moved to Hang-chou, under the Southern Sung, the official Pien-ching style moved with it. It developed there, under the auspices of the strong Ch'an sect, into a new official style which was exported to Japan in the late 13th century along with Zen Buddhism, and which became known there under the name of *Karayo*, or "Chinese style." This represented in many ways a conspicuous softening and dissipation of the vigorous forms inherited ultimately from the T'ang. Southern Sung architects also exploited that baroque play with projections and heights, the innumerable variations of masses, which animated the best pleasure-palace designs of Northern Sung.

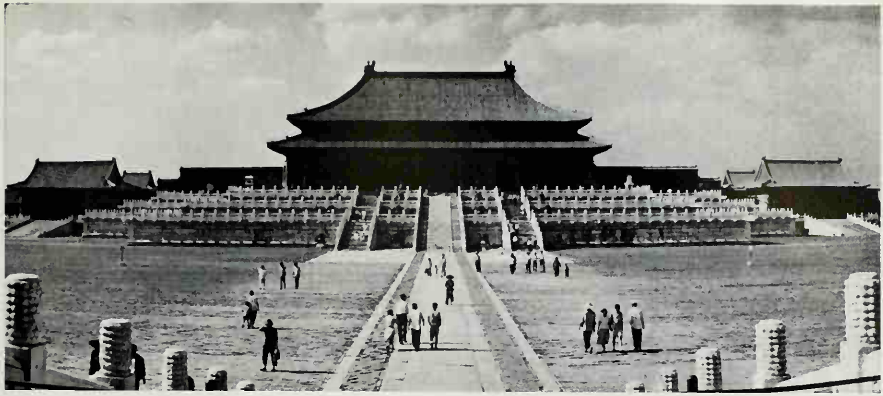
Another style of building contemporary with the *Karayo* of Southern Sung was the so-called "Indian style," *Tenjikuyo*, which survives primarily in some late 12th-century structures in Japan. It was distinct from the official style in the power and directness of its forms. The design allowed for no play with subtleties or superficial enrichment. The great south gate of Todaiji remains as a prime example of the masculine power of this mode of building, and the twin pagodas at Ch'uan-chou (Chin-chiang), Fukien, witness its influence upon the masonry styles of the day.

The Sung temple at Lung-hsing-ssu, Cheng-ting-hsien, western Hopeh, preserves a good deal of its earlier form. Its general plan is long and narrow, widening out to make a courtyard in the rear. A strictly defined axis dominates the plan which differs from T'ang usage in that there is none of the grand spaciousness common to T'ang designs and there is a greater complication of building forms. The conventional oblong hall seems to have been abandoned in favour of more varied and picturesque types which place an unusual stress on height.

The Shrine of the Saintly Mother, Sheng-mu-miao, at Chin-tz'u, T'ai-yuan-hsien, Shansi, presents an unusual combination of two separate halls; a large, closed, main hall and an open offering hall. The plan of the main hall betrays a new and greater freedom in establishing interior spaces. An open porch, doubly wide in front, surrounds a closed sanctuary; the front portico was made more spacious by the omission of four centre columns in the middle line. In the Wen-shu-t'ien at Fo-kuang-ssu on Wu-t'ai Shan, the traditional chancel and aisle scheme with its essential 18 supporting pillars had given way to a freer, more unified space with only four interior columns. The transition from the four supports to the framing of the roof was made by an ingenious arrangement of extra girders and beams.

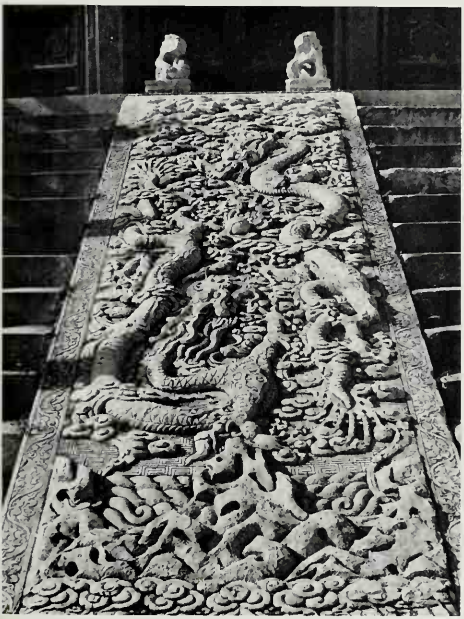
The structural daring and ingenuity of Sung architects was matched by an increased interest in the aesthetic impact of functional forms. A greater preoccupation with delicate and rich ornamentation is seen in the Ch'u-tsu-an chapel, Shao-lin-ssu on Mt. Sung, Honan, where the stone pillars were delicately sculptured. The wooden main hall of the Taoist Yuan-miao-kuan in Soochow, rebuilt in the late 12th century, used both functional and fictitious bracketing units to further animate the design.

8. Yüan Dynasty (1280–1368).—The Sung style continued as the official style of the Mongol Yüan line as the barbarian conquerors reconstructed the ruins of China with the help of architects and craftsmen who had earlier served the Sung rulers. With little cultural tradition of their own, the Mongol warriors were helpless before the sophistication of the Chinese society they now controlled, and had little choice but to imitate carefully those whom they had vanquished. They exceeded their Chinese models only in size and costly display; the basis of their art was still that of the examples of Sung times. A two-story main hall of the Taoist Shrine of the Northern Peak at Ch'u-yang-hsien, Hopeh, remains as the most impressive remnant of Yüan splendour and this clearly imitates the Southern Sung official style in every detail.

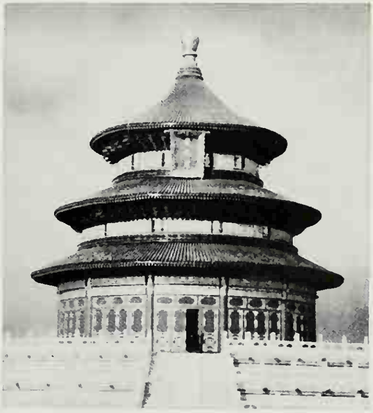


T'ai-ho-tien (throne hall), largest of the three central halls of the former Imperial palace, Peking. It was built in the Ch'ing dynasty during the reign of K'ang Hsi, A.D. 1661–1722

CHINESE ARCHITECTURE OF THE MING AND CH'ING DYNASTIES

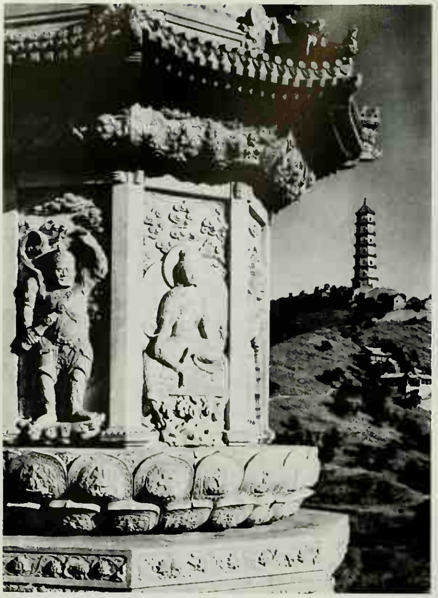


Dragon ramp leading up to the Temple or Pavilion of the Universe in the Temple of Heaven complex, Peking

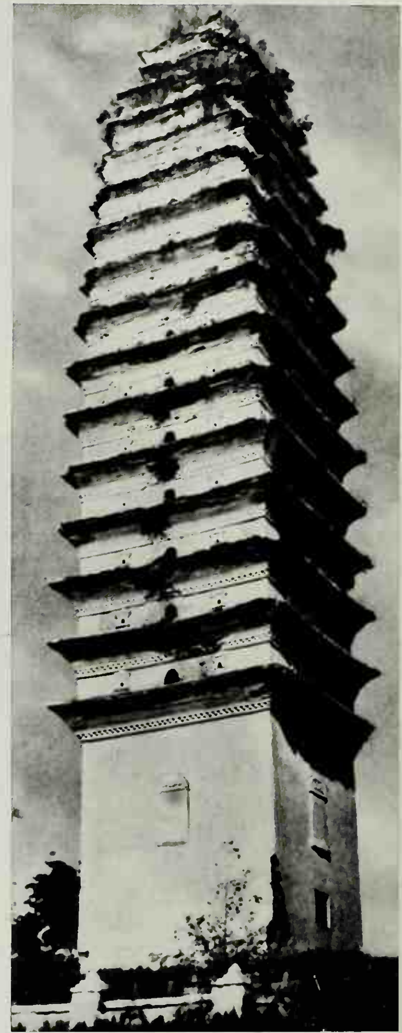


Ch'i-nien-tien (Hall of Annual Prayers), the principal hall of T'ien T'an (the Temple of Heaven complex), Peking, first built during the Ming dynasty (1368–1644) and reconstructed in 1896 after it was destroyed by lightning

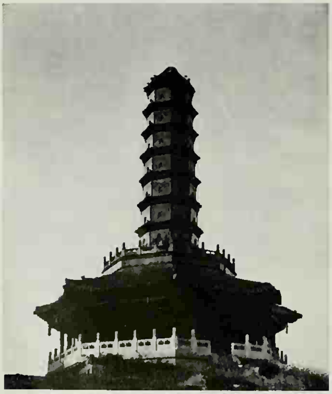
PHOTOGRAPHS (TOP) EASTFOTO, (LEFT) L. TAGER FROM BLACK STAR, (RIGHT) CARTER O. HOLTON



Base of the Marble pagoda with the Jade pagoda in the background. Located on Jade Fountain hill in the western hills outside of Peking; built in the 18th century



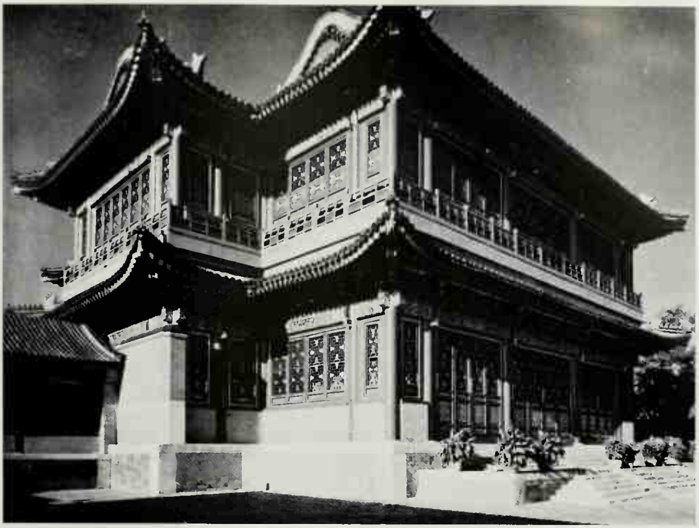
Ch'ien Hsün pagoda, Ta-li, Yünnan, built in the 9th century (T'ang dynasty)



Pagoda of the Hsin-kung temple-monastery complex at Jehol (Ch'eng-te), built by the emperor Ch'ien-lung in the 18th century

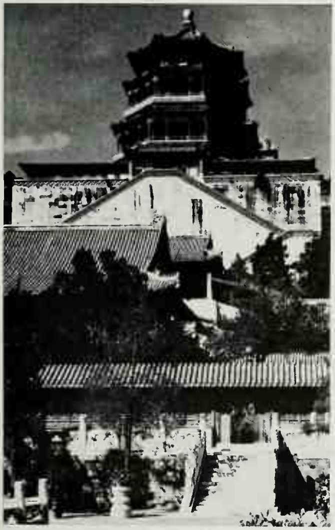
CHINESE PAGODAS

PHOTOGRAPHS, (TOP LEFT) FRITZ HENLE—PUBLIX, (BOTTOM LEFT) HARRISON FORMAN, (RIGHT) CULTURAL OBJECTS PRESS

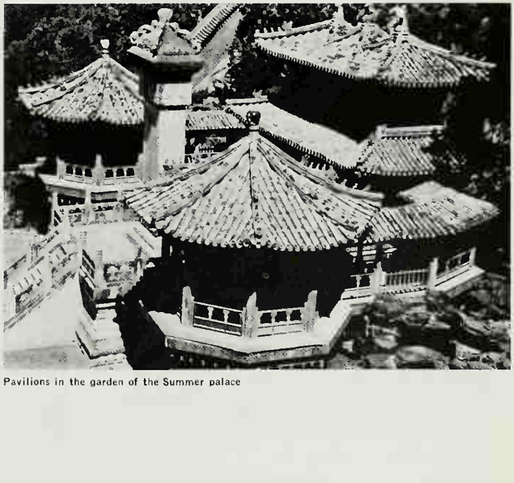


The theatre in the Summer palace, Peking. The palace was first built in the late 12th or early 13th century and rebuilt in 1494

THE SUMMER PALACE, PEKING



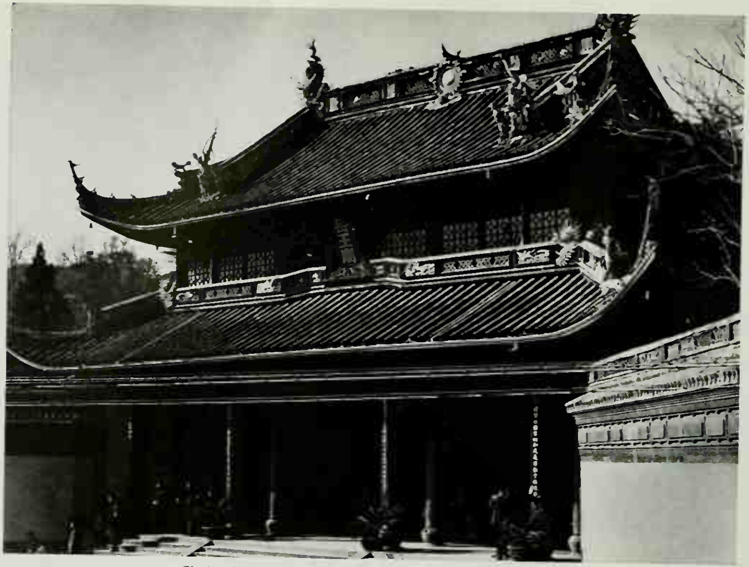
Fo Hsiang Ko (Tower of Buddha's Fragrance), the highest building in the centre of the architectural composition of the hill in I Ho Yuan (Summer palace)



Pavilions in the garden of the Summer palace

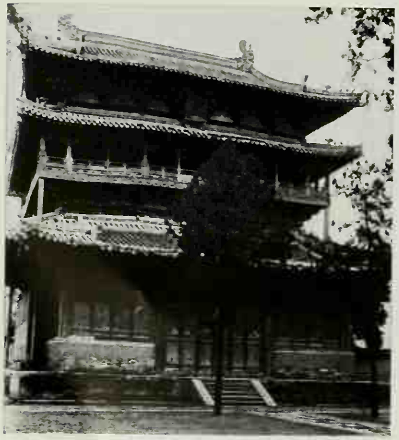
PHOTOGRAPHS, (TOP, LEFT) EASTFOTO, (RIGHT) HARRISON FORMAN

CHINESE ARCHITECTURE

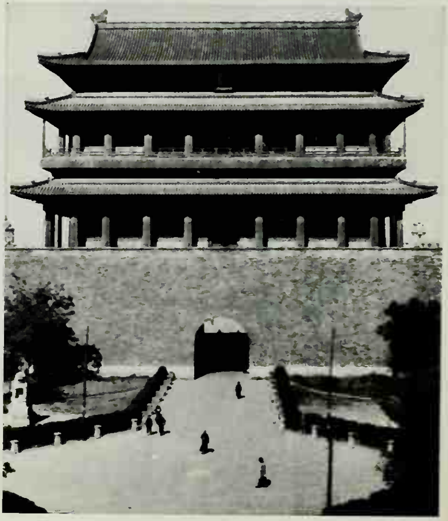


The temple of Yao Fei at the Western lake, Hangchow; Sung dynasty

FURTHER EXAMPLES OF CHINESE ARCHITECTURE



Library at Lung-hsing-ssu, Cheng-ting-hsien, western Hopeh, Sung dynasty



Ch'ien Men city gate, Peking; Ch'ing dynasty. It was built in the reign of Kuang-hsü (1875–1908) as part of remodeling activities

BY COURTESY OF (LEFT) SEKINO MASURA, PHOTOGRAPHS, (TOP) EASTFOTO, (RIGHT) FRITZ HENLE FROM BLACK STAR

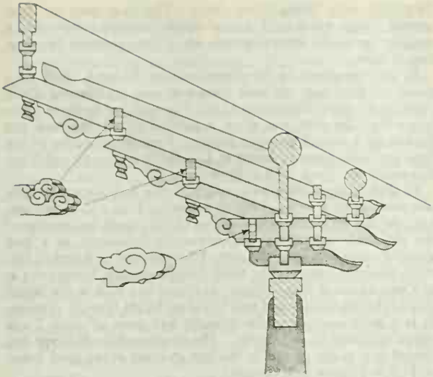


FIG. 3.—BRACKETING SYSTEM FROM A PAVILION AT THE CONFUCIUS TEMPLE AT CH'Ü-FOU, YÜAN PERIOD

9. Ming and Ch'ing Dynasties (1368–1912).—The story of architecture under the Ming and Ch'ing rulers must necessarily stress the prolonged decadence of the art of fine building. The Ming style at its best was little more than a modification of the Southern Sung mode. The Manchus were even more satisfied than were the Mongols to ape their Chinese predecessors. Under the Ch'ien-lung emperor of the 18th century, a great deal of monumental building was done and a considerable amount of refacing of earlier structures was undertaken. In the best of this work, the underlying monotony is broken by the majesty of big halls, courtyards and gates and by the charm of the pleasure quarters.

The typical Ming or Ch'ing building was rather small in scale, a simple oblong in plan, and had interior columns arranged according to the old aisle and chancel convention. An enclosed porch at the front or the rear may have had a separate roof, and there may or may not have been extensions in the form of wings. Pillars and large beams did the work of supports; the bracketing systems, greatly diminished and nestled together, were little more than ornamental. Gorgeous decorative effects, gained through tile work, sculpture and polychromy, invested the architecture with a certain distinction.

Some examples of the use of structural vaulting exist. The great city gates of Peking (early 15th century) incorporated tunnel vaults in their construction. Two large temple halls, built late in the 16th century, were made entirely of brick and were tunnel vaulted. These are the temple at Shan-t'a-ssu, T'ai-yuan, and the "beamless hall," Wu-liang-tien, in Soochow. Some curious structures built in an adaptation of the late European baroque style were among the exotica laid out in the gardens of the Ch'ien-lung emperor's summer palace west of Peking.

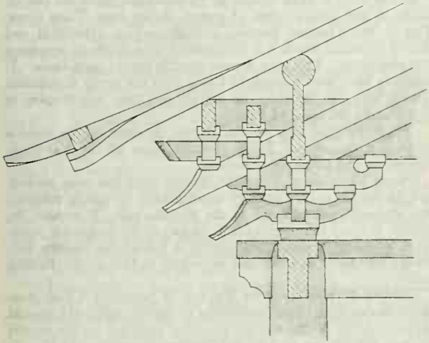


FIG. 4.—BRACKETING SYSTEM ON BELL TOWER AT SHAO-LIN-SSU, YÜAN PERIOD

The "Tatar city" of the capital betrayed an attempt to follow superficially the prescriptions of the ancient Chou ritual books. The plan of the city approximated a square form and had the imperial palace placed near the centre.

The "forbidden city" was partitioned off into a number of major walled-in areas, the most imposing of which was the series of audience courtyards and halls which were strung out along the grand axis. This precinct was followed by a somewhat smaller one, the imperial living quarters, which repeated in many ways the schema of the larger group. The grand audience group was unique in Ming and Ch'ing building in the massiveness of its building blocks, in their dramatic heights and powerful proportions, and was enlivened by magnificent coloristic effects achieved in tile and paint. The major court, square and about 200 yd. across, was broken toward the rear by a massive tripartite stepped terrace upon which rose, in succession, three splendid halls. The first, the T'ai-ho-tien, a massive throne hall, was oblong in plan and had a monumental hipped roof above a skirting penthouse. The smaller middle hall, the Chung-ho-tien, which served as a waiting place, was square and capped by a pyramidal roof. The Pao-ho-tien, used for state banquets, was a smaller version of the throne hall and was distinguished by a hip and gable roof.

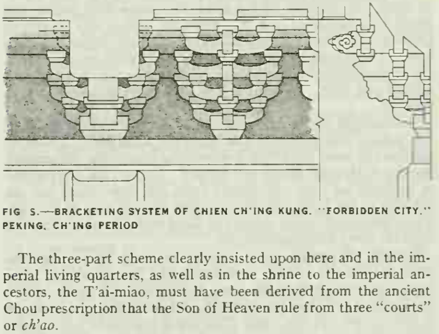


FIG 5.—BRACKETING SYSTEM OF CHIEN CH'ING KUNG, "FORBIDDEN CITY," PEKING, CH'ING PERIOD

The three-part scheme clearly insisted upon here and in the imperial living quarters, as well as in the shrine to the imperial ancestors, the T'ai-miao, must have been derived from the ancient Chou prescription that the Son of Heaven rule from three "courts" or *ch'ao*.

The architectural remains of Peking have suffered much modification, rebuilding and remodeling in the course of history, and all too often decadence and tasteful design were hopelessly intermingled. The last gasps of a dying tradition, however, occasionally produced remarkable gems. The circular Hall of Annual Prayers, Ch'i-nien-tien, at the Altar of Heaven in the "Chinese city," was built at the very end of the 19th century and manifested, in a surprising way, the pure geometrical order and coloristic splendour which we have come to associate with the Chinese mode.

II. THE PAGODA

The predilection of the Chinese for towerlike buildings and the requirements of Buddhism led to the development, in the Six Dynasties period, of the pagoda (*q.v.*) form. It derived ultimately from the stupa of ancient India, which was a domical funeral mound erected over the remains of a holy man or king. Perhaps the most celebrated pagoda in India was the multistoried tower erected by Kanishka I near Peshawar to enshrine a notable collection of the Buddha's relics. This famous tower, built in the 2nd century of the Christian era, was the inspiration for the pagodas of China, where the design always consisted of the repetition of a basic story unit (circular, square, polygonal) in regularly diminishing proportions. Each unit had its own projecting roof and the whole pile was topped by a prominent mast and disks. (*See* INDIAN ARCHITECTURE.)

The pagoda, like the stupa, was at first thought of as an architectural diagram of the cosmos. The great pillar which ran up the core of the building was symbolic of that invisible world axis which joins the centres of the earth and heaven. The separate stories, diminishing in size as they mount upward, were thought of as the many terraces of the mythical world mountain. The disks of the finial corresponded to the various heavens of the gods. The cosmic diagram, thus fixed in architectural form, was thought to be animated by the precious relics which were enshrined within. The history of the pagoda in China may be illustrated by a fairly large number of extant monuments.

Just as the principal monument of Indian Buddhist establishments had been the stupa, the pagoda was the dominant feature of early Chinese Buddhist temples. As the principal centre of worship, it rose isolated in the courtyard, on axis. Behind it was placed a Buddha hall with an altar set out with images. Another large building closed off the courtyard at the rear; this was the lecture hall where the monks met to study the scriptures. A major gate building shut off the court in front of the pagoda and smaller galleries surrounded it.

1. The Six Dynasties.—During the Six Dynasties period, the number of pagoda stories varied from three in the 4th century to nine in the 6th century. An occasional outstanding monument had 12 stories.

The greatest early pagodas were built by the Northern Wei. In 467 there was built for the Yung-ning-ssu temple in the capital city a seven-story pagoda which was lauded as the tallest then on earth. At the same time, a great stone three-story pagoda was raised to a height of 100 ft. After the capital was moved to Lo-yang, a new and more splendid Yung-ning-ssu (begun 516) was built. The pagoda of the new temple was square in plan, about 400 ft. high, lavishly studded with gold ornaments and strung with myriad gold bells. Its doors and windows were lacquered in brilliant red.

Examples of the square, multistoried pagoda may be found in the rock-cut cave shrines at Yun Kang and Lung Men. Full-scale examples in wood have been preserved in Japan: the 7th-century pagodas in Horyuji, Hokiji and Horinji. In this type, the number of openings on each side ranged from the three doors and six windows of the Yung-ning-ssu pagoda to the one door of Horyuji. The architectural details of the Yun Kang examples were borrowed from the north Indian prototypes.

Certain 6th-century brick pagodas in north China represent other designs which were used during the Six Dynasties. The Sung-yueh-ssu pagoda on Mt. Sung, Honan, was built in the 520s in emulation of an Indian Gupta model. Its dodecagon plan is unique in the far east. It has a high plain plinth above which is a piano nobile with corner columns. Then follows a succession of eaves which gradually diminish in size. At the top are the usual mast and disks. The details are purely Indian. An arched recess decorates each cardinal face of the main story and miniature arches are spaced around the eaves. Each secondary façade is filled by a representation in relief of a square, single-story pagoda whose pedestal is underlined by lion busts and whose dome rises out of foliated acroteria.

A structural example of the square, single-story type is found in the small four-doored pagoda, Ssu-men-t'a, of Shen-t'ung-ssu in Shantung (544). The tomb-pagoda of Fa-ting at Ling-yen-ssu has a similar form slightly elaborated by a double row of corbeled eaves. The ancient pilgrimage temple of Fo-kuang-ssu on Wu-t'ai Shan, Shansi, has two hexagonal stories of which the lower is plain except for a single arched doorway leading to the core of the structure. The upper story has squat, indianizing columns at its corners; each column is banded with three rings of lotus petals. On the axis is a small arched door; each other face has a simulated lattice window. The plinth and eaves are faced with tiers of small overhanging lotus petals and the spire was once ornately formed.

2. T'ang Dynasty.—Almost all extant T'ang pagodas rise from square plans and are made of brick. The octagonal plan, which was to dominate pagoda design from the 10th century on, was infrequently used during T'ang times. The basic unit in T'ang pagoda design was a cube with a simple corbeled cornice and a roughly pyramidal superstructure which was crowned by some sort of spire.

In the monument to the dhyana master Fa-yuan (died 791) raised on Mt. Sung, the basic form was used, manifesting T'ang taste in the slight elaboration of it. The roof was made to simulate tiling; the door was given a pointed arch frame and was flanked by a pair of guardian deities. Standard examples of the type are those pagodas found at Lai-shui-hsien (712) and Yun-chu-ssu on Mt. Fang, both in Hopeh.

In slightly more involved versions of this basic type, the cube was crowned by a series of closely set eaves, from 7 to 16 in number. At this period the proportioning of the pagoda was excellent; the silhouette tapered upward across the horizontals in a long graceful curve following the early T'ang instinct to design in big, clear, sweeping forms. The Small Gander pagoda, Hsiao-yen-t'a, of Chein-fu-ssu at Sian (Hsi-an) in Shensi was built in the beginning of the 8th century and rose to a great height through 15 eaves. It is a good example of the strength and grace of early T'ang design undiluted by elaboration. The simple multiroofed type was carried to a height of 330 ft. through 16 eaves in the giant tower at Ta-li in Yunnan (9th century).

During the T'ang period, pagoda design as a whole was dominated by the habits of building in wood and the aesthetic standards evolved in wood construction prevailed throughout China no matter what materials were being used. The big brick tower of Hsian-chi-ssu near Ch'ang-an (late 7th century) has a separate story between the eaves which is marked by paneling. Wood construction is recalled in the regular spacing of simulated column capitals just under each of the eaves. This tendency is more marked in the Great Gander pagoda, Ta-yen-t'a, of Tz'u-en-ssu. Seven clearly marked stories were stepped back to diminish as regularly as in a wooden pagoda. The walls were divided by tall flat pilasters and decorated with simulated beams, intercolumnar struts and capitals. This pagoda was first built by Hsuan Tsang in 652 and was extensively renovated in 701–705. A more thoroughgoing imitation of wood effects is seen in two late T'ang pagodas, the one built over the ashes of Hsuan-tsang in the monastery of Hsing-chiao-ssu, and the unique pagoda of Master Lang at Shen-t'ung-ssu in Shantung.

The octagonal plan appears in the low tomb-pagoda of the dhyana master Ching-ts'ang (died 746) at Hui-shan-ssu on Mt. Sung, Honan. Here, too, the design simulated features of wooden construction in masonry brick. False doors and windows, quasi-octagonal pillars, projecting beam ends running through capitals, intercolumnar V-shaped struts—all useless to brick construction but fundamental to wood—appeared as more or less ornamental features.

In the Wu-t'ai Shan temple of Fo-kuang-ssu there are the remains of still another type of pagoda dating from T'ang times. This is the Treasure pagoda, a single-storied, cylindrical and domed structure which was surmounted by a series of octagonal corbeled eaves. This type derives directly from Gupta India. It seems to have been brought to China with the newly fashionable Tantric sect. In the early 9th century this form was adopted in Japan under the name of Tahoto.

The T'ang style may be clearly seen in some of the wooden multistory pagodas of Japan, notably those of the Yakushiji, Taimadera and Daigoji monasteries.

During T'ang times, Buddhism became more and more sinified, and the pagoda, once of primary importance in the temple complex, was gradually subordinated to the Buddha hall. It became the fashion to move the pagoda from the axis of the courtyard, sometimes doubling it, sometimes placing it behind the Buddha hall, always putting it in a position secondary to that of the Buddha hall.

3. Sung Dynasty.—With the rise in power of Ch'an Buddhism during Sung times the building of pagodas suffered a gradual decline, for the devotees of Ch'an had as little use for the pagoda as they did for the rest of the traditional trappings of the developed Buddhism of the day. A number of remarkable towers were constructed, however, and their splendour was recorded in political and religious history. Perhaps the most famous of the pagodas was that erected at Pien-ching in 989 to house the famous reliquary stupa of Asoka from Ningpo. This tower was octagonal and had 11 stories. It was burned in 1037 and rebuilt with nine stories and the remarkable feature of being open all the way up inside. The pagoda of the pilgrimage temple on the Huai river, called P'u-ch'ao-wang-ssu, was octagonal and 13-storied. Each story had a roof of yellow tiles and was covered with myriad niches containing images of bodhisattvas and minor deities. Inside was a spacious chapel glitteringly furnished with gold and silver fittings. Above the interior columns were gilded busts of bodhisattvas; the partition beam ends took the form of angels.

The typical Sung pagoda had a serviceable interior in which images were often enshrined.

The extant brick pagodas of Sung times all run true to a single type. Almost all are hexagonal or octagonal and strictly continue, in elaborated form, the T'ang multistoried formula. The northern examples are, on the whole, more conservative in design and are distinguished by a special mode of eave enrichment which consists of corbel blocks closely spaced in two regular tiers. This device is seen in an elaborate form in the pagoda at Tsou-hsien in Shantung and on the 11th-century Iron-Coloured pagoda, T'ieh-t'a, at K'ai-feng (old Pien-ching). In each case an obvious attempt had been made to imitate wooden bracketing. It was also the style to encase whole towers in richly decorated square, glazed tiles; sometimes each tile was centred with a round image niche.

A large number of southern brick pagodas were not only designed to simulate wood construction but actually incorporated wooden rafters to hold the tiled roofs and balconies and sometimes even had wooden brackets. The Pei-t'a at Soochow in Kiangsu is just such a pagoda.

This tower is characteristically tall and slender, and has an unusual small masonry cupola, which rises from an octagon to a circle. Each corner of the octagon holds a two-tier bracketing unit, the top of which helps to support the rim of the circle. In addition, a stone rib runs between each opposite pair of bracket tops and the four ribs meet at a capstone.

Some southern pagodas were made of iron and were consequently small in scale and extremely slim in appearance. The one at Kan-lu-ssu in T'an-tu-hsien, Kiangsu, and that at Ching-chou in Hopeh were each set upon an elaborately designed pedestal ornamented with waves and peaks. Early Sung pagodas were relatively simple and sturdy in appearance; the eaves curved up only at the corners. In the course of 100 years, the style moved toward a fragile richness; the bracketing systems became small and crowded and the eaves acquired sweeping continuous curves.

The pair of pagodas at Ch'uan-chou in Fukien, built of brick in the mid-12th century and encased in stone in the mid-13th century, each have five stories which are squat and wide. The bracketing is bold and uncomplicated. Only the sweeping curves of the eaves and the consistent imitation of pillar and beam forms mark the style as southern.

4. The Barbarian Empires.—The barbarian emperors of Liao and Chin, who were the constant adversaries of the Sung house from the 10th century through the 13th century, patronized a brand of Buddhism which created a distinctive pagoda type. Octagonal in plan, its elevation had three stages which were sharply differentiated. The base was fairly high and was subdivided into courses enriched with sculpture. The shaft was relatively plain, being decorated only by Buddhist groups in relief and some kind of corner accent to maintain the verticality. The crown was a series of close-set roofs, usually 13 in number. The bottommost eaves were bracketed in imitation of Chinese carpentry; the others were simply corbeled out. The whole multiple crown diminished until it joined the form of the spire.

The Liao octagonal pagoda differed from the Sung examples in the baroque exuberance of its design. It represented a peculiar combination of T'ang and Northern Wei characteristics and can probably be traced back to some distant Indian original. The octagonal ground plan was a clear reflection of Tantric Buddhism, the cosmological pattern of which was subdivided into eight compass points instead of four. The Liao pagoda, then, mystically embodied the mystery of the eightfold pattern. A group of four pagodas near Ch'ao-yang, Chin-chou, Jehol, is unique in that each structure retains the square plan. The earliest of these served as the model for the rest. It was originally a T'ang construction but was refaced in the middle of the 11th century when the status and privileges of Ch'ao-yang were raised by the patronage of a Khitan ruler. The four major wall areas served to display relief representations of enthroned Tantric Buddhas attended by bodhisattvas. Each trinity was in turn flanked by a pair of small square pagodas. This scheme brought together the Tantric Buddhas of the Four Quarters and the Eight Great Stupas of Mahayana tradition. According to Tantric theology, the Buddhas of the directions were simply manifestations of the Supreme Buddha, Vairochana, who was therefore symbolized by the pagoda itself. The Four Buddhas also appeared on hexagonal and octagonal pagodas, where some adjustment had to be made with the extra faces.

The standard octagonal pagoda was adorned with representations of the Eight Great Buddhas, or the Four Buddhas with the Four Bodhisattvas. For the great pagoda of Ta-ming-cheng, another canonical favourite, the Eight Great Bodhisattvas, was used.

The typical base for the Liao pagoda incorporated grotesque caryatids at the corners. In three examples, there appear the foreparts of a huge lion protruding from each face. There, the lion, as the Tantric vehicle of Vairochana, appropriately supports the symbolic body of the primal lord.

The Liao standard plans and elevations permitted several variations. In smaller buildings, the number of sides was reduced to six and the number of roofs to nine or seven. Several examples have imitative bracketing under all the eaves.

A less common Liao type, found chiefly in Hopeh, was not adorned with reliefs. The South pagoda of Yun-chu-ssu, Mt. Fang, was erected in 1117 and was adorned with doors and windows only. Another example, at T'ien-ning-ssu, just outside of Peking, has sculptured ornament only in the form of door guardians. This type of unadorned building implied the presence of major images within the shrine.

The bracketing systems in Liao pagodas created areas of rich visual interest. The details of contemporary carpentry were carefully imitated. Corner bracketing was always the most complex and visually fascinating, and the eight-sided plan allowed for twice the usual number of corners set closer together. The Liao architects deliberately exploited a variety of forms. No single scheme seems to have been repeated.

One wooden pagoda, erected in 1058 at Fo-kung-ssu, Ying Hsien, Shansi, has survived. This building has five stories, each of which is very squat. The whole silhouette is so broad that it resembles a *ko* pavilion as much as it does a pagoda. The eaves have that characteristic emphatic projection which demanded a more developed bracketing.

A few curiously exotic works were among the productions of the barbarian kings. The Northern pagoda, Mt. Fang, has a dome and masonry spire which recall a peculiarly Tibetan form of the stupa. The dome and cone superstructure also appears in relief representations of pagodas which are accompanied by mystical Tantric spells.

The most unusual pagoda is one which was built during Chin rule. This is the Hua-t'a of Cheng-ting Hsien, the first story of which is a large octagon. On the alternate faces of this story are hexagonal, single-story wings. The top of the structure was thickly encrusted with an extraordinary collection of sculptured forms: miniature stupas resting on lion or elephant protomes, grotesque caryatids and lion heads. The general plan of the building reproduced the four-around-one scheme of the Tantric mandala.

Nearly all the Liao and Chin pagodas rose singly, on axis and behind the major hall.

Very few of the Yüan pagodas that have survived offer anything new. A particularly baroque tower, in a park in Seoul, Korea, was a gift of the last Mongol emperor on the occasion of the marriage of his favourite granddaughter with the Korean king.

See also references under "Chinese Architecture" in the Index volume.

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CHINESE ART: *see* Chinese Architecture; Chinese Bronze; Chinese Painting; Chinese Sculpture; Embroidery; Enamel; Ironwork; Ivory Carving; Jewelry; Pottery and Porcelain; Tapestry; Textiles.

CHINESE BRONZE. Bronzes have been cast in China for about 3,500 years. Except for a few categories described below, this article is concerned only with the products of about 1500–300 B.C., roughly the Bronze Age in China. Most bronzes of this period may be described as ritual vessels, intended for the worship of ancestors, who are often named in inscriptions on the bronzes. Many were specially cast to commemorate important events in the lives of their possessors, and their inscriptions constitute valuable social and historical documents. The vessels were also meant to serve as heirlooms, and the inscriptions often end with the admonishment "Let sons and grandsons for a myriad years cherish and use."

The ritual bronzes of ancient China include some of the loveliest objects ever made by man, and as a group they represent possibly the most remarkable achievement in the whole history of metalcraft before modern times. No one can say how many ancient Chinese bronzes survive; more than 12,000 have been counted.

Traditional Chinese scholarship assigns the ancient bronzes to the period known as the Three Dynasties. Of these the first, the Hsia, may have been historical, but confirmatory archaeological evidence is lacking. The second, variously called Shang-Yin, Shang or Yin, is known by a rich accumulation of material remains from sites in Honan province in northern China. The third, the Chou, also is well represented by material remains, while its extant writings form the inheritance of classical Chinese literature.

Known bronzes belong to the second and third of these dynasties. The widely accepted revised chronology of the Shang-Yin puts its dates at *c.* 1500–1027 B.C. (according to the orthodox school, 1766–1123 B.C.), but most known Shang-Yin bronzes were made after the founding of the last or next last capital, near the modern city of An-yang in northern Honan, during the 14th century B.C. Shang-Yin bronzes were being taken from the An-yang site as early as the 11th century A.D., and systematic excavation in the 20th century uncovered many more; of all Chinese bronzes they are the finest. The Chou period (1027–249, or 1122–256, B.C.) saw two successive major changes in style, as well as the development of regional traditions and a certain deterioration from the standards of Shang-Yin bronze art. Chou bronzes, too, were being collected in the 11th century A.D., and considerable hoards of them continue to come to light.

Beginning of the Bronze Age.—Bronzes of the Shang-Yin and Chou periods fit roughly into three stylistic and chronological phases, using the nomenclature and dating of W. Perceval Yetts: (1) first phase, 13th–10th century B.C.; (2) second phase, 9th–6th century B.C.; (3) third phase, 5th–3rd century B.C.

In 1937 Bernhard Karlgren demonstrated the existence of A and B styles concurrent within the first phase. Many A-style vessels have a single decorative composition covering the main body of the vessel; in B-style vessels the decoration is invariably disposed in horizontal registers. Further, the commonest design element, the *t'ao-t'ieh* (*see* below), is in the A style a coherent and easily distinguishable form, whereas in the B style it is disintegrated and its animal nature cannot easily be perceived. Lastly, the A style presents a variety of animal motifs—*t'ao-t'ieh,* vertical dragons, cicadas—all more or less decipherable, whereas the B style tends to favour formal geometrical motifs such as lozenges, interlocked T's, circle bands and massed vertical ribs. Coexistence of two separate styles within the first phase might be taken to imply an even earlier period during which the art presented a unified style.

Karlgren's study of the way in which the motifs are distributed within the two styles indicates that whole classes of vessels were restricted to one or another of the two styles; he cites as an example the *li-ting* (*see* below). Evidently by the time these vessels were made (*c.* 1300–900 B.C.) prescriptive rules already existed which the bronze designer felt bound to obey, and the art, despite its wonderfully rich vocabulary, had acquired a certain conventionality. Karlgren concluded that the bronze art of An-yang must have had a long antecedent history in China, "an era with a freer high bronze art, with a whole array of vessel types, décor motifs and ornamental constellations not yet bound by fixed conventional rules," intervening between it and a more primitive period.

Of this hypothesized preceding era of high bronze art there is not the least trace. On the other hand, excavation during the 1950s at the sites of Liu-li-ko and Erh-li-kang in Honan revealed a culture with unmistakable early Shang-Yin characteristics, including oracle bones used for divination and a number of bronze vessels that can fairly be described as the rude forefathers of those known from An-yang.

The forms of Chinese ritual bronzes probably were based originally on ordinary domestic utensils made of clay and perhaps other materials, such as horn or gourd; bronze vessels from Liu-li-ko and Erh-li-kang demonstrate this relationship much more clearly than do those from An-yang. In other words, they seem to belong to a period nearer in date to the time when bronze vessels were first made in imitation of Neolithic domestic prototypes. They display features that may rightly be regarded as primitive in Chinese bronze art: thin walls; the legs of *ting* short, conical and hollow, like those of certain prehistoric pottery *ting;* bottoms of *chüeh* and *chia* vessels flat instead of rounded; the *ku* goblet of stout proportions and standing on a squat base. A bronze *ting* from Liu-li-ko is very much like one made of pottery from Erh-li-kang; a bronze *ku* from Liu-li-ko has features in common with an ivory cup found at Erh-li-kang; while *chüeh* goblets resemble pottery examples.

These bronzes, perhaps dating from as much as a century and a half before An-yang, throw fresh light on the controversial question of the origin of metallurgy in China: Was it a cultural importation, or did it originate and develop in China? The importation theory depends mainly on the similarity of a group of curved bronze knives with animal heads and ring handles, found at An-yang, to another group belonging to the Yenisei Bronze Age culture of the area around Minusinsk, U.S.S.R. There is some historical connection between the two groups, but absolute dates for the Karasuk culture, to which the Siberian knives belong, are lacking; indications are that it opened at least a century after the founding of An-yang.

The shapes of the ritual bronzes, for the most part, are distinctive to China; they combine with the amazing *décor*—sometimes amounting almost to an iconography—to produce forms for which no parallel exists in any other part of the world. If metallurgy had been introduced to China from outside, one would expect to find some stylistic trace of foreign antecedents. If, on the other hand, the origins of the Chinese Bronze Age are to be sought in China itself, then the rather crude bronze vessels from Erh-li-kang and Liu-li-ko represent precisely the sort of early stage it might be expected to have gone through. In short, these vessels provide evidence in favour of the view that bronze casting was an independent Chinese invention.

Materials of Bronze Casting.—Few reliable analyses of the metal used for casting ancient Chinese bronzes have been made. One, done on part of a Shang-Yin bronze, showed the following constituents: copper 82.39; tin 15.42; lead 0.45; gold 0.38; iron 0.09; sulfur 0.115; residue 1.20. Perhaps because of this it has been supposed in the west that lead entered very little into Chinese bronze alloys. Lead is usually introduced to temper the metal—in Mediterranean bronzes, for example, in proportions varying between 3% and 11%, in south Indian examples up to 25%—and it seems certain that the Chinese followed the traditional practice. Lead is present in proportions as high as 20% in bronzes of the early Chou period onward, and an analysis of part of a vessel dating probably from the Shang-Yin shows copper 75.5; tin 12.6; lead 6.5. While there is no reason to suppose that Chinese founders were incapable of distinguishing one metal from another, as is often said, the formula no doubt varied from one foundry to another.

Abundant remains of foundry products, including malachite, charcoal slag, molds and crucibles, were found at both An-yang and Erh-li-kang. Usable copper and tin ores today come mainly from far southwestern China, but there is a local tradition that both were formerly mined in the vicinity of An-yang.

Methods of Bronze Casting.—Flat objects such as weapons and tools were cast directly by means of temporary molds or "flasks" made of loamy sand or clay composition, one mold for each side of the object to be cast. Among many such molds found at Erh-li-kang is one bearing negative impressions of arrowheads, set slantwise and connected by a central channel, forming a pattern like the veins of a leaf. Hollow vessels, or undercut relief, could not be cast by this method but needed a much more complicated technique.

It is generally believed in the west that ancient Chinese bronze vessels were cast by the *cire perdue*, or lost wax, method (*see* SCULPTURE TECHNIQUES: *Modeling and Casting*), which is capable of yielding extremely fine castings, its disadvantage being that once the outer mold has been formed upon the wax model it cannot subsequently be inspected for possible flaws—the vessel must be cast come what may. The mold cannot of course be used more than once.

In 1935 O. Karlbeck described a series of piece molds recovered in course of excavation at An-yang. These bore negative impressions of typical bronze designs and had smooth, right-angled edges fitted with lugs, so that the pieces could be accurately assembled. Minute particles of bronze found in the negative relief strongly suggested that these molds were used for direct casting of bronze vessels. Many similar piece molds were later found at Erh-li-kang. Evidence is thus accumulating to show that many first-phase bronzes, probably the majority, were cast directly with the aid of sectional molds. By this process, molds in three or four sections would be cast from a model made either of wax or clay. In the Victoria and Albert museum, London, is a solid pottery object in the shape of a *hu*, bearing traces of shellac, such as would have been applied to its surface to prevent adhesion of a clay envelope, and vertical scratches that may have been made by a knife in separating off the mold sections. This, then, may have been a permanent positive model for casting piece molds. Alternatively, piece molds may have been taken from a temporary wax model built up on an inner clay core. Sectional molds allowed the caster to inspect and retouch his mold before casting. Though a sectional mold could not have been used more than once, a number of sets of sectional molds could have been taken from the positive model. Probably this was not usually done; no two first-phase bronzes exactly alike are known.

Classification and Nomenclature.—The first systematic classification of ancient bronzes is to be found in the great catalogues of the Sung dynasty (A.D. 960–1279). Their compilers found that many of the bronzes were self-named in the inscriptions they bore, while others could be identified from descriptions given in the classics; with few exceptions, the classes thus established have stood the test of time. Many problems of nomenclature nevertheless remain to be solved, nor is the question as to what constitutes a separate vessel class always easy to decide. A list of 25 distinct vessel classes published by Yetts in 1929 usually is accepted as a model. For purposes of this article the number can be reduced further to 21, which includes the vast majority of extant bronze vessels found in museums and private collections or known through photographs.

Sacrifice to ancestors involved the offering of food and drink; ritual vessels thus can be further classified as food and wine vessels, together with a small class for ceremonial ablutions.

Food Vessels.—These may be subdivided into cooking vessels (*li, ting, li-ting, hsien*) and containers (*kuei, tou*).

The four classes of cooking vessels are all modeled on tripod domestic cooking pots such as have been found at Neolithic sites throughout northern China. *Li* and *ting* differ in that the three legs of the former are hollow and bulbous, joining imperceptibly with the lower part of the body, whereas those of the *ting* are solid and more or less cylindrical and their articulation with the body is abrupt. *Li* and *ting* were perhaps the first vessel classes made in bronze. Examples are found among bronzes made before the foundation of An-yang, and throughout all three stylistic phases, while their forms were reproduced in bronze and other materials during almost every subsequent period. Both classes are self-named in their inscriptions.

The *li-ting* is intermediate in form between *li* and *ting*, for while the lower part of its body, like that of the *li*, has three lobes or hollow depressions, its legs are solid and cylindrical like those of the *ting*. A Neolithic pottery prototype inherits features of pottery *li* and *ting* and is, in turn, the ancestor of the pottery tripod, *chia*. The bronze *li-ting* is not as a rule admitted as a separate class of vessel, most examples being classified as *ting*. In fact, however, a stylistic gap separates the two; for instance, scarcely a single *li-ting* with B-style decoration can be adduced, whereas B-style *ting* are common.

The *hsien* is a composite vessel; the lower part resembles a *li*, the upper is bowl-shaped. Food put in the upper part is cooked by steam heat rising from the lower. *Hsien* may be cast as one vessel or as two, but in either case a grille divides the two portions. Neolithic pottery prototypes are known, and the vessels were made during all three stylistic phases. Some *hsien* are self-named in their inscriptions.

The *kuei* also was made during the three phases. Basically it is a round bowl standing on a wide and slightly flared foot, and is clearly descended from a pottery prototype. But shapes are often highly elaborated, and second-phase examples have a decidedly flamboyant, "baroque" appearance. Some *kuei* are self-named in their inscriptions.

The pottery *tou*, shaped like a cake stand and mounted on a tall, hollow and often perforated flared foot, is common in the Neolithic pottery cultures of northern China but seems not to have been cast in bronze until the third phase. One bronze variety has a bowl-shaped body and a domed lid which could be reversed to serve as an accessory vessel. *Tou* are not self-named.

Wine Vessels.—These comprise containers (*tsun, yu, hu, fang-i, lei*), goblets (*chih, ku, chüeh, chia*) and vessels for heating wine or mixing it with water (*ho, kuang*).

In bronze inscriptions the word *tsun* serves to designate ritual wine vessels generally and it cannot therefore properly be used to name any particular class. A class of tall, massive wine vessel, shaped rather like a very fat *ku* but too large to have been used as a drinking goblet, was nevertheless called *tsun* by the Sung cataloguers and is generally still so labeled. On the other hand, the classics frequently speak of wine vessels called *hsi tsun*, *hu tsun* and *hsiang tsun*, meaning containers cast in the shape of sacrificial animals, tigers and elephants; and such vessels, realistically modeled to represent animals such as sheep, oxen, hares, buffalo and elephants, are fairly common among known Chinese bronzes. A famous example in the Musée Guimet, Paris, no less than 38 in. long, is fashioned in the shape of an elephant and would therefore correctly be called a *hsiang tsun*.

Of the other wine containers, *yu* may be described as covered buckets with swing handles. They were made during the first phase only and none is self-named. *Yu* show a definite shape relationship with *hu*, for both are usually oval in section and have sloping shoulders and a low-slung belly. A few *yu* are modeled in the shape of a bird, evidently some sort of owl.

Hu, some of which are self-named in inscriptions, were made during all three stylistic phases, but the finest examples belong to the third phase, after which their handsome forms were imitated in glazed pottery of the Han period. They are large vessels, sometimes provided with stoppers, and invariably with a pair of small ring handles, or tubular "ears," through which could be passed a cord or chain for carrying. *Hu* are usually oval in section, sometimes circular, occasionally square.

Fang-i are not self-named in their inscriptions and do not persist beyond the first phase. They are square in section and their form is distinctly architectural, the shape of the cover suggesting a high-pitched, fully hipped roof, while a base is often marked off from the body, recalling the platform that was an integral feature of palace architecture from Shang-Yin times onward.

Lei were used for serving wine. The class is an ancient one, examples being found at Erh-li-kang, but does not seem to have been made after the end of the first phase. No example is self-named. *Lei* are tall and capacious, characterized by a high shoulder and gradually narrowing body below. They have the same sort of cover as the *fang-i*.

Chih are morphologically related to *hu*, though very much smaller and lacking ring handles or "ears." They are typically oval in section. The class is not self-named and the Sung identification cannot be guaranteed correct. *Chih* were made during the first phase and again, with what seems to have been an archaizing impulse, during the third.

The tall and slender *ku*, with its long, flared mouth and foot, is one of the most memorable of the bronzes. It is an ancient class, being represented at the pre-An-yang sites and disappearing completely after the first phase. The *ku* may have evolved from a pottery ancestor of *tou* type, as J. G. Andersson supposed, but more probably derives from one made of horn or similar material. A squat ivory cup found at Erh-li-kang (*see* above) may be such a vessel. Toward the base it has a single cruciform perforation shaped exactly like the diametrically opposed pair of perforations seen just below the middle horizontal zone of many *ku*, which have not been explained. The class is not self-named.

Chüeh and *chia* are related, both perhaps descending from a Neolithic pottery vessel of *li-ting* type, from which stage intermediate pottery forms lead down to the mature bronze types found at An-yang. Both vessels stand on three long, lance-shaped legs and both are provided with side handles and with a pair of small capped pillars mounted on the mouth rim. In addition, the *chüeh* has a long, troughlike spout and a tapering tail extending from the mouth rim. These several features give it an elegance and poise not matched elsewhere among the bronzes. Primitive versions of both *chüeh* and *chia*, very similar to contemporary pottery examples, have been found at sites older than An-yang, so that the record of their formal evolution seems nearly complete. They were made throughout the first phase, but never subsequently. Neither class is self-named.

Ho, used for mixing wine with water, are like teapots, being provided with spouts, side handles and lids which are usually connected to the body by a short chain. They are generally mounted on three or four legs and the basic shape of the body is that of the *li* or *ting*. *Ho* are self-named in some inscriptions and persist through all three phases. A Neolithic pottery prototype is known.

The name *kuang* was given to a group of first-phase vessels looking like sauceboats with covers modeled in the shape of an animal head, often that of an ox. There are, however, good reasons to doubt the identification. *Kuang* are not self-named; in shape, they closely resemble the water ewer, *i*, which in many cases *is* self-named, the only difference being that the *i* usually lacks a cover.

The Sung cataloguers made no distinction between *kuang* and *i*, assigning all such vessels to the latter class. If they are one, this would account for the fact that so-called *kuang* are restricted to the first phase, *i* to the second and third. A vertical partition running across the short axis in some examples is perhaps evidence that *kuang* were used for mixing wine with water.

Water Vessels.—These include containers (*chien, p'ou*), basins (*p'an*) and ewers (*i*).

Chien provide self-named examples, the graph showing a person bending over a bowl, apparently looking at his reflection in the water. One of the meanings of *chien* is "mirror," and it is possible that this bowl was used as such, but references in the classics indicate that it was normally filled with ice and used to preserve sacrificial food in hot weather. *Chien* are among the largest bronze vessels, one in the Musée Cernuschi, Paris, measuring 40 in. across the mouth. *Chien* were not made before the second phase.

There is some doubt as to whether *p'ou* were used as containers for wine or for water. They are large jars, usually provided with covers, and were made during all three phases and reproduced subsequently in glazed pottery of the Han and Six Dynasties periods. This class is not self-named.

P'an are large shallow bowls that were used for washing other ritual vessels or for ceremonial ablutions. The class is self-named. Examples occur among bronzes older than the An-yang culture and throughout the three phases to Han times. The flat inner surface of *p'an* particularly fits them for long inscriptions.

The water ewer, *i*, probably descends from the so-called *kuang*. The class is self-named and is found only in the second and third phases. Most *i* lack covers; early examples often have the spout enclosed above by an animal mask, the vessel being supported on three or four legs. Later the mask disappears and the legs may then be replaced by a hollow, spreading base, but many other variations occur.

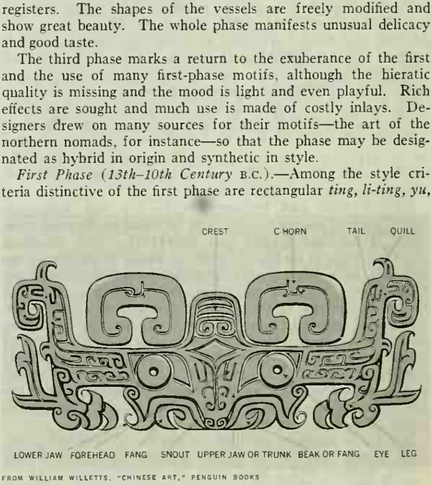
Stylistic Phases.—Two radical changes in the style of the ancient bronzes occurred, one about the beginning of the 9th century B.C., the other approximately four centuries later. Three stylistic phases thus may be discriminated. These changes were not cataclysmic: decorative elements persisted from one style to the next, so that many vessels display features common to both and resist classification into either. Nevertheless a typical first-phase bronze is very different from one typical of the second, just as one typical of the second phase differs radically from one belonging to the third.

The art of the first phase may be qualified as hieratic, for its motifs seem to have a real iconographic import, less evident in the later phases. The *t'ao-t'ieh* mask, set in a background of squared spirals, is its main subject, supplemented by an astonishing array of other animal motifs. There is a tendency, more pronounced in the case of vessels in A style, for decoration to cover the entire surface. Often the shapes of such vessels are almost submerged beneath the profusion of symbolic form.

The second phase expresses a simpler and less tense spirit. Animal forms have all but vanished and the *t'ao-t'ieh* is reduced to little more than a geometrical pattern. Decoration is used for its own sake, the design being carefully placed in horizontal registers. The shapes of the vessels are freely modified and show great beauty. The whole phase manifests unusual delicacy and good taste.

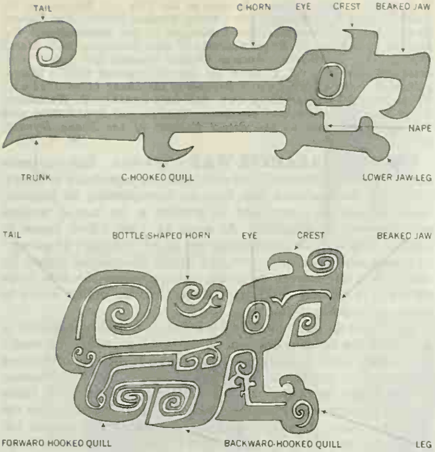
The third phase marks a return to the exuberance of the first and the use of many first-phase motifs, although the hieratic quality is missing and the mood is light and even playful. Rich effects are sought and much use is made of costly inlays. Designers drew on many sources for their motifs—the art of the northern nomads, for instance—so that the phase may be designated as hybrid in origin and synthetic in style.

First Phase (13th–10th Century B.C.*)*.—Among the style criteria distinctive of the first phase are rectangular *ting, li-ting, yu,*



FROM WILLIAM WILLETTS, "CHINESE ART," PENGUIN BOOKS

FIG. 1.—T'AO-T'IEH MASK FROM A FIRST-PHASE TING, 13TH–10TH CENTURY B.C.



FROM WILLIAM WILLETTS, "CHINESE ART," PENGUIN BOOKS

FIG. 2.—K'UEI DRAGONS, 13TH-10TH CENTURY B.C.: (ABOVE) FROM A FIRST-PHASE SQUARE TING, (BELOW) FROM A FIRST-PHASE YU

fang-i, ku, chüeh, chia and *kuang;* cylinder legs; an animal's head on the upper part of *ting* legs; vertical, segmented flanges and lid knobs as opposed to disks. A dominant feature is the deep bowl shape of *ting,* and vertical handles, or "ears," are mounted on the mouth rim, not on the body of these vessels.

The most important motif, the *t'ao-t'ieh,* is a mask seen in front face, composed of two confronting animal forms seen in profile; what it is or what it signified is not known. Resemblances to it in the art of Mycenae and of pre-Columbian America must be regarded as chance. Its earliest-known occurrence in Chinese art is on a steep-sided pottery bowl recovered at the Neolithic site of Shih-chia-ho in Hupeh province (1955).

Almost as universal as *t'ao-t'ieh* are the creatures called by the Chinese *lung,* "dragons"; indeed the two halves of the *t'ao-t'ieh* itself may for practical purposes be regarded as a pair of dragons in profile. Though the form is highly stylized, a beaked jaw, snout, forehead, crest, horn, eye, body, tail and leg or legs usually can be recognized.

Many more familiar animals occur on first-phase bronzes, a cicada being one of the commonest, usually incorporated in the tall, tapering motif called by Karlgren "rising blade" or "hanging blade," according to whether it points upward or downward.

Most of the geometrical motifs are restricted to vessels decorated in the A style. They include massed round bosses, massed compound lozenges, lozenges with central spikes, massed vertical ribs, circle bands, interlocked T's and the *ling hua,* "flower of the water chestnut." The commonest geometrical motif, however, in A style as well as in B, is the squared spiral. Its significance is unknown, but the Sung cataloguers called it *lei wen,* "thunder pattern," probably because of a chance resemblance to the ancient written character for "thunder."

Second Phase (9th–6th Century B.C.*).*—A group of bronzes, assigned to the early 9th century, shows many typical second-phase motifs but none typical of the first. A *ho* found with other vessels and a bell at P'u-tu Ts'un in Shensi province (1954) has an inscription naming King Mu, who ruled in the middle 9th century; the vessels are typical of the second phase. The latest examples that can be approximately dated are the hoard of bronzes (eight vessels and a bell) found at Hsin-cheng in Honan province in 1923, perhaps made in the middle 6th century. By the beginning of the 5th century the third phase was in full swing, and it is likely that second and third phases were coeval for a century or more.

The second phase is marked by total disappearance of the vessel classes distinctive of the first phase—a fact difficult to account for. *Kuang* probably survived into the second phase as *i.* Characteristic changes in the shape of other vessel classes took place. *Ting* become much shallower, the "ears" L-shaped and mounted on the body, the legs thin, splayed and cabriole-shaped. *Li* are also shallow, with flat spans between the legs. *Kuei* often are cast together with a massive square stand, have lobed handles representing animals or birds, a lid and a lid knob looking like a crown. *T'ao-t'ieh* and dragons are among the few first-phase motifs to survive, but their forms are so fragmented as to be almost unidentifiable, and the first-phase animal forms have been practically banished. Prominent among new motifs is the continuous wavy band with faulted sides, called by the Chinese *pan yün,* "undulating cloud." Another is the horizontal fluting characteristic of the Hsin-cheng bronzes, which may have been an innovation from the near east. A third is the scale or imbricated pattern, in which the scales may hang vertically side by side to form a band, or else are massed together either vertically or horizontally to cover a wide area.

Third Phase (5th–3rd Centuries B.C.*).*—The first reliable date for a vessel in third-phase style is probably that afforded by inscriptions on a pair of vessels, the Huang-chih *hu,* referring to events that happened in 482 B.C. Again, in 1955, 485 miscellaneous bronzes were recovered from the tomb of a marquess of Ts'ai at Shou Hsien in Anhwei province, part of the ancient state of Wu; the rulers of Ts'ai were refugees in Wu between 493 and 447 B.C., during which period the bronzes were probably made. A third *point de repère* is provided by a group of bronzes found in 1923 at Li-yü, near the Great wall in northern Shansi. Some of the bronzes excavated in 1953 at T'ang Shan in northern Hopeh, in the territory of the state of Yen, show a style and decorative treatment similar to these Li-yü vessels, whereas the Shou Hsien bronzes, with the Huang-chih *hu* and a set of 13 bells found in a tomb at Hsin-yang in Honan in 1954, belong to a style associated with the southern state of Ch'u. Some of the feudal states, in other words, seem by this time to have developed their own conventions within the main phase.

The lower limit of the third phase has been fixed at the end of the 3rd century B.C., mainly on the strength of the sudden disappearance at that time of certain categories of bronze mirrors. Undoubtedly the breakup of feudal China and the founding of the Han dynasty marked the end of the phase in most parts of China. In the south, however, Ch'u continued to enjoy some political independence as late as 122 B.C. Dozens of tombs have been excavated in the vicinity of the Ch'u capital (modern Cha'ng-sha), and while many of these date from the 3rd and possibly 4th century B.C., some belong to the early Han period. The third-phase bronze style is here expressed in other materials, for example lacquer, and the family likeness of these objects, possibly made over a period of three centuries, clearly demonstrates that in this region at least the stylistic break was not sharp.

The phase is marked by a revival of certain Shang-Yin motifs, including a freely treated *t'ao-t'ieh,* climbing dragon handles, rising and hanging blades, interlocked T's, the circle band, the square *ting,* the *chih* goblet, the use of turquoise as an inlay. Other motifs, such as the *pan yün,* are taken over from the second phase. Nomad art made an important contribution. Modeled animals, such as adorn the covers of certain third-phase *ting,* often have small pear-shaped cells on their bodies. These are vestigial on the Chinese bronzes, but in nomad art were used as *cloisons* to hold turquoise and other inlays; indeed the whole conception of these animals is borrowed from the nomads. The practice of inlaying, while known in first-phase art, was probably stimulated during the third phase by contact with the nomads. A variety of rich materials is used—jade, glass, lacquer, silver, gold, copper, turquoise and malachite—and naturalistic subjects such as hunting scenes are finely rendered, usually on the bodies of *hu.* Many motifs seem to be original, among them the twisted and plaited cord pattern separating horizontal registers, the comma-shaped hook and the free ring handle depending from an animal mask.

Bronzes Other Than Vessels.—Among other ritual bronzes, bells constitute an important group. Perhaps the oldest class is the small clappered bell called *ling*, which occurs among the bronzes older than An-yang; but the best known is certainly the suspended, clapperless bell, *chung*. *Chung* were cast in sets of eight or more, to form a musical scale, and were probably played in the company of string and wind instruments. The section is a flattened ellipse and on each side of the body appear 18 blunt spikes or bosses, arranged in three double rows of three. These often show marks of filing and it has been suggested that they were devices whereby the bell could be tuned to the requisite pitch, by removing small quantities of the metal. The oldest specimen recovered in a closed excavation is one from P'u-tu Ts'un, dating from the 9th century B.C.

Vast numbers of secular bronzes were cast during the three phases and later. These include weapons, such as the *chih* and *ko* dagger axes and the short sword; chariot and harness fittings; trigger mechanisms for bows; weights, scales and measures; belt hooks; mirrors. The last appear in great numbers from the third phase onward. They are flat disks, with a central perforated boss by which they could be mounted on a stand. Their backs are covered with a maze of intricate relief designs and feature a diversified series of well-defined subjects.

Karlgren's C and D category mirrors, which disappear at the beginning of the Han period, bear typical third-phase motifs such as interlocked T's, comma pattern, granulated band and continuous compound lozenge band. They also feature a composite creature called "bird-dragon" by Karlgren and a device in which a dragon is combined with an open lozenge. Karlgren's F category appears in the 2nd century B.C., and features a magical mountain landscape peopled with fantastic beings, probably a Taoist subject. About 100 B.C. the Animals of the Four Quarters first appear on mirrors of TLV type, so called because they are decorated with simple geometrical forms resembling those letters. TLV mirrors are often very complex in design, with several concentric zones of ornamentation, and carrying inscriptions naming the 12 signs of the zodiac and the 28 Stellar Mansions; for this reason they are also sometimes known as cosmic mirrors.

An important type of mirror, called by the Chinese "sea horses and grapes," appears in T'ang times. It reproduces a late antique motif of vine trails bearing bunches of grapes intermingled with various animals and birds and is probably derived from Sassanian Persian metalwork.

Later Bronzes.—By Sung times archaistic versions of the ancient bronzes were being plentifully made, but from this stage onward the art, if not the technique, so degenerates that it no longer holds interest. Between Han and Sung, however, quantities of small votive Buddhist images were cast in bronze, and in fact the oldest Chinese Buddha image known, a Sakyamuni inscribed with the date A.D. 338, is such a piece. This period, that of the Wei, Sui and T'ang, was one of vital achievement in Chinese sculpture and the lovely bronzes reflect prevailing stylistic trends.

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(W. Y. W.)

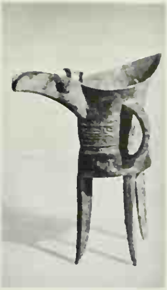
CHINESE-JAPANESE WAR (1894–95). This war grew out of a conflict between China and Japan for supremacy in Korea. China, on the one hand, was bent on strengthening its position, which it could no longer take for granted in the face of western and Japanese imperialism. As early as 1880 China began to tighten its hold on this most important of its "tributary kingdoms" by means of a trade agreement and special commercial agents, by taking over the Korean telegraph, by appointing the able Yuan Shih-k'ai as Chinese resident in Korea, and by urging Korea to shore up its military forces.

Japan, for its part, emerged from two centuries of isolation in 1868 with the fundamental aim of increasing its national strength and making itself a respected world power in the face of western pressure that threatened its independence. Asserting influence in Korea was one aspect of this goal. As early as 1874 Japan sent an expedition to Formosa, ostensibly to seek redress for the murder of some Ryukyu islanders by Formosan aborigines but in fact to test China's attitude toward this dependency. Upon receipt of an indemnity and under pressure from Britain, Japan withdrew its troops. In 1879 Japan annexed the Ryukyu Islands.

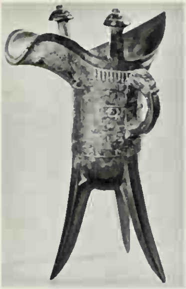
But Japan was particularly interested in Korea because of its natural resources, especially coal and iron, in which Japan was poor, and because of its strategic position. For some years Japan's objective was Korean independence, for such independence would allow trade relations and economic penetration. In 1876 Japan was more or less successful in this connection when it signed an agreement with Korea that opened three ports for trade and declared Korea to be an "independent state." China, however, continued to speak of Korea as "our tributary kingdom." The international status of Korea during these years remained confusing. In the 1880s it negotiated treaties with various western nations as if it were independent but at the same time declared itself dependent on China.

Factional strife in Korean politics added impetus to Chinese-Japanese rivalry after 1880. In 1882 one Korean group, headed by relatives of the queen, backed by Japan and favouring intercourse with the west, clashed with another group, headed by the regent, backed by China and pro-Chinese in sentiment. In the fighting the Japanese legation was attacked and both China and Japan sent troops to the scene. Two years later there was a similar clash in which Yuan Shih-k'ai's forces overcame Japanese troops and put down the revolt. The pro-Chinese group was left in control of the government with Yuan as the virtual ruler of Korea. Japan, it is apparent, did not want war at this time. The so-called peace party, which may be distinguished from the war party in that it was willing to make haste somewhat more slowly, was then predominant in the Japanese government.

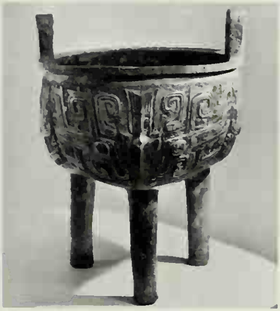
But when another crisis arose nine years later (1894), Japan used it as a cause for war to eliminate China from Korea. Chinese troops entered Korea at the request of the Korean government to put down a serious rebellion. Japan dispatched troops to Korea as a countermove. When the uprising was under control, China suggested that both sides remove their troops; Japan replied that this would be unwise because the situation was too unstable. It proposed instead the formation of a joint commission to compel drastic reform of the Korean government, and added that if China declined to participate it would proceed alone. Japan was reasonably sure China would not accept this proposal because Chinese influence depended on keeping the *status quo*; any reforms would have meant admitting at least some of the pro-Japanese faction into the government. China's counterproposal, refused by Japan, was that Japan's reform proposals be discussed after a mutual withdrawal of troops. With the diplomatic situation thus stale-



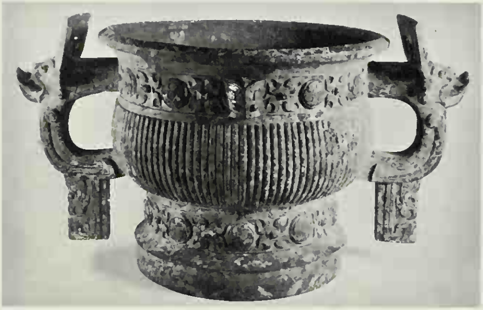
Right: Chueh wine goblet, pre-Anyang style, *c.* 14th century B.C.: early Shang-Yin period. Height 5⅝ in. In the British museum, London



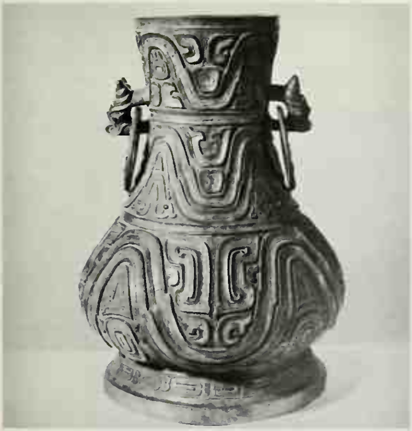
Left: Chueh wine goblet, 13th–11th century B.C.: Shang-Yin or early Chou period. Height 8½ in. In the Seligman collection, London



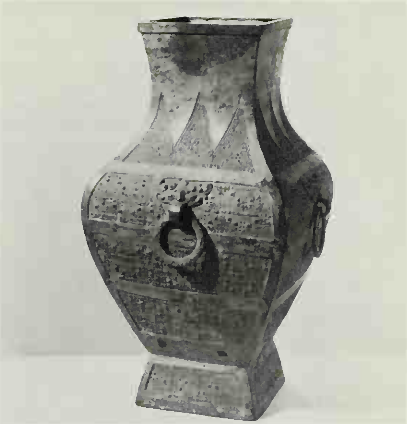
Ting cooking vessel, 13th–11th century B.C.; Shang-Yin or early Chou. Height 8⅝ in. In the Seligman collection, London



Kuei food container, 11th century B.C.; early Chou. Height 8¼ in., width 16½ in. In the Dugald Malcolm collection, London



Hu wine container, 10th–7th century B.C.; second phase of the Chou. Height 18 in. In the Dennis Cohen collection, London

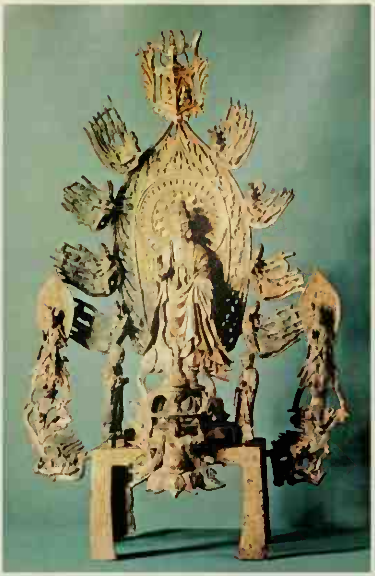


Hu wine container, 6th–3rd century B.C.; third phase of the Chou. Height 16⅞ in. In the Ashmolean museum, Ingram collection, Oxford

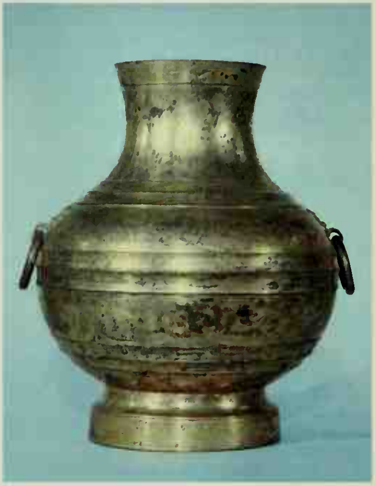
ANCIENT CHINESE RITUAL BRONZES

BY COURTESY OF (TOP LEFT) S. N. HANSFORD, (TOP RIGHT, CENTRE LEFT) ARTS COUNCIL OF GREAT BRITAIN, (CENTRE RIGHT, BOTTOM LEFT AND RIGHT) ORIENTAL CERAMIC SOCIETY, LONDON

CHINESE BRONZE



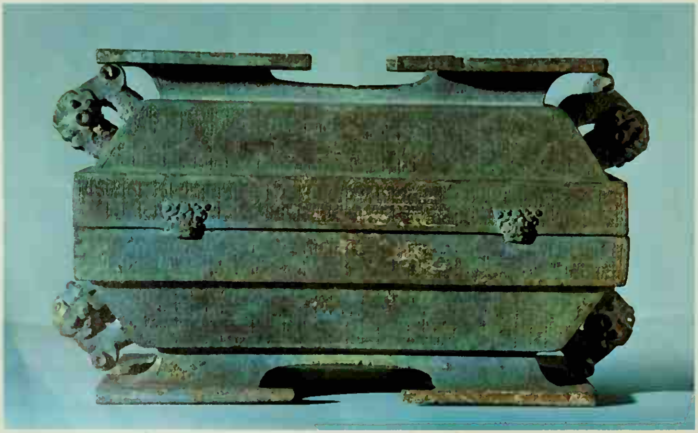
Gilt-bronze altar group of Buddha and attendant divinities. Period of the Six Dynasties (A.D. 221–589). In the Metropolitan Museum of Art, New York city



Gilt-bronze *hu*, or wine jar. Han dynasty (202 B.C.–A.D. 221). In the Lucy Maud Buckingham collection, the Art Institute of Chicago

ANCIENT CHINESE RITUAL BRONZES

Fu, a covered food vessel. From the third stylistic phase (5th–3rd century B.C.). In the Lucy Maud Buckingham collection, the Art Institute of Chicago



BY COURTESY OF (TOP) THE METROPOLITAN MUSEUM OF ART, ROGERS FUND, 1938; (OTHERS) THE ART INSTITUTE OF CHICAGO, LUCY MAUD BUCKINGHAM COLLECTION

mated, the occasion for war occurred in Aug. 1894, when Chinese naval vessels fired on some Japanese ships.

From the outset of the conflict, China had little confidence in victory and its misgivings proved correct. The Chinese government and armed forces were unable to cope with the small but effective Japanese legions, and within six months China was sending missions to Japan in search of a settlement. By March 1895 the Japanese had gained control of Wei-hai and southern Manchuria, and an assault on Peking was in sight. At this juncture, Li Hung-chang, China's leading statesman, himself made the humiliating journey to Japan to sue for peace.

The outcome was the treaty of Shimonoseki of April 17, 1895, which included the following provisions: (1) China was to pay an indemnity of 200,000,000 taels to Japan; (2) China was to recognize the complete independence of Korea; (3) China was to cede Formosa, the Pescadores Islands and the Liaotung peninsula in south Manchuria to Japan; and (4) China was to draw up with Japan a commercial treaty opening up four new treaty ports and allowing the establishment of factories under foreign ownership and management. The severity of this treaty was somewhat modified by the triple intervention of April 1895 by Russia, France and Germany. In the name of "friendship" for Japan, they "advised" Japan to relinquish its claim to Liaotung. Faced with such an array of power, Japan had no choice but to acquiesce.

The war had important consequences. The west had expected a Chinese victory but the fighting exposed China's weakness for all to see; as a result, the next five years were a period of imperialism par excellence in China. China's poor showing in the war also was a decided boon to the revolutionary movement within the country, to which the Manchu regime succumbed in 1912.

Japan's victory established it among the ranks of the great powers. By 1899 it had regained its sovereignty in full through renegotiation of the unequal treaties, something China did not achieve in full until 1943. In 1902 Japan was accepted by Britain as a partner in a full-fledged alliance. And, finally, the war put Japan unmistakably on the course of expansion in east Asia.

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(F. W. Po.)

CHINESE LANGUAGE. Chinese, the principal language of eastern Asia, is spoken by more people than any other language in the world. Though speakers of Chinese live in all parts of the world—from Singapore to New York city—and though small minorities within China speak non-Chinese languages—Miao-Yao, Thai, Turkish, etc.—more than 95% of speakers of Chinese live in China and more than 95% of the population of China speaks Chinese. Chinese is therefore essentially the national language of one country, as contrasted with English, the second most spoken language of the world, which is an international language of several countries. Chinese is one of the five official languages of the United Nations.

In linguistic stock Chinese belongs to a family of languages known variously as the Indo-Chinese, Tibeto-Chinese or Sinitic languages. Besides Chinese the other main branches are the Thai, Miao-Yao and Tibeto-Burman subfamilies of languages. There are three characteristics that all these languages share to various degrees: (1) they all tend to use monosyllabic meaningful units; (2) they all tend to develop a system of tones, whether original or evolved out of earlier consonantal features; (3) earlier voiced initial consonants tend to become unvoiced in the modern forms of the languages.

PHONOLOGY

The phonetic system of modern Standard Chinese, or Mandarin, is comparatively simple and regular.

Sounds of Mandarin.—The accompanying list gives the sounds of Mandarin, as represented in the Wade-Giles system of romanization, commonly used in books in English on Chinese subjects. Initial consonants do not go beyond the following list (where two approximations are given; the first one is easier to make and the second more accurate as to phonetic value). Thus, every word begins either with one of these consonants or consonant groups, or with an open vowel, and anything beginning with, say, *sl-*, *pr-* or *shm-* cannot be Chinese.

There are three high vowels, *i* (pol*i*ce), *u* (r*u*le) and *ü* (Ger. *ü*ber); three mid-vowel qualities, *e* (y*e*n), *ê* (*u*p, lengthened) and *o* (b*o*rse); and one low vowel, *a* (f*a*ther). The high vowels also serve as semivowels in forming diphthongs and triphthongs, such as *ia*, *ai*, *uei*, except that *ü* never occurs as the ending of a syllable. Sometimes a word consists of an initial of the (1) *ts*, *ts'*, *s* type or (2) the *ch*, *ch'*, *sh*, *j* type, followed by a vocalization with the tip of the tongue remaining in the same position as the consonant. To remind one of the buzzing quality of the vowel of type (1), the whole syllable is rewritten, in the Wade-Giles system, as *tzŭ*, *tz'ŭ*, *ssŭ* (or *szŭ*), the breve sign indicating not so much brevity—the vowel being no shorter than any other vowel—as that it is not really the *u* but the *z* that gives the quality of the vowel. In type (2), *ch*, *ch'*, *sh*, *j*, which already have an *r*-like quality, the prolongation is indicated by the digraph *-ih*. Thus, a word like *shih* is pronounced something like *shr*. These two vowels, *ŭ* and *ih*, have been described in some detail here because they occur with great frequency and because those who try to learn them usually make too much effort, whereas the essence of their quality is zero, and the method of producing zero consists in doing nothing.

Modern Chinese is like Italian in having few consonantal endings. The only common ones are *-n* and *-ng*. The ending *-r*, though frequent in occurrence as suffix, is limited to a very few roots. When a word ends in *-m*, there is almost always an alternate form with *m* followed by a vowel. Hence one can say that there is practically no final *-m* in Mandarin.

Tone.—As has been indicated above, Chinese has the element of tone as a word-forming constituent. The otherwise identical syllable *t'ang*^{1}, pronounced with a high level tone, is the word for "soup"; *t'ang*^{2}, with a tone rising from medium to high pitch, is the word for "sugar"; *t'ang*^{3}, with a low dipping circumflex tone, is the word for "lie down"; and *t'ang*^{4}, with a wide drop from high to low pitch, is the word for "hot." Tonal distinctions are sometimes, but not usually, correlated with grammatical or etymological distinctions. For example, *shu*^{3} "to count": *shu*^{4} "number"; *chung*^{3} "seed": *chung*^{4} "to plant"; *liang*^{2} "cool": *liang*^{4} "to cool, to air." Such instances are of comparable frequency or rarity to that of similar uses of vowel modulation in English like get: got or tooth: teeth. By and large, words with the same consonants and vowels but different tones are quite as unrelated as are English pin, pen, pan, pun, or peat, beat, meat, feat.

Stress.—Stress accent in Mandarin plays an important part to the extent that a difference in stress often makes a grammatical or semantic difference, though not usually in etymological identity. Thus, *mai*^{3} *mai*^{4} is a phrase meaning "buy and/or sell," but *mai*^{3}*.mai*^{4} (where the dot indicates a loss of stress and loss or weakening of tone on the following syllable) is a compound noun meaning "trade."

Again, both *ta*^{4}*-i*^{4} and *ta*^{4}*.i* are compounds, made up of *ta*^{4} "great," and *i*^{4} "idea," but while the former means "main ideas," the latter means "careless." These cases can be compared with such pairs in English as con-

p as in *b*ore or s*p*ore	*t* as in *d*oor or s*t*ore	*k* as in *g*ore or s*c*ore
p' as in *p*our	*t'* as in *t*ore	*k'* as in *c*ore
m as in *m*e	*n* as in *n*ight	*h* as in *h*igh or Ger. ma*ch*e
f as in *f*ine	*l* as in *l*et	
ch(*i*,*ü*) as in *j*eep	*ch*(*ih*, or other vowels) as in *d*ray or s*t*ray	
ch'(*i*,*ü*) as in *ch*eap	*ch'*(*ih*, or other vowels) as in *t*ray	
hs as in *sh*eep or Ger. Ei*ch*e	*sh* as in *sh*red	
	j as in between *r*ay and French *j*e	
ts as in loa*ds* of	*y* as in *y*es	
ts' as in *t*setse fly or i*t's h*ot	*w* as in *w*ide	
s as in *s*ay		

tráct *v.* cóntract or a blàck bírd *v.* a bláckbird.

GRAMMAR

It is a common belief that Chinese has little or no grammar. This is true insofar as grammar is taken in the narrow sense of having inflections of person, case, number, tense, voice and the like. But there is as much orderly organization of parts into wholes in Chinese as in any other language. There is, as will be shown, regular structure in word formation; there is functional significance in word order: adjective-noun, verb-object, subject-predicate; there is distinction of parts of speech: *t'ien*^{1} "sky" is a noun, *lai*^{2} "come" is a verb, *hung*^{2} "red" is an adjective (which in Chinese can also act as a predicate), *wo*^{3} "I, me" is a pronoun. In other words, Chinese has grammar.

Another common belief is that Chinese is a monosyllabic language. There is, again, a sense in which this is true. Ninety-nine per cent of syllables in Chinese sentences consist of meaningful monosyllabic units, called *tzŭ*^{4} in Chinese. This is the kind of thing that a mother teaches her child to say, that one learns to read and write in school, that one is charged for "so many of" in a telegram and on which one makes slips of the tongue. If one fails to get an answer to a question, one says "He didn't say a *tzŭ*^{4}." This unit is, therefore, the exact social counterpart of the word in an English-speaking society, and it is with good idiomatic reason that occidental sinologists have translated *tzŭ*^{4} as "word," or any of its other European equivalents. This tendency of making every *tzŭ*^{4} mean something is so strong that even for the relatively few originally unanalyzable dissyllables, both the scholar and the popular etymologist have never ceased to try to put meanings into the separate parts.

But if one looks for those units in Chinese sentences and phrases which can be uttered independently and can be rearranged and combined with a great deal of flexibility in the way English words can, then these turn out to be not always monosyllables but quite often polysyllabic units. Examples of such units, which may be called syntactic words, are: *ch'ih*^{1} "eat," *nien*^{2}*-nien*^{2} "yearly," "every year," *hao*^{3}*-k'an*^{4} "pretty," "good-looking."

Derivation.—Since Chinese has no inflection, syntactic words, apart from free monosyllables which are already words, are formed by derivation and compounding. Of the derivational processes, phonetic modification, such as *chien*^{4} (from *kian*) "to see": *hsien*^{4} (from *g'ian*) "to appear" and *ch'ang*^{2} (from *d'i̯ang*) "long": *chang*^{1} (from *ti̯ang*) "to extend," has never been active in historical times. Reduplication with various functions is a very active process: with distributive sense, *jên*^{2}*-jên*^{2} "everyman"; *ko*^{4}*-ko'r*^{4} "everyone"; to express liveliness, *t'ou*^{1}*-t'our*^{1} "stealthily"; to form certain nouns, *pa*^{4}*.pa* "papa," *ma*^{1}*.ma* "mamma," *wa*^{2}*.wa* "baby," *ch'ü*^{1}*.ch'üêr* "the cricket."

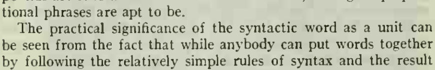
Affixes.—Prefixes and infixes are rare, but suffixes, though few in variety, are extremely frequent in occurrence. The diminutive suffixes *-tzŭ* and *-r* (the last not forming a separate syllable) are attached to a great many roots to form nouns. Verbs often take aspect suffixes: *-lê,* perfective, *-chih*, durative, and, if reduplication may be regarded as an affix, the second *k'an* may be regarded as a "tentative" suffix in *k'an*^{4}*.k'an* "just look." The single most important suffix in Chinese is the subordinate suffix *-tê* (with a reading pronunciation of *ti*^{4}), which makes the word to which it is attached a modifier of what follows. For example, *chin*^{1}*.tê ch'ien*^{2} "gold kind of coin"—"gold coin"; *ch'ang*^{2}*.tê hsien*^{4} "long kind of thread"—"long thread"; *ni*^{3}*.tê pao*^{4} "your newspaper"; *fei*^{1} *ch'ang*^{2}*.tê ch'i*^{4} "un-usual-ly angry."

There is a small but important class of suffixes which, though closely joined to whatever happens to precede them, do not belong to the word immediately preceding but to the whole phrase or sentence. These are called particles or final particles. For example, *Ni*^{3} *pu*^{4} *nêng*^{2} *chiu*^{4} *tsou*^{3} *.eh!* "You can't just leave!" where the untranslated atonic *eh* expresses the mood or attitude of the speaker toward the listener, with the force of "you see?" or "don't you know?" Some particles overlap in form and function those of suffixes for single words. For example, *Chê*^{4} *hua'r*^{1} *tei*^{3} *ch'ang*^{2} *chiao*^{1} *shui*^{3} *tê* "This flower must often be watered," where the subordinate particle *tê* indicates that this is the kind of situation. Used with parts of sentences, this particle has the function of "who," "which," "of" or "'s." *Na*^{4} *san*^{3} *shih*^{4} *kên*^{1} *wo*^{3} *t'ung*^{2} *tsou*^{3}*.tê hsiao*^{2}*.chieh tê* "That umbrella is with me together go's lady's." Compare the American "That umbrella is the young lady I go with's." (H. L. Mencken, *The American Language*, 4th ed., p. 461, New York, Alfred Knopf, Inc., 1936). The only difference here is that while the English is something of a curiosity, it is the typical construction in Chinese.

Compounding.—The most important process in Chinese word formation is compounding. A compound may consist of parts in various grammatical relationships. It may consist of subject and predicate. For example, from the sentence *Hsin*^{1} *t'êng*^{2} "The heart aches," one can form a compound transitive verb *hsin*^{1}*.t'êng*^{2} "to have a heartache for"—"to be solicitous for" as in *Shei*^{2} *pu*^{4} *hsin*^{1}*.t'êng*^{2} *tzŭ*^{4}*-chi*^{3} *.tê êrh*^{2}*.tzŭ?* "Who is not solicitous for his own child?" A compound may have parts in coordinate construction, with parts meaning similar or opposite things, as *ch'ing*^{1}*.ch'u* "transparent-distinct"—"clear"; *hêng*^{2}*-.shih* < *hêng*^{2}*-shu*^{4} "horizontal vertical"—"anyway"; *lai*^{2}*-wang*^{3} "come-go"—"checking (account)." The first part may be subordinated to the second, as *wu*^{4}*-li*^{3} "things-principles"—"physics"; "*hsin*^{1}*-li*^{3} "mind-principles"—"psychology"; *nan*^{2}*.jên* "male person"—"man"; *nü*^{3}*.jên* "female person"—"woman." There is one class of subordinate compounds which deserves special mention because of its great productivity. They are formed by putting words of location, or localizers, after a noun. Thus, *t'ien*^{1}*-hsia*^{4} "heaven('s) below"—"the world"; *hai*^{3}*-shang*^{4} "sea('s) above"—"on the sea"; *ch'êng*^{2}*-li*^{3} "city('s) inside"—"downtown"; *ch'êng*^{2}*-.li* "city('s) in"—"in the city." Because these localizers usually translate into English prepositions, they are sometimes called postpositions. It should be remembered, however, that these compounds are substantive words and not adverbs, as English prepositional phrases are apt to be.

The practical significance of the syntactic word as a unit can be seen from the fact that while anybody can put words together by following the relatively simple rules of syntax and the result will be at least grammatical, the formation of new derived and compounded words from *tzŭ*^{4}, apart from the few very productive types already noted, cannot be trusted to the hands of any but highly literate persons. Otherwise the result would be felt as solecisms and described as being *shêng*^{1}*-ying*^{4} "raw and stiff."

Syntactical Division.—The main syntactical division in a Chinese sentence is between subject and predicate. The connection between them is, both formally and semantically, much looser than between similar parts in an English sentence. The subject is literally the subject matter and the predicate is any comment one makes about the subject. For example, *Chê*^{4} *ti*^{4}*.fang k'o*^{3}*.i*^{3} *t'iao*^{4}*-wu*^{3} "This place can dance"—"as for this place, one can dance"—"one can dance here." A very interesting corollary of this is that after announcing a subject (often with a pause, or pause particle *a*, *ne* or *me*) one often starts again with a more specific part of the general subject matter as a second subject, so that the latter, together with its predicate, forms a clause-predicate to the first (main) subject, and this may go on after the manner of box within box of a Chinese puzzle. For example:


Wo^3. mên i^4- chia^1 . tzŭ Ma^1. ma p'i^2.ch'i tsui^4 hao^3.
S_3
P_3
S_2
P_2
S_1
P_1

"We the whole family (S_1), Mamma (S_2), the temperament (S_3) is most good (P_3)"—"Mamma is the most good-natured member of our family." Now the addition of "the" in the above translation is not done gratuitously, merely to make the English smoother, because it actually translates an element of the Chinese sentence, namely, position in the sentence. In general, an initial or an early position in a sentence tends to imply definite reference, whereas a late position, especially after a verb, tends to imply indefinite reference. Thus, *K'o*^{4} *lai*^{2}*.lê* "The guest (whom I expected or invited) has come," as against *Lai*^{2} *k'o*^{4}*.lê* "There has come a guest (whom I have not expected)."

Within the subject or the predicate, if it consists of more than one syntactic word, there may be various other syntactic constructions. Co-ordinate constructions are usually formed by mentioning item after item without any conjunction (with or without pause). For example, *Ni*^{3} *ch'ih*^{1} *fan*^{4} *ch'ih*^{1} *mien*^{4}? "You eat rice or noodles?" *Fan*^{4}, *mien*^{4}, *wo*^{3} *tou*^{1} *hsi*^{3}*.huan* "Rice and noodles I both like." Subordinate constructions are formed in the order of modifier-modified, even though the modifier may be a clause, as has been seen in connection with the particle *tê*. If a modifier apparently follows, as in *T'a*^{1} *tsou*^{3}*.tê* *man*^{4} "He walks slowly," the "wrong" word order is in the English translation, since the original sentence is of the construction "He walks 's (manner) is slow," so that *man*^{4} is not an attributive adverb (as all Chinese adverbs are) but a predicative adjective. Verb and object always occur in that order. Verb-complement constructions are bordering on compounding, especially when they take infixes *-tê-* and *-pu-* to form potential forms, as *nien*^{4}*.tê-wan*^{2} "can finishing reading," *nien*^{4}*.pu-wan*^{2} "cannot finish reading"; *sao*^{3}*.tê-ch'ing*^{1} "can sweep clear," *sao*^{3}*.pu-ch'ing*^{1} "cannot sweep clear."

Congruence.—While Chinese syntax has no congruence of number, tense, etc., there is one kind of congruence which is not unlike that of gender. Each noun, according to its nature, usually the shape of the object named, has a specific classifier, which is compounded with the numeral or demonstrative to be used with the noun. A good dictionary will indicate the appropriate classifier under each noun, much as the gender of nouns is indicated for languages with genders. Thus, when a dictionary gives: *ho*^{2} river (*t'iao*^{2}), it means that one has to say *i*^{4}*-t'iao ho*^{2} for "a (strip of a) river," and *nei*^{4}*-t'iao ho*^{2} "that (strip of a) river." There are about 100 commonly used classifiers, including the general individualizing classifier *ko*^{4} or *.ko*, which can be used for most nouns for individual things or persons which also have their specific classifiers.

Negation.—Negation is expressed by putting the adverb *pu*^{4} (second tone before another fourth tone) before the word modified, as *pu*^{4} *nêng*^{2} *shuo*^{1} "cannot say"; *nêng*^{2} *pu*^{4} *shuo*^{1} "can not-say"—"can keep silent"; *pu*^{4} *nêng pu*^{4} *shuo*^{1} "cannot but say." The only verb (also used as an auxiliary verb) which takes a different negative adverb, *mei*^{2}, is *yu*^{3} "have," as in *mei*^{2}*.yu*^{3} *ch'ien*^{2} "have not money"; *mei*^{2}*.yu*^{3} *lai*^{2} "have (or did) not come."

Questions.—A question is asked by (1) adding an interrogative particle or a special intonation at the end of the statement, as *Shui*^{3} *shên*^{1}*.ma* (or *.pa*, or *.a*)? "Water deep, huh?"—"Is the water deep?" (2) giving the alternatives to choose from, as *Mi*^{3} *kuei*^{4} (no pause) *.pu.kuei*^{4} "Rice expensive (or) not expensive?"—"Is the rice expensive?" (3) substituting an interrogative word (what, where, when, why, etc.) in the sentence where the word in the answer will be, as *Ni*^{3} *chiao*^{4} *shei*^{2} "You call whom?"—"Whom are you calling?" *Chiêr*^{1} *hsing*^{1}*-ch'i*^{1}*-chi*^{3} "Today week-how many?"—"What day of the week is today?" (answer *Chiêr hsing*^{1}*-ch'i*^{1}*-liu*^{4} "Today week-six"; *i.e.*, "Saturday"). The rule of word order for such questions is: Ask as you would be answered.

HISTORY AND DIALECTS

Old Chinese.—Old Chinese had a much richer system of sounds than modern Mandarin. In the period which occidental sinologists have called Archaic Chinese, covering the five or six centuries B.C. when the great classics were composed, there were as many as four grades of initial consonants: *p*, *p'*, *b*, *b'*; *t*, *t'*, *d*, *d'*; *k*, *k'*, *g*, *g'*—comparable with *p*, *ph*, *b*, *bh*, etc. in Sanskrit, as against the two grades *p*, *p'*, etc., in Mandarin. There was also a richer variety of initial consonant clusters, such as *kl-*, *gl-*, *pl-*, *bl-*. For endings there were *-m*, *-n*, *-ng*, *-r*, *-p*, *-b* (rare), *-t*, *-d*, *-k* and *-g*. During this period there were probably three tones.

By the beginning of the 7th century, the language had lost the pure voiced stops *b*, *d* and *g* in both initial and final positions. These had become semivowels *i̯* or *w*, resulting in a poorer system of consonants but a richer system of diphthongs and triphthongs; for example *di̯ad* in Archaic Chinese became *i̯äi* in Ancient Chinese, as the language of this period is called by occidental sinologists. The loss of final *-d*, *-g* and *-b* resulted in, or contributed to, the rise of a new tone class, thus making the full list of the four tones of Ancient Chinese.

Because of the availability of a rich store of source material, it is possible to have a detailed knowledge of Chinese as it was spoken in the 6th or 7th century and to trace the changes from ancient to modern forms. Ancient voiced stops and sibilants have become voiceless. Voiced stops (including affricates, *dz'*, *dź'*, etc.) have become modern aspirated: *d'ien* to *t'ien*^{2} "field" if in the even tone, unaspirated if in the other tones: *d'ien* to *tien*^{4} "lightning." Ancient palatals become modern retroflexes (cacuminals): *śiän* to *shan*^{4} "fan." Ancient bilabials become modern dentilabials under certain conditions: *pi̯ung to fung*^{1} to *fêng*^{1} "wind." Ancient final *-m* becomes modern final *-n*, thus coalescing with original *-n*. Ancient final *-p*, *-t* and *-k* have been dropped. There has so far been no way to reconstruct the exact pitch values of the ancient tones, but one can easily trace the correspondence between the tone classes and their modern correlates. Ancient first tone has become modern first or second tone according as the initial was voiceless or voiced. Ancient second is mostly modern third. Ancient third is modern fourth. Ancient fourth, with its endings *-p*, *-t*, *-k* dropped, becomes modern 1, 2, 3 or 4.

The Dialects.—The preceding account of the development from ancient to modern Chinese is true, in its main features, of about three-fourths of the area and two-thirds of the population of China. For a country of this size and such antiquity this is remarkable uniformity. From K'un-ming, Yünnan, to Harbin, from Urumchi, Sinkiang, to Nanking, one slightly educated person can talk with another with no more difficulty than people from New York and New Orleans do, although a "slightly educated" Chinese is probably more sophisticated linguistically than a "slightly educated" American. This is the area of Mandarin, in the wide sense, with the pronunciation of Peking as the standard. Though this group is usually divided into Northern Mandarin, Southwestern Mandarin (with Chungking as centre) and Southern Mandarin (with Nanking as centre), the differences in pronunciation and vocabulary among these is less than between all of Mandarin and any of the other dialects.

The greatest variation in dialects is found in the provinces of the southeast. With Soochow as the cultural and Shanghai as the commercial centre, the Wu dialects are spoken in southeastern Kiangsu and most of Chekiang province. They have kept the ancient three-grade consonant system *p*, *p'*, *b'*, etc., and have seven or eight tones, having split each of the ancient tones into two according to voicing of initials. The Min group, marked by preservation of archaic dentals and absence of dentilabials, is split into a northern Foochow type and a southern Amoy type, the latter being spoken in Amoy, Taiwan, Swatow and by the majority of the Chinese living in the South seas. The Kam-Hakka group is spoken in Kiangsi province and northeastern Kwangtung, with the special feature of aspirating ancient voiced stops for all tones, whereas the Hsiang (Hunan) dialects unaspirate (and sometimes voice) all ancient voiced stops. Finally, the Yüeh (Cantonese) group has kept most of the final consonants *-m*, *-n*, *-ng*, *-p*, *-t*, *-k* of ancient Chinese. Its speakers live in Kwangtung, part of Kwangsi, and form good-sized speech communities in the South seas and the United States. Dialects differ mainly in pronunciation, secondarily in vocabulary—affecting mostly the high-frequency part of everyday vocabulary—and hardly at all in grammar, if differences in particles are counted as vocabulary.

The Literary Language.—The literary language, or *wênyen*, occupies a more important position in Chinese than the literary language in other countries because (1) it is a common idiom for all dialects; (2) it is based on a common body of literature read everywhere; and (3) it is written in a system of writing which is the same without regard to dialect. It should be understood, however, that *wênyen* is not merely a system of writing, nor the language of ancient books regarded as a concluded corpus of texts. Even from the mouth of an illiterate storyteller, one hears phrases and sentences in *wênyen*. Blind fortunetellers are literally conversant with the literary idiom, which differs widely in vocabulary and to some extent in grammar from everyday speech. It is not a closed-book language, because one learns to compose in *wênyen* after the model of writers anywhere from the 6th century B.C. to the 20th of this era. While there are, of course, great differences of style from age to age, it is still in *wênyen* that government papers, legal documents, business letters, news dispatches and advertisements are being written in the second half of the 1900s. The Chinese do not learn *wênyen* by visual reading only, but usually by reading aloud; they often compose aloud and even hum the melodic swing of phrases and sentences. Thus it is a living language to many intents and purposes.

A common confusion has been to take *wênyen* to be the same thing as Mandarin. While Mandarin is primarily a type of everyday speech, with a definite system of pronunciation, and is confined to only a part, even though the greater part, of the country, *wênyen* has no single standard of pronunciation, is never used in conversational speech and is not limited in geographical distribution. Nor is *wênyen* the language of Ancient or Archaic Chinese. The Chinese student does not read the *Analects* of Confucius or the poems of Li Po as an English student tries to read *Beowulf* or Chaucer, but gives the words the frankly modern pronunciation of whatever happens to be his dialect. If a Cantonese reader finds pleasure in Li Po's perfect rhymes, well and good. If a northerner finds Li Po's tones all mixed up, he blames himself for the loss of ancient pronunciation, but would not dream of trying to recover it. He feels that he is truly reading Confucius or Li Po although all the sounds that he utters are really 20th-century Mandarin.

What, then, is it that makes *wênyen* one, if it is neither the language as pronunciation nor the modern dialect of any locality? It lies in the unity of vocabulary and grammar, maintained in history through the unity of the system of writing and its literature and its continued use in modern life. Because *wênyen* was based largely on an older form of the language, with its much greater variety of syllabic types (one dictionary of Ancient Chinese had 3,877 different syllables, as against 1,300 of modern Mandarin), it was much more nearly monosyllabic in the syntactic sense than most modern dialects. It is significant that Cantonese, with its richer store of 1,800 syllables, uses fewer polysyllabic syntactic words than Mandarin.

SYSTEM OF WRITING

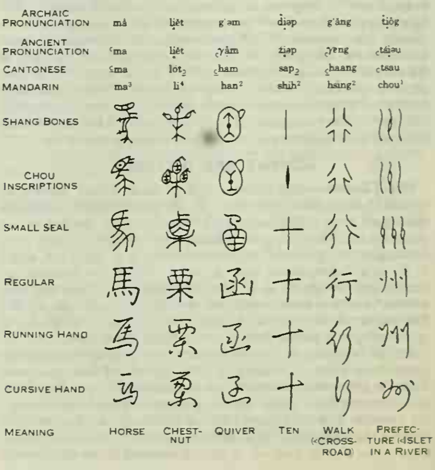
The monosyllabicity of most of the meaningful units of the Chinese language, the *tzŭ*, makes it natural to write *tzŭ* with unit symbols. In high antiquity, in the Shang dynasty (1766?–1123? B.C.) bone and shell oracles, some of the characters were direct representations of things or ideas. But even in those times, most of the characters were already symbols of particular words in the language and not of some different, though synonymous, words. Chinese characters are therefore not strictly ideographs, *i.e.*, symbols of ideas, but logographs, *i.e.*, symbols of words.

Characters.—Traditionally, the Chinese have classified the characters into six categories: (1) pictographs, as 弓 *kung*^{1} "a bow," 爪 *chao*^{3} or *chua*^{3} "claw," 雨 *yu*^{3} "rain," 田 *t'ien*^{2} "field"; (2) simple ideographs, as 二 *êrh*^{4} "two" (different from 兩 *liang*^{3}, which means the same thing but is a different word and has a somewhat different grammatical function), 上 *shang*^{4} "up," 下 *hsia*^{4} "down"; (3) compound ideographs, as 卡 *ch'ia*^{3} "caught in the middle," 止 *chih*^{3} "to stop" and 戈 *ko*^{1} "arms," together forming 武 *wu*^{3} "military" (*cf.* "war to end all wars"), 不 *pu*^{4} "not" and 正 *chêng*^{4} "upright" to form 歪 *wai*^{1} "crooked," "awry"; (4) phonetic loans, that is, borrowing the use of a homophonous word for writing something that cannot be pictured or indicated graphically, 來 *lai*^{2} "come" from a homophonous word for a kind of wheat which the character depicts, 其 *ch'i*^{2} "his," "her," "its," "their," borrowed from a word for "dustpan" of which the character is a picture; (5) phonetic compounds, consisting of a phonetic, giving the sound, and a signific, giving the meaning, 肌 *chi*^{1} "muscle" from 月 *j(o)u*^{4} "flesh" as the signific and 几 *chi*^{1} as the phonetic (the meaning "small table" being irrelevant); (6) derivative characters, a very small class about which scholars disagree even as to its membership.

If one leafs through a Chinese dictionary, which is usually arranged by a set of 214 recurring constituents called "radicals," one gets the impression that the vast majority of characters are phonetic compounds, in which the radicals serve as significs. But if one examines closely what look like phonetics, one will find that in the majority of cases they are not simply phonetics, but something more. Take the character 裘 *ch'iu*^{2} "fur (for a coat)," apparently made up of radical 145 衣 *i*^{1} "clothing" and 求 *ch'iu*^{2} "beseech," used merely as a phonetic. As a matter of fact, the graph 求 was originally a pictograph of the word for "fur," and then used as a loan character for a homophonous word *ch'iu*^{2} "beseech." In order to avoid ambiguity, an additional signific 衣 *i*^{1} "clothing" was added to form 裘 for the original word for "fur," leaving the simple pictograph for the abstract word for "beseech." Again, 評 *p'ing*^{2} "discuss," "criticize" apparently has radical 149 言 *yen*^{2} "to speak" for signific and 平 *p'ing*^{2} "level" for phonetic. Actually, the main word is 平 *p'ing*^{2} "level," with various extensions of meaning: "level," "equal," "fair," so that "to speak fairly" is "to discuss," "to criticize"; with 土 "earth," "ground" one forms 坪 *p'ing*^{2} "plateau," "level ground," "village"; with 艹 "grass" and 氵 "water" one gets 萍 *p'ing*^{2} "duckweed," which has level leaves floating on water. All these *p'ing*^{2}'s are therefore really one linguistic word, written differently according to various extensions of meaning. It is as if in English one wrote "slip" for the root meaning, "pslip" for a narrow piece of paper, "dslip" for what is worn under a dress, "lslip" for an accidental error in speech, etc., all pronounced "slip."

As a consequence of this luxury of differentiation, there have developed many more characters than there are words, even if homophones are counted as different words. In the K'anghsi dictionary of 1716, which is still much consulted, there are 40,545 characters. After eliminating obsolete forms and graphic variants, the telegraphic code book—Chinese characters are telegraphed in four figures to the character—still has nearly 10,000 characters, with many differentiations from semantic extensions.

History.—The structure of Chinese writing has changed less since antiquity than the sounds of the language. The most ancient forms of writing are those found on the shells and bones of Shang; then followed the Chou (1122?–256 B.C.) inscriptions on bronzes and stones. In the Ch'in dynasty (221–207 B.C.), under the First Emperor, writing was standardized in what are known as the small-seal characters, still used on seals. Since then, the forms of characters have changed mainly in the style of strokes, and there has



been no basic change in structure. The most commonly used form is the *k'ai*³ or model form, in which most books are printed. The running hand and cursive hand are used only for personal notes and calligraphic purposes. The preceding diagram gives examples of the chief kinds of characters.

LANGUAGE AND WRITING REFORMS

Language and writing, like other phases of human culture, have always been in the process of being reformed, sometimes more consciously than at other times. The building up of the system of seal characters under the First Emperor, though it was far from being done in a day or by one person Li Ssŭ, was one of those planned reforms. The compilation of the *Ch'ieh yün* of A.D. 601, though it was only a semiofficial undertaking, was an organized attempt on the part of a group of specialists, and the resulting dictionary had a greater unifying effect on the language than any other book, insofar as mere books have any influence on the spoken language. During the 20th century there have been three major conscious movements for reform in the Chinese language and system of writing: (1) the vernacular literature movement; (2) the unification of the national language; and (3) reforms in the system of writing.

The Vernacular Literature Movement.—The literary revolution is a movement for writing in the spoken language. While there is some difference in diction and style between speech and writing in all languages of all ages, there was probably not so wide a gap between them in the Chinese of early classical times as there is in modern Chinese. By the time of the T'ang dynasty (618–906), as seen from verbatim records of lectures on Buddhism, there was already a distinct cleavage between the colloquial and the literary language. Writing in the colloquial was, however, extremely rare. Apart from a few novels, plays, and some religious and philosophical writings, everything was written in *wênyen*. It was not until 1917, when Hu Shih started the movement for writing in the vernacular or *paihua* "plain talk," that writing as one speaks became respectable and acceptable. Hitherto, one had to write in a literary idiom different from the speech of any locality, as described above. Now one can write as one speaks, at least for two-thirds of the people, who already speak some form of Mandarin. The rest of the country, Shanghai, Canton, Amoy, etc., will have to learn the Mandarin idiom, which, though different from *wênyen* and from their own vernacular, is much easier to learn than *wênyen*. In less than half a century the *paihua* movement has proved to be one of the most definitive changes in the cultural life of China.

The Unification of the National Language.—The unification of the national language, like the use of the vernacular for writing, already had good working capital to start with in the fact that Mandarin was already very widely understood. Formerly called variously *kuan*¹*-hua*⁴ "official speech," whence the term "Mandarin," or *p'u*³*-t'ung*¹*-hua*⁴ "general (*v.* local) speech," the movement was officially designated as unification of *kuo*²*-yü* "national language," when the program was launched in the 1910s. As aids to the unification of pronunciation, a system of national phonetic letters (1919), consisting of 21 initials and 16 finals, and a system of national romanization (1927) were promulgated. The Communist regime has made some use of the national phonetics and has recently devised forms of romanization or latinization for the same purpose (*see* CHINA: *The People: Language Reforms*).

Writing Reform.—The problem of writing reform is immediately bound up with the preceding problems. *Wênyen* being always pronounced in some modern pronunciation, with many of the ancient distinctions lost, it is not always intelligible to the ear, and *wênyen* written in a modern alphabetic form of writing will not always be intelligible to the eye. A story like the following is in quite idiomatic *wênyen*, so far as the characters go, but when pronounced, the story consists of nothing but a series of repetitions of the syllable *chi* in the four tones. On the other hand, in ancient Chinese, the title of the story *ki' kiə kiei dz'iəp kiəi tsiäk*, or, in modern *paihua*, *chi*⁴*.lu ê*⁴*.tê chi*¹ *chü*⁴*.tsai fei*¹*-chi*¹*.tê pei*⁴*.shang* is phonetically quite clear and unambiguous.

記饑雞集機脊

唧唧雞、雞唧唧！

幾機擠擠集機脊。

機極疾、雞極饑。

雞冀己技擊及鯽。

機既濟薊畿、

雞計疾機激幾鯽。

機疾極、鯽極悸。

急急擠集磯級際。

繼即鯽迹極寂寂。

繼即幾雞既饑即唧唧。

Reminiscences of Famished Chickens Assembled on the Ridge of a (Flying) Machine

Chick, chick, chickens! Chickens, chick, chick!
Several chickens squeezed and assembled on the machine's ridge.
The machine was extremely swift; the chickens extremely famished.
The chickens surmised their skill was sufficient to strike some perch.
The machine having crossed the suburbs of Chi,
The chickens reckoned the swift machine should stir up several perch.
The machine was swift; the perch were extremely scared.
Hastily they squeezed and assembled in the interstices of stone steps.
Subsequently the perch's traces were extremely silent, silent.
Subsequently the chickens, since still famished, said chick, chick!

Unless one should revert to an ancient orthography, as has indeed been actually worked out and proposed by some European missionaries in China, an alphabetic system of writing must be based on the *paihua* and not on *wênyen*. Moreover, if one writes as one speaks, then, even within the vast region of the Mandarin provinces, which have substantially the same vocabulary, the variation in pronunciation will be great enough to make the same word look quite different, and in the case of Cantonese or Wu the difference will look as great as that between French and Italian or between English and Dutch, thus creating what would look like different languages.

In order, therefore, to make alphabetic writing intelligible to the eye, one will have to write what is auditorily intelligible to the ear, namely, *paihua*. In order to preserve the unity of the language, which has so far been supported by the universality of the characters, this *paihua* must be the *paihua* of standard Mandarin and not the *paihua* of any of the other dialects or even subvarieties of Mandarin. Since, however, unification of pronunciation is only in process of succeeding and has not yet succeeded, the country is not ready for the immediate adoption of an alphabetic writing. In the early 1960s the simplification of the characters was the order of the day. It is significant that the official position of the Communists during the 1950s was exactly that of the Nationalists during the 1930s, namely, to take the national phonetics or the Latin alphabet as aids to (1) the unification of standard pronunciation and (2) the learning of the characters. At the same time, Chinese linguists and educators, in private or semiofficial capacities, have never ceased working toward a system and a program for an alphabetic form of Chinese writing that might become a reality in the reasonably near future.

See also references under "Chinese Language" in the Index volume.

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(Y. R. C.)

CHINESE LAW. Ancient Chinese law had the same influence in eastern Asia as Roman law in western Europe. The first written laws were inscribed on bronze tripods during the second half of the 6th century B.C. By recording the duties and rights of the people in a lasting form, legislators intended to limit the arbitrary power of princes and feudal lords. Confucius (*q.v.;* 551–479 B.C.) considered these "tables of the law" to be a dangerous change undermining the social order. Thereafter, discord about the character and the very necessity of laws never ceased between two fundamentally different viewpoints. According to the legalist school of thought a universal, uniform and absolute law (*fa*), unvarying and binding on everybody, was essential for the maintenance of the social order, and only a legal system of rewards and punishments could guarantee the authority of the ruler. The dream of the legalists was realized when the Ch'in dynasty succeeded (221 B.C.) in unifying the Chinese empire under a strong and absolutist state power based on harsh administrative and penal measures, which they considered to be the most efficient deterrent to crime. Against this public law and method of intimidation, Confucianists upheld the norms of proper behaviour (*li*), a kind of particularist and traditional customary law regulating by minute prescriptions not only rites and ceremonial but the whole of social intercourse. If these venerated rules, differentiated according to the social positions of high and low, are carefully respected, there is no need for laws because no crime is committed. (*See* also CONFUCIANISM.)

The struggle between these two theories ended in a compromise. The first known laws, the code of the Han dynasty (2nd century B.C.), had been compiled by legalists. However, the Confucianists, who had accepted law in the meantime as an instrument of state power, maintained that the prescriptions of the moral code were sufficient for the discipline of the upper class, and succeeded during the middle ages in mitigating the rigour of the laws, bringing them into harmony with the *li*. The combination of these two disparate elements resulted in a legal system characterized by principles that were unchanging and rigid (a draconian penal code, collective responsibility of the social group, inequality before the law in favour of the privileged nobility and officials), but which were applied by a flexible and supple procedure that took into account the special circumstances of every case. Each dynasty had its own code and a huge corpus of ordinances, administrative laws and regulations. The most famous is the still extant T'ang code (A.D. 653), the model of all subsequent Chinese codifications down to the Manchu dynasty (1644–1912) and imitated equally in Korea, Japan and Annam. All codes were arranged in the same way. The general principles at the beginning contained the list of penalties (death, banishment, hard labour, bastinado) and their degrees, the tables of relationship, of awful crimes and of privileged persons. Any offense against the laws, enumerated under different headings, could easily be fitted to the corresponding punishment, the legal sanction being diminished or aggravated by the status of the offender, with each paragraph referring to the tables of relationship. This system enabled the local or provincial magistrate, who had no special juridical training, to judge quickly the lawsuit brought before him. The higher level of judicial administration (ministry of justice, censorate and supreme court of justice) likewise lacked separation of powers. There was no place for lawyers and advocates.

This legal system, lacking precise rulings on civil and commercial law, not to speak of international law (all countries being considered as subject and tributary to China), could not continue beyond the 19th century. Under western impact more and more critics demanded a thorough reform. Bastinado and penal sanctions for civil-law offenses were abolished and a special committee worked out proposals for new laws based on German and modern Japanese models (1902–10). Nevertheless, these were only a modernized version of the *Ta-Ch'ing lü-li*, the code of the Manchu dynasty, which remained in force until 1931. In that year the nationalist Kuomintang government set up a legislative court in order to work out a provisory constitution and a civil code on western lines, but the great output of legal texts was of no practical use in circumstances of civil war and foreign invasion. The People's Republic of China, established in 1949, deliberately abandoned the western legal system and began immediately to promulgate a new set of laws accompanied by a far-reaching reform of judicial administration. So far the main legislative acts are the agrarian law (legalizing agrarian reform) and the marriage law (enforcing the equality of the sexes and monogamy), both promulgated in 1950, and the constitution of 1954. Judicial authority is formally set apart at all levels and exercised by the supreme people's court and procuratorate as well as by local and special people's courts and procuratorates. New laws and decrees adopted by the national people's congress are published in official papers and periodically collected in special volumes. *See* CHINA: *History; Administration and Social Conditions.*

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CHINESE LITERATURE, one of the major literary heritages of the world, with an uninterrupted history of more than 3,000 years, which has profoundly influenced the literary traditions of other Asian countries, particularly Korea, Japan, and Vietnam. In these countries not only has the Chinese script been adopted as the mainstay of the written language but some writers have also adopted the Chinese language as their chief literary medium.

Earliest Writings, to 221 B.C.—The oldest specimens of Chinese writing extant are inscriptions on bones and tortoise shells dating back to the last three centuries of the Shang dynasty (*i.e.*, *c.* 1400–*c.* 1122 B.C.) and recording divinations performed at the royal capital. (*See* CHINA: *History.*) These inscriptions, like those engraved on ceremonial bronze vessels toward the end of the Shang period, are usually brief and factual and cannot be considered literature. Nonetheless, they are significant in that their sizable vocabulary (about 3,000 characters, of which nearly 2,000 have been reliably deciphered) has proved to be the direct ancestor of the Chinese script of today. Moreover, the syntactical structure of the language bears a striking resemblance to later usages. From the frequent occurrences in the bone inscriptions of such characters as "dance" and "music," "drum" and "chimes" (of stone), "words" and "southern" (airs), it can safely be inferred that, by the Shang dynasty, songs were sung to the accompaniment of dance and music, but these songs are now lost.

Poetry.—The first anthology of Chinese poetry, known as the *Shih Ching* ("Classic of Poetry") and consisting of temple, court, and folk songs, was given definitive form somewhere around the time of Confucius (551–479 B.C.). But its 305 songs range in date from the very beginning of the Chou dynasty (*c.* 1122 B.C.) to around 585 B.C., when the dynasty was already declining. They were originally sung to the accompaniment of music, and some, especially the temple songs, were accompanied also by dancing. In all subsequent periods of Chinese literary history, new trends in poetry were profoundly influenced by music.

The *Shih Ching* is generally accounted the third of the Five Confucian Classics, the other four of which are (1) the *I Ching*, a book of divination with philosophical and folklorist accretions; (2) the *Shu Ching*, a collection of official documents; (4) the *Li Ching*, a book of rituals with an accompanying record containing anecdotes; and (5) the *Ch'un Ch'iu*, an annal of the state of Lu where Confucius was born, consisting of topical entries of the major events from 722 to 481 B.C. The five classics have been held in high esteem by Chinese scholars since 136 B.C.; the *Shih Ching* and the *Shu Ching* are discussed below.

Most of the poems of the *Shih Ching* have a preponderantly lyrical strain, whether the subject is hardship in military service or seasonal festivities, agricultural chores or rural scenes, love or sports, aspirations or disappointments of the common folk and of the declining aristocracy. Apparently the language of the poems was relatively close to the daily speech of the common people, and even repeated attempts at refinement during the long process of transmission has not spoiled their freshness and spontaneity. In spite of this, however, when the songs are read aloud and not sung to music their prevailing four-syllable lines conduce to monotony, hardly redeemed by the occasional interspersion of shorter or longer lines; a sample (in modern pronunciation) illustrates this:

Kuan kuan tsui chiu
Tsai he chih chou

Miao t'iao shu nü
Chün tzu hao ch'iu

("Kuan kuan" cry the ospreys
On the islet in the river.
Lovely is the good lady,
Fit bride for our lord.)

If there ever was an epic tradition in ancient China comparable to that of early India or the West, only dim traces of it persist in the written records. The *Shih Ching* has a few narrative poems celebrating heroic deeds of the royal ancestors, but these are rearranged in cycles and only faintly approximate the national epics of other peoples. One cycle, for example, records the major stages in the rise of the Chou kingdom, from the supernatural birth of its remote founder to its conquest of the Shang kingdom. These episodes, which according to traditional history cover a period of more than 1,000 years, are dealt with in only about 402 lines. Other cycles, which celebrate later military exploits of the royal Chou armies, are even briefer.

The *Shih Ching* exerted a profound influence on Chinese poetry, which, generally speaking has stressed: (1) the lyrical rather than the narrative element; (2) dependence more on end rhymes for musical effect than on other rhetorical devices; (3) regular lines consisting of a standard number of syllables; and (4) utilization of intonation inherent in the language for rhythm, instead of the alternation of stressed and unstressed syllables as in Western poetry. The high regard in which this anthology has been held in China is due both to its antiquity and to the legend that Confucius himself edited it. It was elevated in 136 B.C. to the position of a major classic in the Confucian canon.

Meanwhile, another type of poetry, also originating in music and dance, had developed in the south, in the basin of the Yangtze River, an area dominated by the principality of Ch'u—hence the generic appellation *Ch'u Tz'u* or "Elegies of Ch'u." These southern songs, though adorned with end rhymes like the songs of the *Shih Ching,* follow a different metrical pattern: the lines are usually longer and more irregular and are commonly (though not always) marked by a strong caesura in the middle with a syllable representing a sigh. Their effect is thus rather plaintive, and they lend themselves to chanting instead of singing. The beginning of this tradition is obscure because most of the early samples were eclipsed by the brilliant compositions of the towering genius Ch'ü Yüan (343–277 B.C.?), China's first known poet.

Among some 25 elegies attributed to Ch'ü Yüan, the most important and longest is *Li Sao* ("Fallen into Sorrow"), which has been described as a politico-erotic ode, telling, by means of a love allegory, of the poet's disappointment with his royal master and of his imaginary travels in distant regions and the realms of heaven, in his attempt to rid himself of his sorrow. Ch'ü Yüan committed suicide by drowning in the Milo River, and his tragic death, no less than his beautiful elegies, perpetuated the new literary genre. In contrast to the poems of the *Shih Ching,* which had few successful imitators, the genre created by Ch'ü Yüan was cultivated for more than five centuries, with later revivals.

Prose.—Prior to the rise of the philosophers in the 6th century B.C., brief prose writings were reported to be numerous, but of these only two collections have been transmitted: (1) the *Shu* or *Shu Ching* ("Classic of Documents"), consisting of diverse kinds of primitive state papers, such as declarations, portions of charges to feudal lords, and orations; and (2) the *Yi* or *I Ching* ("Classic of Changes"), a fortune-telling manual. Both grew by accretion and, according to a very doubtful tradition, were edited by Confucius himself. Neither can be considered as literature, but both have exerted influence on Chinese writers for over 2,000 years as a result of their inclusion in the Confucian canon.

The earliest writings claiming individual "authorship," in the loose sense of the term, were the *Lao-tzu* (or *Tao-te ching*), attributed to Lao-tzu (*q.v.*), who might have been an older contemporary of Confucius, and the *Analects* (*Lun Yü*) of Confucius. Obviously, neither philosopher wrote extensively, and the gist of their teachings was recorded by their followers. Thus the *Lao-tzu* consists of brief summaries of Lao-tzu's sayings, many in rhyme and others in polished prose to facilitate memorization (*see* further TAOISM; TAO-TE CHING.) Likewise, the *Analects* is composed of collections of the sage's sayings, mostly as answers to questions or as a result of discussions. However, because writing implements and materials were expensive and scarce, the circumstances of the conversations were usually omitted, and as a consequence the master's words were often made to sound cryptic and disjointed, despite the profundity of the wisdom.

By about 400 B.C. writing materials had improved and a change in prose style resulted. The records of the discourses became longer, the narrative portions more detailed; jokes, stories, anecdotes, and parables, interspersed in the conversations, were included. Thus the *Mencius Book* (*Meng-tzu*), containing the teachings of Mencius (*q.v.*), not only is three times longer than Confucius' *Analects* but also is topically and more coherently arranged. The same characteristic may be noticed in the authentic chapters of the *Chuang-tzu,* attributed to Chuang-tzu, who "in paradoxical language, in bold words, and with subtle profundity, gave free play to his imagination and thought. . . . Although his writings are inimitable and unique, they seem circuitous and innocuous. Although his utterances are irregular and formless, they are unconventional and readable" (quoted from the epilogue of the *Chuang-tzu*). (*See* further CHUANG-TZU.)

The first real example of the well-developed essay, however, is found neither in the *Mencius* nor in the *Chuang-tzu* but in the *Mo-tzu,* attributed to Mo Ti or Mo-tzu, a predecessor of Mencius and Chuang-tzu, whose singular attainments in logic made him a forceful preacher; his recorded sermons are characterized by simplicity of style, clarity of exposition, depth of conviction, and directness of appeal. (*See* MO TI.)

The prose style continued to be developed by such outstanding philosopher-essayists as Hsün-tzu (*q.v.*) and his pupil the Legalist Han Fei-tzu (280–233 B.C.?). The peak of this development, however, was not reached until the appearance of the first expertly arranged full-length book, *Lü-shih ch'un-ch'iu* ("The Spring and Autumn of Lü"), completed in 240 B.C. under the general direction of Lü Pu-wei (290–235 B.C.?). The work, comprising 60 essays arranged into 26 sections, summarizes the teachings of the several schools of philosophy as well as the folklore of the various regions of China.

Ch'in and Han Dynasties.—*Poetry.*—Following the unification of the empire by the Ch'in dynasty (221–207 B.C.) and the continuation of the unified empire under the Han (202 B.C.–A.D. 221), literary activities took new directions. At the feudal courts, the *fu* genre began to flourish. The *fu,* long and elaborate descriptive poetic compositions, were in form a continuation of the Ch'u elegies, now made to serve a different purpose—the amusement of the new aristocracy and the glorification of the empire—by dwelling on such topics as the low table and the folding screen, or descriptions of the capital cities. Even the best *fu* writing, by such masters of the art as Mei Sheng (before 200–140 B.C.) and Ssu-ma Hsiang-ju (179–118 B.C.), bordered on the frivolous and bombastic. Another major *fu* writer, Yang Hsiung (53 B.C.–A.D. 18), in the prime of his career remorsefully realized that the genre was a minor craft not worthy of a real poet. Nonetheless, the *fu* was almost universally accepted as the norm of creative writing, and nearly a thousand pieces were produced.

A more creative contribution to literature by the Han government was the reactivation in 125 B.C. of the Yüeh Fu or Music Bureau, which had been established at least a century earlier to collect current songs and their musical scores. This office succeeded in preserving, besides temple and court songs, a large number of songs popularly sung or chanted by the common folk. This category—called *yüeh fu,* after the Music Bureau—includes not only many touching lyrics but also such charming ballads as "The Orphan" and "The Song of Lo Fu," the latter relating in 353 lines the tragedy of a young married couple crushed by the cruelty of the husband's mother. In contrast to the irregular Ch'u elegies and the four-syllable line of the *Shih Ching* songs, the *yüeh fu* are made up mainly of five-syllable lines. They became the fountainhead of a new type of poetry; contemporary Han dynasty poets at first merely refined the originals without claiming credit, and later imitated their fresh and lively metre.

Prose.—Prose literature was also further developed. In addition to the prolific output of philosophers and political thinkers—of whom Liu An (179–122 B.C.?), prince of Huai-nan, hence called Huai-nan-tzu, is a most brilliant example—an important and monumental category of Han dynasty literature consisted of historical works. Outstanding among these is the *Shih Chi* ("Records of the Historian") by Ssu-ma Ch'ien (*q.v.*), a masterpiece which took 18 years to produce, dealing with the major events and personalities of about 2,000 years up to the author's time, comprising 130 chapters and totaling more than 520,000 words. Not only was the *Shih Chi* the first general history of its kind attempted in China but also it set a pattern in organization for the dynastic histories of subsequent ages. Being an artist as well as a historian, Ssu-ma Ch'ien succeeded in making events and personalities of the past into living realities for the benefit of his readers. His great successor, the poet-historian-soldier Pan Ku (*see* PAN KU AND PAN CHAO), author of the *Han Shu* (history of the Han dynasty), which totals over 800,000 words, performed a similar tour de force but did not quite equal Ssu-ma Ch'ien in either scope or style.

Moreover, Pan Ku's prose style, though not necessarily archaic, was more consciously literary—a result of the ever-widening gap between the spoken and written aspects of the language. This anomaly was more evident in China than elsewhere, and it was to have far-reaching effects in the evolution of the Chinese literary tradition. In an attempt to resolve the difficulties in communication among the speakers of many dialects in the far-flung empire, a standard literary language, *wênyen*, was promoted as a common medium, from the Han dynasty on. Perpetuated for over 2,000 years, the literary language failed to keep pace with the continual changes in the spoken tongue, and eventually it became almost unintelligible to the illiterate masses.

The Six Dynasties and Sui Period.—After the fall of the Han dynasty, there was a long period of political division (221–589), with barely four decades of precarious unification (280–317). Despite the social and political confusion and military losses, however, the cultural scene was by no means dismal. Several influences upon the development of literature are noteworthy. First, Buddhism, introduced earlier, had brought with it religious chantings and Indian music, which helped to attune Chinese ears to the finer distinctions of tonal qualities in their own language. Second, aggressive northern tribes, which invaded and dominated the northern half of the country from 316, were being culturally absorbed and converted. Third, the political division of the empire between the south and the north (as a result of the domination of non-Chinese in the north) led to an increase in cultural differences and to a subsequent rivalry to uphold what was regarded as culturally orthodox, frequently resulting in literary antiquarianism.

Poetry.—Folk songs flourished in both regions. In the south, popular love songs, originating in the coastal areas which now came increasingly under Chinese political and cultural domination, attracted the attention of poets and critics. Love songs of the north were more militant; reflecting this spirit most fully is the ballad "Mu Lan," which sings of a girl who disguised herself as a warrior and won glory on the battlefield.

The number of writers of "literary" poetry greatly increased. Among these, two poets deserve special mention. Ts'ao Chih (192–232), noted for his ethereal lyricism, gave definite artistic form to the poetry of the five-syllable line, already popularized in folk song. T'ao Ch'ien (365–427), one of China's major poets and the greatest of this period, was, despite his continuous struggles against poverty, an unceasing advocate of the joys of nature. Using several verse forms with effortless ease—including the *fu* for his "Homeward Bound"—he was representative of the trend of the age to explore various genres for lyrical expression.

Prose.—As orthodox Confucianism gradually yielded to Taoism and later to Buddhism, nearly all the major writers began to cultivate an uninhibited individuality. Lu Chi (261–303), poet and critic, in particular emphasized the importance of originality in creative writing and discredited the long-established practice of imitating the great masters of the past. The Taoist philosopher Ko Hung (254–334?) insisted that technique is no less essential to a writer than moral integrity. The revolt of the age against conventionality was revealed in the new vogue of *ch'ing-t'an* ("unsullied discourse"), intellectual discussions on lofty and nonmundane matters, recorded in the collection of anecdotes entitled *Shih Shuo* ("Sayings of the World") by Liu Yi-ch'ing (403–444).

Chinese translations of Indian Buddhist literature, which had grown in bulk and in variety from the 3rd century, were also to influence the literature of China. Though prose writers as a whole continued to be most concerned with lyrical expression and rhetorical devices for artistic effect, there were notable deviations from the prevailing usage—seen especially in writing concerned with philosophical disputes and religious controversies—in the polyphonic type of prose called *p'ien-wen* ("parallel prose"). In this form, parallel construction of pairs of sentences and counter-balancing of tonal patterns were the chief requirements.

Among prose masters of the 6th century, two northerners deserve special mention: Yang Hsien-chih (fl. 530–550), author of *Loyang Chia-lan Chi* ("Record of Buddhist Temples in Loyang"), and Li Tao-yüan (fl. 526), author of *Shui Ching Chu* ("Commentary on the Water Classic"). Though both these works seem to have been planned to serve a practical, utilitarian purpose, they are magnificent records of contemporary changes and charming storehouses of accumulated folklore, written with great spontaneity and artistry.

T'ang Dynasty.—During the T'ang dynasty (618–906) Chinese literature reached its golden age.

Poetry.—In poetry, the greatest glory of the period, all the verse forms of the past were freely adopted and refined and new forms were crystallized. A form perfected early in the dynasty was the so-called *lü-shih* ("regulation poetry"), consisting of eight five- or seven-syllable lines—each in accordance with strict tonal patterns—calling for parallel structure in the middle two pairs of lines. The following poem by Shen Ch'üan-ch'i, addressed to Tu Fu's grandfather in 705, illustrates the *lü-shih* form (the Cantonese used here approximates the T'ang pronunciation at the capital):

T'in chëung tei fut leung tao fan
Hui kwok lei ka kin paak wan
Lok p'o fung kwong ho soh ch'i
Sung shaan cheung lai pat ham man
Naam fau cheung hoi yan hoh chue
Pak mong hang yeung ngan kei kw'an
Leung tei kong shan maan yue lei
Hoh shi ch'ung kin shing ming kwan

(The sierra divides the vast heaven and the wide earth.
Far away from country and home appear the same white clouds.
The scenery on the banks of the Lo River, what does it resemble?
The pestilential vapours of the Sung Mountain are unbearable!
Floating southward on the surging seas, where is my friend?
Going northward toward Hengyang [city], how many flocks are there of swans?
Between us are mountains and rivers stretching over ten thousand miles.
How soon are we again to see our sage and enlightened emperor?)

Another form was the *chüeh-chü* ("broken-off lines"), quatrains of five- or seven-syllable lines, which though subject to the limitations of tonal sequence were not always dependent on musical accompaniment. The following example (in modern Chinese pronunciation) is by Li Po:

Pu chien Tung Shan chiu
Ch'iang-wei chi tu hua
Pai yün huan tzu shan
Ming yüeh lo shui chia

(For long I have not seen the Eastern Hill.
How many times has the rose flowered?
Do the white clouds as then scatter themselves?
And behind whose dwelling sets the moon?)

In short, the fine distinctions of tonal variations in the changing spoken language had reached their height at that time, with eight tones, and the rules and regulations concerning the sequence of the lighter and heavier tones had been formulated. But since the observance of strict rules of prosody was not mandatory in the *ku-shih* ("ancient style") form still in use, it was possible for an individual poet to enjoy conformity or freedom as he saw fit.

Of the more than 2,000 T'ang poets whose works have been preserved, only a few can be mentioned. Meng Hao-jan (691–740), who led the life of a recluse, excelled in poems of five-syllable lines reminiscent of the spirit of T'ao Ch'ien. Wang Wei (699–759), musician and landscape painter as well as poet, exemplified his own dictum that poetry should have the beauty of painting and vice versa. Li Po (*q.v.*), one of the two major poets of the T'ang dynasty, a lover of detachment and freedom, deliberately avoided regulation poetry and chose the less formal verse forms to sing of friendship or wine. But the greatest of them all was Tu Fu (*q.v.*), a keen observer of the political and social scene who criticized injustice wherever he found it and who clearly understood the nature of the great upheaval following the rebellion of 755, which was a turning point in the fortunes of the T'ang. As an artist, Tu Fu excelled in all verse forms, transcending all rules and regulations in prosody while conforming to and exploiting them. As a man, despite his sensitivity to the tragedy in life and his failure to win recognition, he never lost his sense of humour. One of the greatest admirers of Tu Fu as a poet-historian was Po Chü-i (*q.v.*), who, like his great predecessor, was deeply concerned with the social problems of his age. Po Chü-i sought to learn from ordinary folk not only naturalness of language but also their feelings and reactions, especially at the height of his career when he wrote what he called the *New Yüeh Fu* poems.

Prose.—In prose writing a major reform was led by Han Yü (*q.v.*) against the peculiarly artificial prose style of *p'ien-wen*, which, cultivated by the literati for almost a thousand years, had become so burdened with restrictive rules as to make forthright expression virtually impossible. Han Yü boldly advocated the use of Chou philosophers and early Han writers as models for prose writing. This seemingly conservative reform had, in fact, a liberalizing effect. One result may be seen in the impetus given to the writing of prose romances in the *ku-wen* ("ancient prose") style. It also enabled Liu Tsung-yüan (773–819), Han Yü's associate in the reform, to write his charming travel pieces.

Development of Tz'u.—Folk literature of the T'ang also evolved new forms, especially toward the end of the period. A noteworthy genre was the *pien-wen* ("records of the marvelous"), utilizing both prose and verse to retell episodes from Buddha's life and, later, non-Buddhist stories from Chinese history and folklore.

Even more significant, however, was the development of a new verse form, composed normally of lines of irregular length, written as lyrics to musical tunes. This form came to be known as *tz'u*, in contrast with *shih*, which comprehended all the verse forms mentioned above. Since the lines in a *tz'u* might vary from 1 to 9 or even 11 syllables, they were comparable to the natural rhythm of speech and therefore easily understood when sung. First sung by ordinary folk, they were popularized by professional women singers and finally, before the end of the T'ang, attracted the attention of poets. It was not however until the transitional period of the Five Dynasties (907–960), a time of division and strife, that *tz'u* became the major vehicle of lyrical expression. Of *tz'u* poets in this period the greatest was Li Yü (937–978), last monarch of the Southern T'ang, who was captured in 976 as the new Sung dynasty consolidated its power. Li Yü's *tz'u* poetry is saturated with his tragic nostalgia for better days in the south, suffused with a note of sadness—a new depth of feeling notably absent from earlier *tz'u*, which had been sung at parties and banquets. The following is typical:

Lin hua hsieh liao ch'un hung
T'ai ch'ung ch'ung
Wu nai chao lai han yü
  wan lai feng
Yen chih lei
Hsiang liu tsuei
Chi shih ch'ung
Tzu shih jen sheng ch'ang hen
  shui ch'ang tung

(Vernal redness is faded from the flowers.
Why so soon?
But who could prevent the cold showers of the morning and the
  cruel blasts in the evening?
How the tears, dyed in rouge,
Used to coax me to take more wine.
When will this happen again?
'Tis as inevitable for life to overflow in sorrow as for the waters
  to flow toward the east!)

Sung Dynasty.—The Sung dynasty (960–1279) was marked by cultural advancement and military weakness. During this period literary output was spectacularly increased, thanks mainly to the invention and improvement of printing from the 8th century and to the establishment of public schools throughout the empire from 1044. Nearly all the literary genres in verse and prose were continued, and some trends begun in T'ang times were accelerated.

Prose.—In prose, the reform introduced by Han Yü in the name of ancient style (*ku-wen*) was re-emphasized by such writers as Ou-yang Hsiu (1007–72) and Su Tung-p'o (*q.v.*). Although both men were outstanding poets, their contribution to prose writing in *ku-wen* style was as important as their poetry. The *ku-wen* movement was further supported by men whose primary interest was not belles-lettres, such as Ssu-ma Kuang (1019–1086), the statesman-historian, and Chu Hsi (*q.v.*), the scholar-philosopher and principal formulator of Neo-Confucianism, both of whom advocated greater naturalness in prose writing.

Shih Poetry.—Poetry of the conventional type (*shih*) was cultivated by numerous rival schools, each claiming many illustrious members. On the whole, the rival literary movements were significant as steps toward greater naturalness in syntax, and a few outstanding writers approximated the spoken vernacular language. Among the many *shih* writers of the Sung dynasty, Lu Yu (1125–1210) was a towering figure. A traveler and patriot, he wrote throughout his long career no fewer than 20,000 poems, of which some 9,200 have been preserved.

Tz'u Poetry.—But it was in their utilization of the newer verse form, *tz'u*, that Sung poets achieved their greatest distinction, making *tz'u* the major genre of the dynasty. As noted above, the *tz'u* form had been popularized at first orally by women singers, and the first generation of *tz'u* writers had been inspired and guided by them in sentiment, theme, and diction; their lyrics were thus redolent with the fragrance of these women. Later in the 12th century, as men of letters began to take over, the notes of intimacy and femininity declined and conscious artistry or bold attempts to rise above even meticulous artistry became apparent. Li Ch'ing-chao (1081–after 1141), a great woman poet, may be considered representative of the first trend, and Hsin Ch'i-chi (1140–1207), soldier turned recluse, represents the second. It was the latter who imbued the writing of *tz'u* with new characteristics by rising above rules without breaking them, surpassing in this respect his contemporaries as well as those who came after.

Yüan Dynasty.—Fleeing from the Chin (Jurchen) Tatars, who captured the Sung capital in 1126, the Sung dynasty retreated southward. For almost a century and a half, China was again split in half. And in spite of political reunification by Kublai Khan, founder of the Yüan dynasty, beginning in 1260, the cultural split persisted. In the south, where China's historic traditions found asylum, racial and cultural homogeneity persisted. In fact, the centre of Chinese philosophy and traditional literature never again returned north of the Yangtze delta. But in the north new developments arose, which led to wholly new departures. First, the migration and fusion of the various ethnic groups gave birth to a common spoken language with fewer tones, which was later to become the basis of a national language; second, with the southward shift of the centre of traditional culture, the prestige of the old literature began to decline in the north, especially in the eyes of the conquerors. Thus, in contrast to the south, north China under the Yüan (Mongol) dynasty (1280–1368) provided a unique milieu for unconventional literary activities.

Drama.—In this period, dramatic literature came into a belated full flowering. The skits and vaudeville acts, the puppet shows and shadow plays of previous ages had laid the foundation for a full-fledged drama, but the availability of Indian and Iranian models during the Yüan dynasty may have been a more immediate cause for its accelerated growth. Many Chinese men of letters practised noncooperation with the alien government, seeking refuge in painting and writing. As the new literary type developed—the drama of four or five acts, complete with prologue and epilogue, and including songs and dialogue in language fairly close to the daily speech of the people—many men of letters turned to playwriting. Between 1234 and 1368, over 600 plays were written and staged, and over 100 dramatists are recorded, the first of whom to attain distinction was Kuan Han-ch'ing (1230?–1307?).

This new literary genre acquired certain distinct characteristics: (1) All the extant compositions may be described as operas. (2) Each play normally consists of four acts following a prologue. (3) The language of both the dialogue (for the most part in prose) and the arias—which alternate throughout the play—are fairly close to the daily speech of the common people. (4) All the arias are in rhymed verse and only one end rhyme is used throughout an act. (5) All the arias in an act are sung by only one actor.

Another literary innovation, preceding but later interacting with the rise of the drama, was the new verse form known as *san-ch'ü* ("detached songs"), a liberalization of the *tz'u*, which utilized the spoken language of the people as fully as possible. Though line length and tonal pattern were still governed by a given tune, extra words could be inserted to make the lyrics livelier and to clarify the relationship between phrases and clauses. The major dramatists were masters of this genre.

Vernacular Fiction.—Similarly fiction writers in the vernacular began to emerge, continuing the tradition of storytellers of the past but writing their stories rather than reciting them orally. The authors of fiction differed significantly from the prose romance writers of the T'ang and Sung. Their works not only were much longer but also were written in the vernacular. Clearly, these fiction works were addressed to the masses and not to the authors' fellow literati. All the early pieces of this type of book-length fiction were poorly printed and anonymously or pseudonymously published. The first known master of the art was Lo Kuan-chung (1330–1400?), a bold social critic in his historical and supernatural romances, the best known of which are *San Kuo Chih* ("Romance of the Three Kingdoms"), *Shui Hu Chuan* ("The Story of the Water Margin," also translated as "All Men Are Brothers"), and *P'ing Yao Chuan* ("The Subjugation of the Evil Phantoms").

Ming Dynasty.—The unified empire of the Yüan dynasty was continued by the Ming dynasty (1368–1644), under which cultural influences from the south again became important, expressed in movements toward cultural orthodoxy. Nearly all the major poets and prose writers in traditional literature were southerners, who enthusiastically launched and supported antiquarian movements based on a return to models of various ages of the past. With the restoration of competitive literary examinations, which had been virtually discontinued under the Mongols, the highly schematic *pa-ku* ("eight-legged") essay was adopted as the chief yardstick in measuring the candidate's literary attainments. Despite occasional protests, it continued to engage the attention of aspirants to official literary honours from 1487 to 1904.

Although Ming poets wrote both *shih* and *tz'u*, and their output was prodigious, poetry on the whole was imitative rather than freshly creative. Tirelessly, the poets produced verses imitating past masters, with few individually outstanding attainments.

In vernacular literature, however, writers of this period made a real contribution. In drama, a tradition which had been started in the Sung dynasty and tenuously maintained in southern China during the period of Mongol domination was revitalized. This southern drama, also musical and known as *ch'üan ch'i* ("telling of the strange"), had certain special traits: (1) a *ch'üan ch'i* play contains from 40 to 50 changes of scene. (2) The change of end rhymes in the arias is free and frequent. (3) The singing is done by many actors instead of by the hero or heroine alone. (4) Many of the plots, instead of being extracted from history or folklore, are taken from contemporary life. Since there were no rules regulating the structure of the *ch'üan ch'i*, playlets approaching the one-act variety were also written. This southern theatre movement, at first largely carried on by anonymous amateurs, won support gradually from the literary men until finally a new and influential school was formed under the leadership of the poet-singer Liang Ch'en-yü (1510–80) and his friend the great actor Wei Liang-fu. This, the K'un school, initiating the new style of soft singing and subtle music, was to dominate the theatre to the end of the 18th century.

Aside from drama and *ta-ch'ü* ("dramatic songs") writing—which in the south were noticeably modified in spirit and structure, becoming more ornate and bookish—it was prose fiction which made the greatest progress in the 16th century. Three important novels took shape at that time: Wu Ch'eng-en's (1500–82) *Hsi Yu Chi* ("Monkey"), a fictionalized account of the pilgrimage of the Chinese monk Hsüan Tsang to India in the 7th century; Lo Mao-teng's (fl. 1573–1620) *Hsi Yang Chi* ("Adventure to the Western Ocean"), an embellished tale of the 15th-century explorer Cheng Ho; and *Chin P'ing Mei*, a realistic novel of contemporary life and manners in 16th-century China, by an unknown hand.

Ch'ing Dynasty.—The conquest of China by the Manchus, who set up the Ch'ing dynasty (1644–1912), did not disrupt the continuation of major trends in traditional literature. Antiquarianism dominated literature as before, and excellent poetry and prose in imitation of ancient and medieval masters continued to be written, many works rivaling the originals in archaic beauty and cadence.

Prose Fiction.—P'u Sung-ling (1640–1715) continued the prose romance tradition by writing in *ku-wen* ("classical language") a series of 431 charming stories of the uncanny and the supernatural under the title *Liao-chai Chih-i* ("Strange Stories from a Chinese Studio"). Wu Ching-tzu (1701–54) satirized the literati of his time in his realistic masterpiece *Ju-lin Wai-shih* ("Forest of Scholars"), 55 chapters loosely strung together in the manner of a picaresque romance. Unlike P'u Sung-ling, whom he far surpassed in both narration and characterization, he adopted the vernacular as his medium. Better known and more widely read was Ts'ao Chan's (1715?–1763) *Hung Lou Meng* ("Dream of the Red Chamber"), a novel of a triangular love and the fall of a great family, also written in the vernacular and the first outstanding piece of Chinese fiction with a tragic ending.

Drama.—In drama, the Ming tradition of *ch'üan ch'i* was worthily continued by several leading poets of the conventional school, although as a whole their dramatic writings failed to appeal to the masses. Toward the end of the 18th century the folk dramas of numerous localities began to gain popularity, converging finally at the theatres of Peking and giving rise to what came to be designated as Peking drama—a composite product which has continued to delight large audiences in China.

Translations of Western Writing.—By the early 19th century, China could no longer ward off the West, and after the first Anglo-Chinese War (1839–42) China's port cities were forcibly opened to increased foreign contacts. In due course, many Western works on diverse subjects were translated into Chinese. The quality of some of these was so outstanding that they deserve a place in the history of Chinese literature. One distinguished translator was Yen Fu (*q.v.*), who had studied in Great Britain and whose renderings of Western philosophical works into classical Chinese were acclaimed as worthy of comparison, in literary merit, with the Chou philosophers. Another great translator was Lin Shu (1852–1924), who, knowing no foreign language himself but depending on oral interpreters, made available to Chinese readers over 170 Western novels, translated into the literary style of Ssu-ma Ch'ien.

Native Prose and Poetry.—Meanwhile writers of native fiction, especially in central and south China, began to be seriously influenced by Western models. Using the vernacular, and mostly following the picaresque romance structure of the *Forest of Scholars*, they wrote fiction usually intended for serial publication and satirizing Chinese society and culture. A good example of these was Liu E (1857–1909), whose *Lao Ts'an Yu Chi* ("Travel Records of Lao Ts'an"), a fictional account of contemporary life, pointed to the problems confronting the tottering Manchu dynasty.

Poetry, long stagnant, at last began to free itself from the shackles of traditionalism. Huang Tsun-hsien (1845–1905), most prominent among the poets, inspired by folk songs and foreign travel tried to write poetry in the spoken language and experimented with new themes, new diction, and new rhythm. His young friend Liang Ch'i-ch'ao (1873–1929) not only fervently supported Huang and his associates in what they called the revolution in Chinese poetry but also ventured forth in new directions in prose. Liang's periodical publications especially exerted an extensive influence on the Chinese people in the early years of the 20th century. Fusing all the unique and attractive features of the various schools of prose writing of the past into a new compound, Liang achieved a vibrant and widely imitated style of his own, distinguished by several characteristics: (1) flexibility in sentence structure so that new terms, transliterations of foreign words and phrases, and even colloquial expressions could be accommodated; (2) a natural liveliness; (3) a touch of infectious emotionalism which the majority of his readers enjoyed. Though he was too cautious to use the vernacular, except in the writing of fiction and plays, he did make an attempt to approximate the living speech of the people as Huang Tsun-hsien had done in poetry.

The Literary Revolution and After.—The real Literary Revolution, however, did not get under way until after the establishment of the republic in 1912. The monarchical institution of over three millenniums had ended, and with it went also the competitive literary examination system, which had been directly responsible for excessive conservatism and conventionality in thought as well as in literature.

The Chinese Literary Revolution, the aim of which was to bring about a thorough-going modernization of all aspects of Chinese literature, was touched off in 1916 by Hu Shih (*q.v.*), who was then studying in the United States. He had come to advocate in private discussions with his Chinese fellow students the urgent need for a new national literature for China, to be written in the living language of the people—a national literature which would compare to Italian literature since Dante and Boccacio and to English literature since Chaucer and Wycliffe. Hu Shih was well prepared to defend his proposal, for as early as 1906, when he was still only a preparatory school student in Shanghai, he had founded a quarterly magazine in which the vernacular was used and had published in it popular essays and an unfinished utopian novel. Ever since his arrival in the United States in 1910, and especially since his decision (1912) to change his field of specialization from agriculture to philosophy, he had become convinced that China's literary reform had to be consciously accelerated.

It was not until January 1917, however, that his proposals were published in the influential monthly *Hsin Ch'ing-Nien* ("The New Youth") edited by Ch'en Tu-hsiu (1879–1942). Ch'en gave Hu Shih immediate support and declared his arguments to be irrefutable. Hu Shih's article, "My Humble Proposals for Literary Reform," ironically was written in simple classical Chinese. As he himself observed later, he "was too much tempered by the moderation of a historian to be successful in revolutionary activities." His caution and willingness to listen to the opposition were effectively counterbalanced, however, by the uncompromising attitude of Ch'en Tu-hsiu, who also published an article "On the Literary Revolution" in February 1917, in which he boldly hoisted the banner of rebellion against the aristocratic, archaic-classical, and regressive literary traditions of the old China.

In 1919 the Literary Revolution was given new dignity with the publication of the first volume of Hu Shih's *Chung-kuo Che-hsüeh Shih Ta-kang* ("Outline History of Chinese Philosophy"), written entirely in the vernacular, which had never been used before in a scholarly work. Open-minded scholars of the older generation, such as Liang Ch'i-ch'ao, soon followed suit, although Lin Shu and a few other conservatives remained resolutely opposed to the innovation. The May Fourth student movement of the same year, in which thousands of students demonstrated to protest against the weak position taken by China's delegates at the Versailles Peace Conference, spread the use of the vernacular to the whole nation. Student appeals to the unlettered masses of necessity used the language the people could understand. Many new periodicals and daily papers adopted the vernacular exclusively, and there were few creative writers of the younger generation who did not follow the new trend. Finally, in 1921, the vernacular was given official sanction by the government, being called *kuo-yü* or "national language," till the Communist regime, when the term was replaced by *p'u- t'ung hua*, "generally understood language."

Meanwhile, the foundations of the Literary Revolution were strengthened by a whole crop of writers of varied background and training. Among the more experienced and dedicated of these were the brothers Chou Shu-jen (1881–1936; pseudonym Lu Hsün; *q.v.*) and Chou Tso-jen (1885–), who were associated with the Ch'en Tu-hsiu and Hu Shih on the editorial board of *Hsin Ch'ing-Nien*. The brothers had been brought up in the orthodox classical tradition, supplemented and enriched by their acquaintance with Western literature. Lu Hsün was known especially for his stories and familiar essays in which he exposed and ridiculed social and cultural foibles. In "The True Story of Ah Q" (1921), for example, the hero is the epitome of the ultraconservative forces in Chinese society—repugnant, obsolete, and yet so pitiable that he elicits sympathy rather than disdain and censure. "The Diary of a Madman" presents the jottings of a man diagnosed as insane, who in his inspired moments gives proof that he has not quite lost his mind; he suspects that the world is mad and he alone sober and sane. The aim of Lu Hsün's essays and epigrams is similar. Hurling invective at his opponents, he subjects traditional usages and customs to pitiless scrutiny and devaluation. His younger brother, Chou Tso-jen, a man of entirely different temperament, was not more conservative than Lu Hsün but a milder and gentler critic, reminding us of the manners and refinements of the best traditions of the Six Dynasties (221–589), before the rise of the T'ang empire.

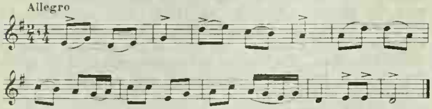
A new drama, modeled after Western prototypes and first introduced toward the end of the 19th century as an experiment, has taken firm root and flourishes side by side with traditional drama of the operatic variety without displacing it.

Although the achievements in poetry have not been so plentiful as in fiction, new and bold experiments were continually carried on, providing the best evidence that Chinese literature in the 20th century was as a river flowing into, and merging with, the ocean of world literature. *See* also CHINA: *The People* and *History;* CHINESE PHILOSOPHY.

BIBLIOGRAPHY.—English translations of most of the individual works mentioned in the article above are available, and are not listed in this short bibliography. *See* Cyril Birch (trans.), *Stories from a Ming Collection* (1959); Ch'en Shou-yi, *Chinese Literature: a Historical Introduction* (1961); Evangeline D. Edwards, *Chinese Prose Literature of the T'ang Period*, 2 vol. (1937–38); David Hawkes (trans.), *Ch'u Tz'u: the Songs of the South* (1959); J. R. Hightower, *Topics in Chinese Literature*, rev. ed. (1953); Hsia Chih-tsing, *A History of Modern Chinese Fiction, 1917–1957* (1961); Hu Shih, *The Chinese Renaissance*, 2nd ed. (1963); William Hung, *Tu Fu: China's Greatest Poet* (1952); James Legge, *The Chinese Classics* (1861–72); Lin Yu-tang (trans.), *The Importance of Understanding* (1960); James J. Y. Liu, *The Art of Chinese Poetry* (1962); Arthur Waley (trans.), *Shih Ching: the Book of Songs* (1937), *A Hundred and Seventy Chinese Poems*, and *More Translations from the Chinese* (1931), and *The Temple, and Other Poems* (1923); Arthur Waley, *Ballads and Stories from Tun Huang* (1960); Wang Chi-chen, *Traditional Chinese Tales* (1944); Burton Watson, *Early Chinese Literature* (1962); Alexander Wylie, *Notes on Chinese Literature*, 2nd ed. (1964); Yüan T'ung-li, *China in Western Literature* (1958). (S.-Y. C.)

CHINESE MUSIC. The types of music of a multinational state, such as China, may well be expected to differ from one region to another, and this account is mainly confined to the music of the *Han-jen*, the "Chinese" in a limited sense.

Melody.—It is not easy to define Chinese melody in such a way that melodies from all periods and styles fall within the limits of the definition. First, however, it may be agreed that it is predominantly five-note melody, provided that the frequency with which it makes use of seven notes is acknowledged. Second, the melodic line tends to break into units of a fourth; so that while chains of fourths (D, G, C', for example) are not uncommon, broken triads are rare. Third, the fourths are spanned by three notes, spaced as a minor third and a major second (DE G or D FG). Fourth, its rhythms are for the most part binary or quaternary, rarely ternary; and though often momentarily irregular, they are never continuously so, as are the irregular (*aksak*) rhythms of India, the middle east or the Balkans. Fifth, Chinese tunes do not show sequential structure and are often nonsymmetrical, in spite of their binary rhythmic structure. All these properties are exhibited in the following example, taken from a folk dance tune that is current south of the Yangtze river in Kiangsu and Anhwei provinces and is called "The golden snake's wild dance."



One structural feature common to western folk song and some Chinese tunes (though much less frequent in China than in the west) is the "answer at the fifth." This is exemplified by tunes consisting of two phrases, A A′, where A′ is a slightly varied restatement of A at the fifth below.

The impression of unusual intonation that a western listener sometimes receives may arise from either of two causes: from gracing of notes by microtonal on or off glides, or from the non-tempered occasional semitones. Fourths, fifths and octaves are usually perfect. The semitones are chiefly used in modulating from one five-note mode to another, but they also occur as passing notes (*see* example).

Musical Practice.—Of great importance for the practising musician is the art of "gracing." A fiddler or flautist accompanying a singer decorates a cadence, such as E $\overset{\frown}{\text{D}}$, for example, as E G $\overset{\frown}{\text{D}}$, E GE $\overset{\frown}{\text{D}}$, or EAGE $\overset{\frown}{\text{D}}$. A lutenist not only graces but fills out sustained notes of the tune with a pattern of repeated notes. In a small band of, say, flute, fiddle and lute, all play the same tune in unison or at the octave, with graces and in a manner appropriate to the properties of each instrument, against a rhythmic framework of percussion—drums and clappers, and single gongs or cymbals, for example. If this ensemble is compared with similar groups from India or the middle east, conspicuous differences are apparent, not only in the specific timbre of instruments and in the predominantly five-note melody but also in the rhythmic framework. The elaboration of "rhythmic modes," so striking in Indian and middle eastern music, is much less conspicuous in China, where rhythmic patterns are simpler and less numerous.

One feature of the instrumental ensemble of the theatre, for which there is no parallel in India or the middle east, is the use of the mouth organ, doubling the melody in parallel fourths. This diaphony is subservient to the purely melodic interest of the tune, but it serves as a reminder that the common view of Chinese music as purely linear does not take into account the practices of folk music. In folk and popular music the mouth organ is used not only to play tunes in fourths or fifths (as far as its structure permits) but also to provide *ostinato* accompaniments—two chords played in alternation, for example. An analogous use of the mouth organ is found among certain national minorities in the republic, such as the Miao and Yao, as well as south of the border in Vietnam, and there can be little doubt that these harmonic features belong to an ancient musical tradition, modified by contact with ideas and practices coming from central Asia.

Reduced to staff notation and played on an equal-tempered instrument, Chinese music strikes westerners as "Scottish," because of its five-note character. Heard on Chinese instruments, however, it is more strange, because of the peculiarities of intonation and the distinctive timbres of the instruments. The muted tone of the two-stringed fiddle, *erh-hu*, is due to the snakeskin diaphragm on which the bridge rests; the "edge" to the sound of the side-blown flute, *ti*, is due to the vibration of a thin membrane closing a supernumerary hole; the shrillness of the shawm, *suo-na*, derives from the smallness of the double reed; the "dry" sound of the pear-shaped lute, *p'i-p'a*, depends on the special qualities of the resonator; and among percussion instruments the flat, circular drum, *pang-ku*, provides an essentially "Chinese" element with its unique and indescribable sound.

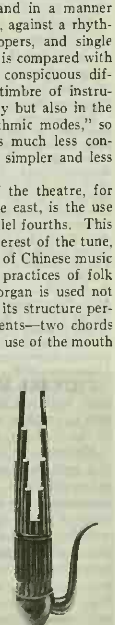

BY COURTESY OF THE METROPOLITAN MUSEUM OF ART, GIFT OF MRS. JOHN CROSBY BROWN, 1889

FIG. 1.—SHENG, MOUTH ORGAN

Opera and Classical Music.—In addition to the wealth of local folk music related to all aspects of daily life—including such characteristic features as storytelling in rhythmized prose to the accompaniment of a long-necked lute, the *san-hsien*—two major kinds of Chinese music must be considered: opera and classical music. The term opera is commonly applied to the music dramas, sung throughout, save for brief passages in highly stylized speech where the tonal accent of the syllables is so emphasized that the result sounds like the *Sprechstimme* of Arnold Schönberg.

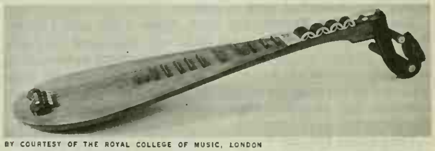

BY COURTESY OF THE ROYAL COLLEGE OF MUSIC, LONDON

FIG. 2.—P'I-P'A, FOUR-STRINGED LUTE

Five types of opera can be distinguished: *k'un-ch'ü*, dating from the 16th century, in which the chief accompanying instrument is a flute; *ching-hsi*, the 19th-century style, with a fiddle as the chief accompanying instrument and existing in a number of variants (*erh-huang*, *hsi-p'i*, etc.), sometimes referred to as the "classical Chinese theatre"; modern opera (*see* below); provincial opera, such as is to be heard in the capitals of the different provinces; and folk opera—the last of great interest and still inadequately recorded and investigated. In listening to Chinese opera, the foreigner has first to accept the use of the voice in high falsetto before the richness of melodic invention, the dramatic appropriateness of the music and the artistry of the performers can be appreciated.

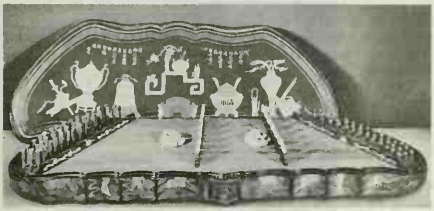
The term "classical" is often applied to those solo musics for lute (*p'i-p'a*), flute (both side blown and end blown) and zither that are preserved as a repertory of scores. The zithers—*ku-ch'in*, or *ch'i-hsien-ch'in*, and *chêng*—are the oldest Chinese stringed instruments, with a documented history from before the 5th century B.C. The repertory of the former (*ku-ch'in*) includes pieces already printed in tablature in the early 15th century, and is beyond question the greatest musical treasure of the Chinese tradition.

This music is the equal of Chinese painting and ceramics in its universal appeal. The sounds of this instrument are intrinsically beautiful and evocative, even for foreign ears at a first hearing, and the musical structure of the suitelike pieces from the classical repertory is of the greatest interest.

Glancing briefly at the musics of certain groups other than the *Han-jen*, it may be said that while the music of Mongolia often resembles that of north China, there is a striking difference in the abundance of unmeasured song in Mongolia in contrast to China. In Tibet, Lamaist music and the music of the historical music dramas differ profoundly from Chinese music in the characteristics of the melodic line. Finally, in Sinkiang province, and among the Turkic peoples—such as the Wei-wu-erh and Khazaks—seven-note melody is the rule rather than the exception.

History.—Excavation of graves of the Yin dynasty (*c.* 1523–*c.* 1027 B.C.) has revealed lithophones (slabs of sonorous stone), bronze bells and globular earthenware flutes, all yielding notes at the same or related pitches, so that there is reason to believe that the Shang people had at that time a standard pitch. At least by the 3rd century B.C., and probably earlier, an arithmetical procedure for generating the note series was known. Starting with a bamboo tube of length x, if other tubes are cut to lengths of $2/3x$, $4/3(2/3x)$, $2/3(4/3(2/3x))$, etc., the first five tubes when blown will yield five notes of relative pitches C G D A E, that is, the five-note series, C D E G A. It is possible that both Greece and China derived from Babylonia their knowledge of the 1:2/3 ratio between fundamental and fifth. There are reasons for believing that the Shang people, like some of the national minorities in modern China, may have practised a three-note ritual music.

Certain musical instruments entered China from central Asia at an early date. Iconographical evidence establishes that a pear-shaped lute with a short straight neck was known in the later eastern Han dynasty (before 200 A.D.?), and a circular, straight-necked lute is attested by contemporary documents and a figure on a pottery vessel from 260 A.D. The date of entry of the fiddle is still uncertain, but rubbed half-tube zithers were known in the T'ang dynasty (618–906 A.D.). The Persian dulcimer, *yang-ch'in*, associated with popular Cantonese music, entered during the Ming period (1368–1644).



BY COURTESY OF CINCINNATI ART MUSEUM

FIG. 3.—YANG-CH'IN, DULCIMER

In T'ang and Sung times the musical influence of central Asia was strong in the entertainments of the court, and seven-note tunes were common in ceremonial music. Some of these tunes survive in the works of Chu Hsi and Chiang Pai-shih from the beginning of the 13th century. Seven-note tunes were also characteristic of the so-called *Northern Songs* of Yüan and Ming times; but on the whole the fundamentally five-note character of Chinese melodies always shows through the seven-note structure.

Modern Music.—In the mid-20th century Chinese composers were experimenting with western instruments and with harmonic and contrapuntal devices adapted to the national idiom. Among many modern works, mention may be made of the *Yellow River Cantata* (for soloists, chorus and an orchestra of Chinese instruments) by Hsien Hsing-hai, and of the impressive opera *The White-Haired Girl* (1945) by a group of composers and writers, perhaps better regarded as a collective work than a work "composed" in the usual sense. Many of its tunes, indeed, are folk and popular songs. The orchestral texture marks a new departure in Chinese music, and there are passages of striking originality and affecting pathos. *See* also Musical Instruments; Percussion Instruments; Wind Instruments; Oriental Music; and articles on individual instruments.

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(L. E. R. P.)

CHINESE PAINTING. Chinese painting is to be ranked with major forms of artistic expression throughout the world. As a point of departure, it can be suggested that Chinese painting is permeated by a sense of the wholeness of things. Separate detail is important only insofar as it affirms more universal characteristics. Portraits to western eyes often appear generalized; for while they may record the nature of an individual, they seek at the same time to assess that individuality as an ideal—of, for example, the Confucian scholar. Small objects—a bird, a flower, a fish, bamboo—are seldom depicted without stressing their growing, moving life and hence the implications of their involvement with all living things. The perfection of shape and proportion that is necessary to depict a Buddha is the artist's way of defining a godlike universality. It is no accident that the Chinese artist has so often turned to the art of painting landscape. In what other theme can one find the vision of far horizons, the extension of time that is in the mysterious recurring passage of the seasons, and a chance to express man's involvement with such a wide and universal theme?

Appreciation of Chinese painting, outside China and Japan, came late, but increasingly during the 20th century more and more paintings have become known, important collections have been formed in western museums, and knowledge is expanding and becoming surer. Certain obscurities, however, are inherent in the long history of the art. Although the Chinese have kept careful historical records, countless paintings have been destroyed by war and natural calamity. For what is preserved, the judgment of authenticity has been complicated by the practice of making copies. Hsieh Ho's (*c.* 500) famous six principles of painting enjoin the artist to "copy" the old masters. In this fashion early creativity might be preserved for the admiration of later generations, much as old masterpieces are reproduced and preserved by photography. From such a background, however, it becomes clear that if artists' names are assigned to the finest early Chinese paintings, this need not mean more than that the painting was done according to a well-established tradition connected with that name.

For descriptions of the historical and cultural background of the periods discussed *see* China: *History;* Buddhism; Confucianism. Specific areas of Chinese painting are treated in Embroidery; Enamel; Tapestry; Textiles. *See* also Chinese Architecture and Chinese Sculpture.

TECHNIQUE AND IDEALS

Chinese painting is water-colour painting with pigments of both vegetable and mineral components. Applied with a binder of glue, colours could be opaque or in semitransparent washes. These were usually added to areas already defined by ink outline, but a free, unoutlined or "boneless" method was also known. Most commonly the surface was a smooth wall or the portable materials silk and paper. Silk was used for painting as early as the 5th to 3rd centuries B.C. Paper, although probably existing earlier, was officially recorded as an invention in A.D. 105. It may have been used in painting, however, several centuries later.

In addition to embellishing walls, Chinese painting from as early as the Han dynasty (202 B.C.–A.D. 221) was often done on standing portable screens. Aside from reflections in Japan, no early Chinese screens have survived. Painting in China tended to three significant forms: (1) the hanging scroll, which was unrolled to hang vertically on the wall; (2) the hand scroll, to be unrolled on a table from right to left, a small section at a time; and (3) the album, a series of separate pictures, assembled like a book and leafed through picture by picture. Such paintings were easily stored. In fact, important masterpieces were shown only on special occasions or to close friends who would particularly enjoy them.

Much of Chinese painting was in ink monochrome. Chinese ink was manufactured in stick form, a combination of pine soot and glue, which was ground in water on an ink stone. The bamboo brushes used to apply the ink or colour could be obtained in an almost endless variety of sizes and qualities, the hardness or softness depending on the kind of animal hair that was used. Even the largest brushes tapered to the finest hairlike point, thus affording tremendous flexibility.

These tools helped create a rather special relation between the artist and what he painted. The brush, which was used as well in writing, had none of the hardness of a pen, and the slightest pressure of the hand caused a marked variation in the character of the brush stroke. The painter thus had to cultivate a most skilful control, a control that was the more remarkable considering that normally the hand that held the brush received no support and that the whole arm moved free. By this the Chinese affirmed that the inspiration in the mind flowed unfettered down the channel of the arm—almost as an electric current—to record itself on the whiteness of silk, paper or wall.

In practice such spontaneous ease must be qualified. Some paintings took days, weeks, even years to complete. There is sometimes evidence for the use of a charcoal sketch. A type of painting practised as early as the 6th century and apparently of central Asian import was known as "painting in relief." A later example (11th century) involved the application of thick layers of paint until it assumed the proportions of physical relief, certainly a laborious technical process. In the 17th century Wang Yüan-ch'i used an iron to dry water-colour pigment, the more readily to apply individual layers of paint.

But the ideal remained, and the mastery of mind made visible through perfect execution turned the painter into a kind of holy man who, according to Han Cho in 1121, "fathoms the uttermost secrets of heaven and earth and illumines what is not lit by sun and moon." His goal was the attainment of Hsieh Ho's enigmatic ideal of "spirit, rhythm, life movement"—to transcribe directly its four Chinese words. Moreover, legend affirms that the artist was able to perform marvelous feats. Thousands of miles unfolded on a square inch. Dragons flew from the walls on which they were painted; and at the end of his career the artist might paint a cave so real that he could walk into its depths, never to be seen again.

HISTORY

Shang Dynasty (1766?–1123? B.C.) and Chou Dynasty (1122?–256 B.C.).—Painting of some kind certainly existed far back in China's history. The use of a brush, apparent at least in China's earliest writing (*c.* 1300 B.C.), is one indication of such antiquity. Only from a much later period (5th–3rd centuries B.C.), however, is there a painting which can properly be associated with the long later fruitful traditions of the art. A product of the culture of Ch'u, a powerful southern state during the feudal Chou period, this painting was excavated at Ch'ang-sha in 1949. It affirmed the early use of line and possibly colour on silk.

Han Dynasty (202 B.C.–A.D. 221).—According to literary references, the Han dynasty knew both large-scale frescoes and portable paintings on silk. Moreover, the names of several Han painters have been preserved. While no major works have survived, a substantial understanding of the art can be derived from tomb carvings and tomb frescoes, from painted pottery and from lacquer. Much of Han painting was preoccupied with the human figure, but molded tiles from southwest China show landscapes. That Han painters were concerned with the spirit world is attested by the appearance of gods and strange imaginative forms. When these were painted on lacquer objects, the fluid easy movement of the brush as it described a figure vibrant with life can often be detected, traits of technique and spiritual intent that long remained the aims of the Chinese artist.

Six Dynasties (221–589) and Early Buddhism.—Ku K'ai-chih (*c.* 344–*c.* 406), who worked at the Chin court at Nanking, was the most important early post-Han artist. The scroll coming closest to his hand is in the British museum (London), "The Admonitions of the Instructress to the Court Ladies." Here the artist illustrated a 3rd-century moral treatise recorded in bits of writing which divided and explained brief, painted scenes. Elegant postures, careful spacing, telling compositions, refined brushing of a thin sure line, even suggestions of shading in drapery folds proclaim its sophisticated qualities.

In 1950 a complete tomb was uncovered at I-nan in Shantung province. A Chinese writer has claimed relationships between the shallow wall carvings and the art of Ku K'ai-chih, and it is possible that future tomb finds will expand the knowledge of post-Han non-Buddhist paintings. Fine later (early 6th century) examples of this "drawing" on stone may be found in an offering shrine in the Museum of Fine Arts at Boston, Mass., and a sarcophagus illustrating scenes of filial piety in the Kansas City (Mo.) museum.

Both in the north and south of China the imported religion of Buddhism was of great significance. Known to China in the Han dynasty, there are only the briefest sculptured expressions of it at that early date. From the 3rd century it flourished in the lower Yangtze valley. By the early 6th century the most admired artist in the south was Chang Seng-yu, who worked at Nanking for the Buddhist Liang dynasty. A chief aspect of Chang Seng-yu was his ability to paint in a manner referred to as "relief." By this may be inferred, if not actual physical relief, the use of shading techniques imported from India which gave to objects a sculpturesque quality of volume and substance that was to the Chinese a new and marvelous thing.

No Chang Seng-yu paintings have survived, but there are imitations of a relief style in some details from Six dynasties painting in the north at the famous trade route centre of Tun Huang in western Kansu province. Artists first began work there in 366, and the National Art Research institute of Tun Huang has counted as many as 469 caves, 22 of which may be dated in the Six dynasties period. There are Buddhas and their attendants, and popular stories of former lives of the Buddha. The art, as might be expected in such a border region, shows different manners, strains that were related to the mixed environment of Indian, central Asian and Chinese influences.

T'ang Dynasty (618–906).—The T'ang dynasty must be accepted as one of the great glories of Chinese history. The main capital of that dynasty, Ch'ang-an (modern Sian), was a great international city, and painting in temples and palaces was a chief adornment of that city.

No great temple survives, but in the west of China, Tun Huang continued to flourish as a caravan oasis, and many wall paintings among its 206 T'ang cave chapels (or temples) can still be seen. In Japan, the Horyuji temple on the outskirts of Nara preserved (until a damaging fire in 1949) a beautiful series of early 8th-century frescoes. However, fine reproductions are extant. So close were they to Chinese ideals that they may well have been done by Chinese craftsmen, and they stand as proof of the international character of Buddhism at that time.

T'ang scrolls ascribed to specific artists are indeed rare. A famous hand scroll, "Thirteen Emperors" (Boston museum), is given to Yen Li-pen (7th century), a favourite of two early T'ang emperors. In some rather damaged hanging portraits of Buddhist patriarchs (Toji, Kyoto) Li Chen (8th century) caught the religious concentration of the followers of the True Word sect. Han Kan (8th century) was a great painter of horses, and one of his spirited animals may have been preserved in a scroll in the David collection in London.

It is often from the sure and skilful copy that the clearest estimate of T'ang art can be gained. Wei-ch'ih I-seng, son of a Khotanese artist, was sent from central Asia to the Chinese court (*c.* 630). Like Chang Seng-yu of the preceding century, he painted in relief. Something of Wei-ch'ih I-seng's art can be estimated in what appears to be an 11th-century version (by Ch'en Yung-chih), "Buddha Under the Mango Tree," now in the Boston museum. In this hanging scroll, blue and green mineral pigments were applied with such thickness as to stand out physically in relief from the even surface of the silk. Chang Hsüan's (fl. 713–742) "Ladies Beating and Preparing Silk," a Sung copy, by Emperor Hui Tsung (also in the Boston museum), was beautifully coloured in soft green and gentle orange, blue and rose. It could hardly have come closer to more universal T'ang qualities: dignity and harmony, richness without flamboyancy, a truly "classic" sense of control that contained within it the vibrancy of quiet life.

Of the greatest T'ang artists nothing but shadowy copies remain. In this category must be included the fabulous vigour of Wu Tao-tzu, of whom it was said that "some god must have borrowed his hand"; Wang Wei (699–759), the original symbol of a scholar-painter ideal; and Li Ssu-hsun (651–716), the originator of a highly coloured precise landscape style.

The Five Dynasties (907–960).—Times of trouble in China have traditionally nurtured the independent recluse, and in the post-T'ang uncertainties Ching Hao (*c.* 900–960) withdrew to the T'ai Hang mountains in eastern Shansi. The ideals he developed—and from them a suggestion of his painting style—are set down in a treatise, *Notes on Brushwork.* In part he talked of a just bal-

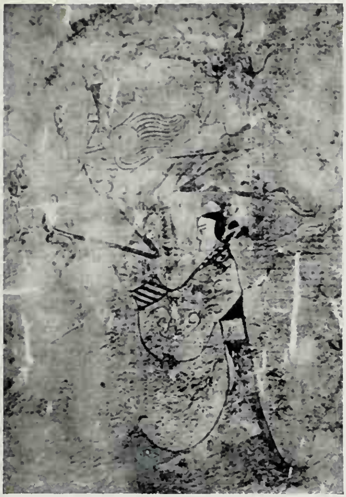
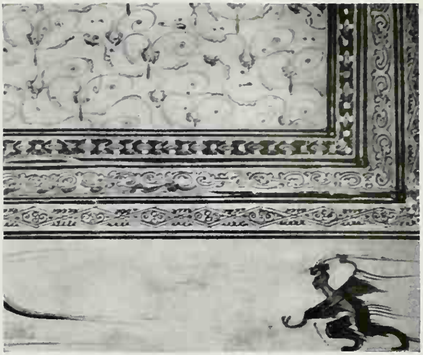
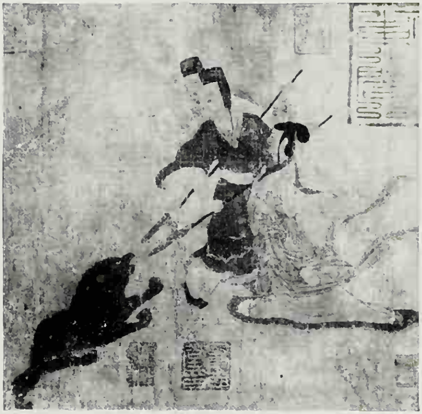


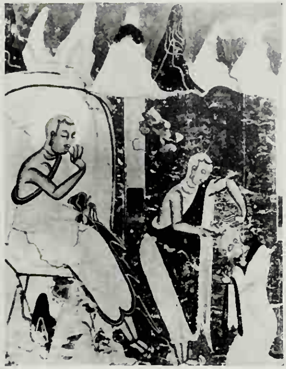
Figure from Ch'ang-sha, 5th to 3rd centuries B.C. This fragment was hailed on its discovery in 1949 as the earliest important example of true Chinese painting on silk. In the Historical Museum, Peking



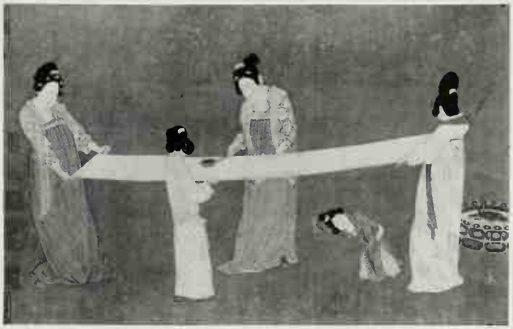
Detail of a lacquered table-top, 1st to 3rd centuries A.D. The wisplike figure of an immortal in the lower right hand corner illustrates a preoccupation with the supernatural world



"Admonitions of the Instructress to the Court Ladies" (detail) by Ku K'ai-chih (c. 344–c. 406). A court lady glides forward to protect an emperor from an onrushing bear and is herself rescued by the guards



"Man Being Tonsured Before a Holy Buddhist Figure," 6th century. From Cave 257 (Pelliot no. 110), Tun Huang, northwestern Chinese caravan centre. Dark bands on face and arms come from oxidation of original warm-coloured flesh tones



Ironing silk, a detail from "Ladies Beating and Preparing Silk," an elegant and beautifully coloured T'ang painting by Chang Hsüan (active 713–42) copied by the artist-emperor Hui Tsung (1082–1135)

BY COURTESY OF (TOP RIGHT) FOGG ART MUSEUM, HARVARD UNIVERSITY, GRENVILLE LINDALL WINTHROP COLLECTION, (CENTRE RIGHT) BRITISH MUSEUM, (BOTTOM LEFT) FROM "CHINESE PAINTING: LEADING MASTERS AND PRINCIPLES" BY OSVALD SIRÉN. USED BY PERMISSION OF THE RONALD PRESS CO., N.Y., AND PERCY LUND HUMPHRIES & CO., LONDON, (BOTTOM RIGHT) MUSEUM OF FINE ARTS, BOSTON

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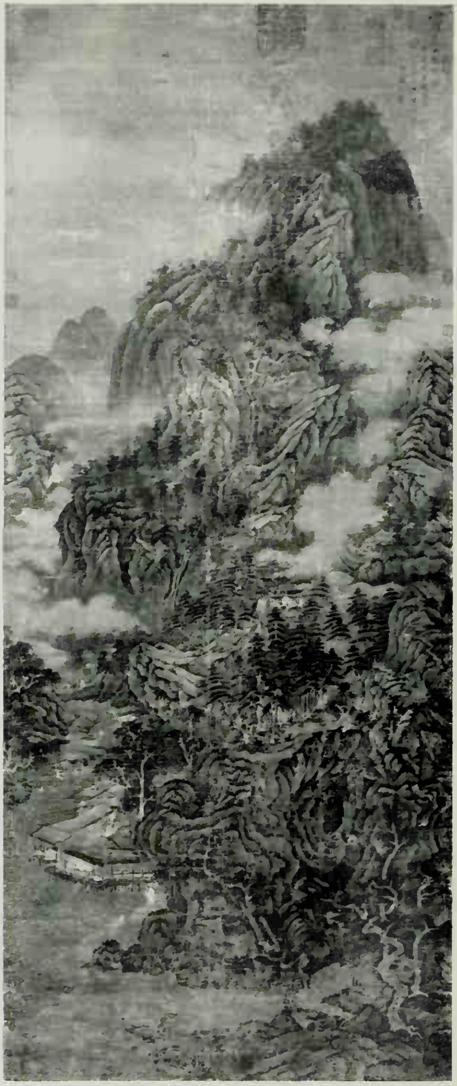

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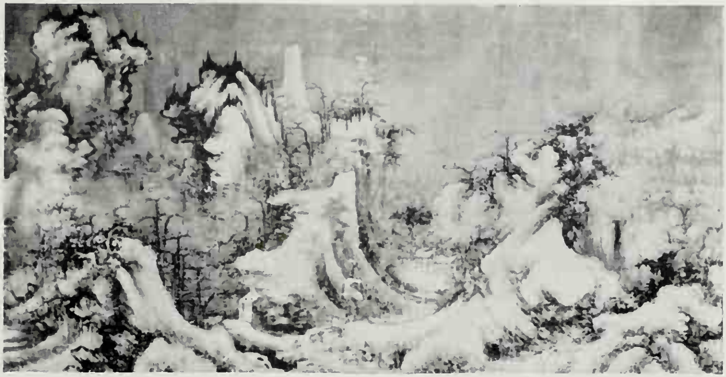
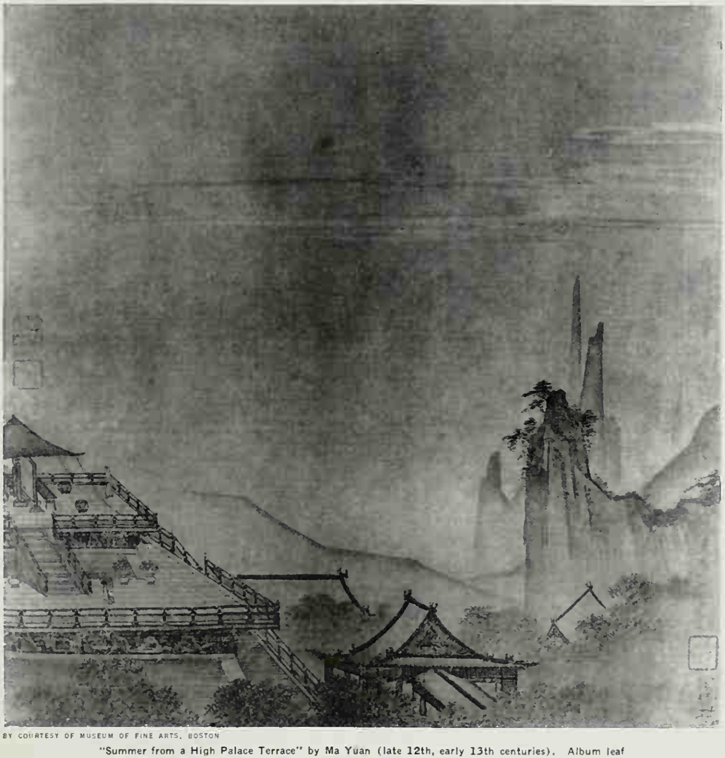
Landscape by Kuan T'ung, 10th century. Light colours, softly varied grades of ink and a complex design of crags reproduce the spirit of mountain and stream



BY COURTESY OF THE TOLEDO MUSEUM OF ART, GIFT OF EDWARD DRUMMOND LIBBEY, 1927

"Winter Landscape" by Kuo Hsi (*c.* 1020–90). A section of a darkened silk handscroll. No colour is used but the ink is given a rich variety of shape and tone



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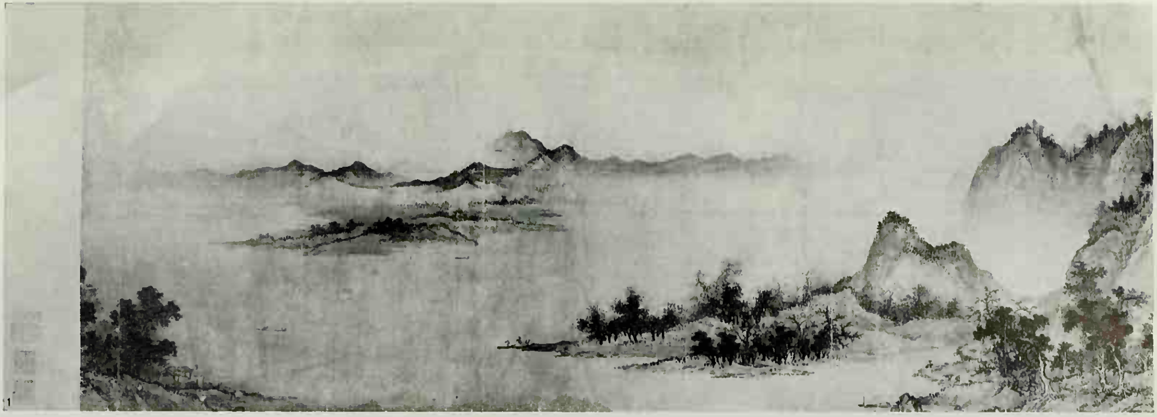
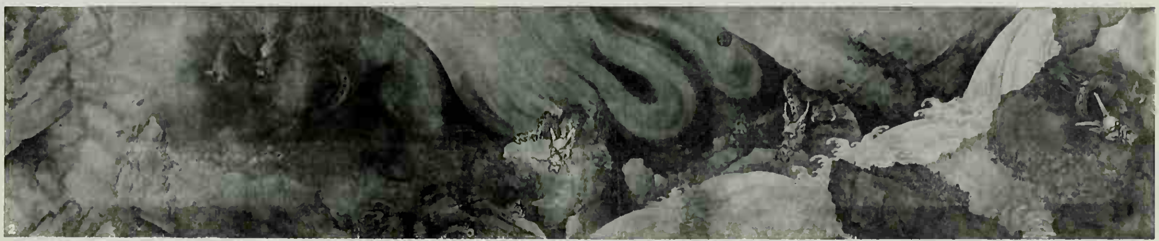
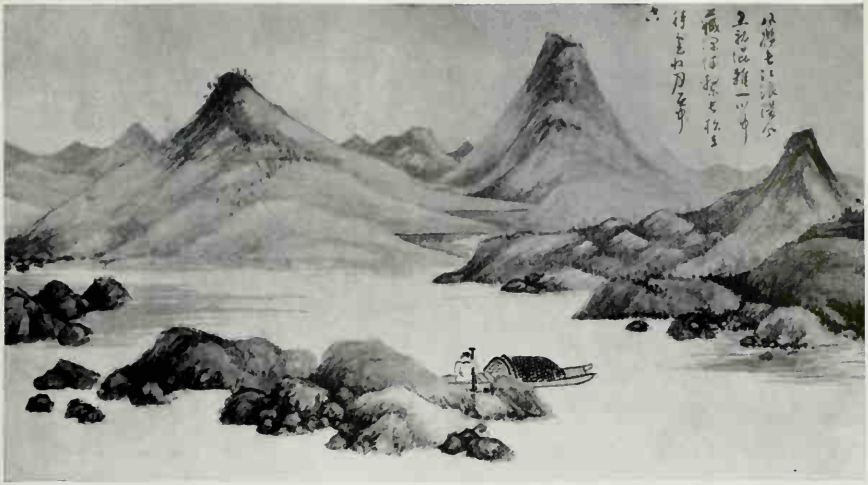
"Summer from a High Palace Terrace" by Ma Yuan (late 12th, early 13th centuries). Album leaf in ink and colours on silk



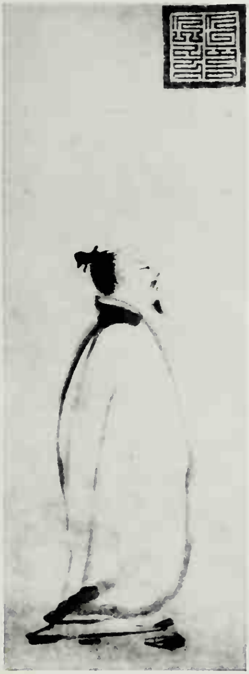


BY COURTESY OF MUSEUM OF FINE ARTS, BOSTON

1. "Clear Weather in the Valley" (detail). Attributed to Tung Yüan, 10th century, but thought by many to be closer to the 13th century. A classically beautiful Chinese landscape with its tiny figures and the misty expanse of endless distance. Ink on paper with light colour wash (on the hills)
2. "Nine Dragons" (detail). Ch'en Jung. The famous mythical beasts of China appearing and disappearing among crags and mists and water. Painted in ink and slight colour on paper in 1244



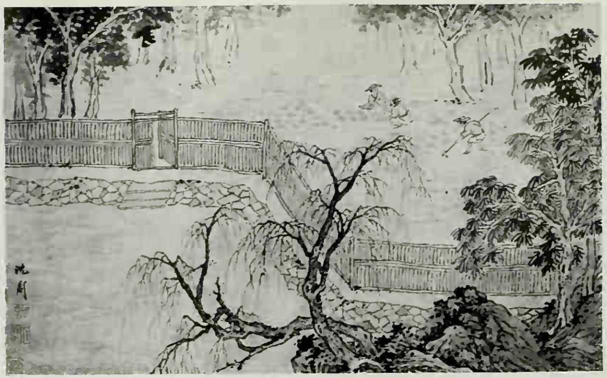
"Fishermen," detail of a section of a handscroll by Wu Chên (1280–c. 1354). Painted with ink on paper in 1352 after a work by Ching Hao (10th century). Artists at this time sought to reinterpret the rich handling of ink tones by Five Dynasties and Northern Sung masters



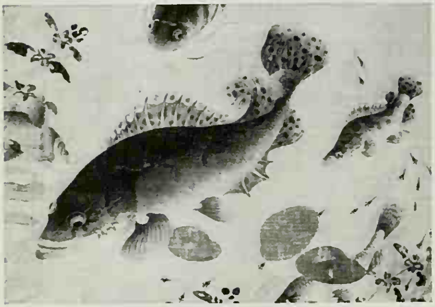
"Li Po" by Liang K'ai, 13th century. A visionary portrait of the great T'ang poet by a Ch'an Buddhist painter. Ink on paper

BY COURTESY OF (TOP) THE SMITHSONIAN INSTITUTION, FREER GALLERY OF ART, WASHINGTON, D.C., (BOTTOM) NATIONAL COMMISSION FOR PROTECTION OF CULTURAL PROPERTIES, TOKYO

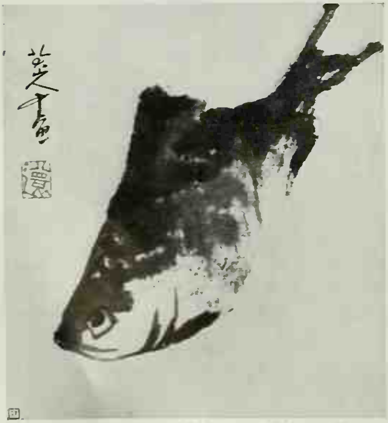
CHINESE PAINTING

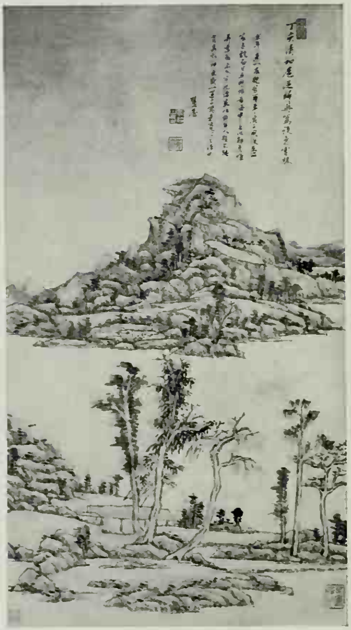


"Gardening" by Shen Chou (1427–1509). A view of Chinese life known and idealized by this artist. Album leaf in ink and colour on paper



Above: Detail of fish by Liu Ts'ai (late 11th century). Ink and colours on silk. *See also* below, left





Above: Landscape after the 14th century artist Ni Tsan by Wang Yüan-ch'i (1642–1715). Later artists often gave their own interpretations to the moods of earlier painters. Painted in 1707, ink and colour on paper

Left: Fish by Chu Ta (1626–c. 1705). Album leaf, ink on paper. Note the marked contrast between the precise detail of the fish above by Liu Ts'ai and the personal, even eccentric, ink expression of the late 17th century shown here. Such studies reflect the continual interest of the Chinese in little things in nature

BY COURTESY OF (TOP) NELSON GALLERY OF ART, KANSAS CITY, MO., NELSON FUND, (CENTRE LEFT) CITY ART MUSEUM, ST. LOUIS, (BOTTOM LEFT) THE SMITHSONIAN INSTITUTION, FREER GALLERY OF ART, WASHINGTON, D.C., (BOTTOM RIGHT) THE CLEVELAND MUSEUM OF ART, JOHN L. SEVERANCE COLLECTION

ance between outward appearance and inner reality: "Truth shows the spirit and substance in like perfection." Concurrently he was affirming a way of life: "Wise men devote themselves to music, calligraphy and painting, thus one by one getting rid of their desires" (S. Sakanishi, ***The Spirit of the Brush***, London: John Murray, 1948 reprint, pp. 87–88, in "Wisdom of the East Series").

Ching Hao was only one of several great masters. His home was in the north as was that of Kuan T'ung (10th century), Li Ch'eng (*c.* 940–967) and Kuo Chung-shu (*c.* 920–*c.* 977). While the greatest single collection of rare early Chinese landscapes is in China's National Palace museum, the Boston museum attributes a beautiful towering landscape to Kuan T'ung. Here in the complexities of curving crags and soft mists may be experienced the grandeur and mysteries of nature that so stirred the imagination of these early artists.

In the south the elegance of the local court at Nanking was reflected in a figure painting by Ku Hung-chung, "Han Hsi-tsai's Night Revels," of which an important version is preserved in China. To this court were drawn the two great landscape painters so much admired from the Yüan to the Ch'ing dynasties, Tung Yüan and Chu Jan.

From the west at the ancient cultured city of Chengtu, the name Huang Ch'üan (*c.* 900–965) stands out. Posterity has paired him with Hsu Hsi of Nanking as one of the most skilled early painters of birds and flowers.

Sung Dynasty (960–1279).—Painting of the Five dynasties blended readily into the art of the Northern Sung when China was once again controlled by a single dynasty. Yen Wen-kuei (late 10th century), Hsu Tao-ning (early 11th) and Fan K'uan (*c.* 990–1030) apparently carried on early traditions well into the 11th century.

Partly because of a famous essay on landscape painting, Kuo Hsi (*c.* 1020–90) is one of the best-known artists of the Northern Sung. In his essay there is an important passage on the variety and subtle uses to which ink may be put. A dated and lightly coloured "Spring Landscape" (1072) in the Palace museum of China and hand scrolls of "Autumn" (Washington, D.C.) and "Winter" (Toledo, O.) show this dexterity of ink, ranging from the thinnest distant mist-veiled peak to bold swirling ink on foreground rocks to towering imaginative and often cloudlike cliff shapes.

The emperor Hui Tsung (ruled 1101–25) is an important name in the arts of the early 12th century. Politically weak and ending his life a captive in Mongolia (1135), he was one of China's greatest art patrons, maintainer of a painting academy, and himself a skilled painter. His painting catalogue, ***Hsuan Ho Hua P'u*** (1120), lists 6,396 paintings by 231 artists. Classification by ten subjects gives first place to Buddhist and Taoist themes, second to human figures and only fifth to landscapes.

Artistic ideals had undergone a change; the emperor relegated a whole cartload of Kuo Hsi paintings for use as waste silk. Much of this change must have involved a care and precision in painting technique that is evident in the emperor's own studies of birds and flowers. Leading examples of his art may be seen in the Boston museum ("Five-Coloured Parakeet") and in the Palace museum ("Bulbuls on a Flowering Allspice Shrub" and "Landscape"). While his perfect technique was doubtless something new, as a painter of such tiny things in nature he was actually only continuing 10th-century traditions already upheld in the Sung by Chao Ch'ang (early 11th century) and Ts'ui Po (late 11th).

Because of their significance as exemplars of a persistent Chinese ideal—the ideal of the scholar-painter-poet-calligrapher—an ideal that was so strongly revived in the Yüan dynasty, a group of late Northern Sung artists have special significance. Mi Fei (1051–1107) invented a new technique whereby he built his hills from repeated horizontal dashes or blobs of ink. In a sense no less scholarly and personal were Li Lung-mien's (*c.* 1070–1106) "plain drawings" (*pai miao*), often of human figures or horses, in a sure sometimes pencillike ink line. Wen T'ung (d. 1079) was the greatest Sung painter of bamboo, while his admirer Su Tung-p'o, a friend of Mi Fei, showed in his skill at calligraphy, bamboo and poetry the kind of personal learned expression for which this scholar class aimed.

When the capital of K'ai-feng was captured (1126) by the Jurchen, Li T'ang, an elderly painter, was credited with reconstituting artistic traditions in the south at Hang-chou (Hangchow) under the patronage of the new emperor, Kao Tsung. Li T'ang's works are best known in China (Palace collection) and in a pair of landscapes in Japan (Daitokuji). There were also many others from the north who continued in the south: Su Han-ch'en, noted for paintings of children; Li An-chung, a painter of birds; Chao Po-chu, who continued the precise manner of the T'ang great, Li Ssu-hsun; and Chiang Ts'an, a perpetuator of Northern Sung landscape ideals. Younger members of a re-established academy grew in stature: Liu Sung-nien, Hsia Kuei and members of a painter family named Ma—especially Ma Yüan and his son Ma Lin.

Because of admiration for them in Japan, and later Europe and America, Ma Yüan and Hsia Kuei have become almost household words to express the character of Southern Sung painting—a brief, yet careful style, in which repeated angular brush strokes ("ax strokes" being particularly important), neatly placed headlands, evenly fading mists, soaring peaks, broad spaces and tiny people presented a picture that was both defined and pregnant with the poetry of suggestion.

Yet another aspect of Southern Sung painting was inspired by Ch'an (Zen) Buddhism. Ch'an paintings attempted to reveal truth by a sudden flash of insight, by quick powerful brush strokes and brief telling areas of wash. These are much admired in Japan, and the best-known Ch'an paintings, especially those by Mu Ch'i and Liang K'ai (both 13th century), are preserved there.

Yüan Dynasty (1280–1368).—This was the era of the Mongol supremacy of the great khans. It is difficult, however, to see any fixed correlation between painting and political control. Some painters were closely connected with the Mongol court at Peking: Chao Meng-fu (1254–1322), Kao K'o-kung (late 13th century), K'o Chiu-ssu (1312–65). Others, shunning official life, prided themselves on independence: Ch'ien Hsuan (1235–90), Huang Kung-wang (1269–1354), Wu Chen (1280–*c.* 1354), Ni Tsan (1301–74). Wang Meng (d. 1385) held office for a time but was essentially an independent spirit. All had in common a rejection of the ideals of the immediate past.

The famous Italian Marco Polo, who was in China at that time, tells of the continuing glories of the old Sung capital Hang-chou, and there is evidence for the perpetuation under Buddhism of Southern Sung styles. But the great Yüan artists turned elsewhere, chiefly to the Five dynasties and Northern Sung. Wu Chen, in a beautiful painting of fishermen (Freer gallery, Washington, D.C.), was inspired by a later lost Ching Hao work. A Chao Meng-fu hand scroll (Palace museum) is a skeletal reflection of ink landscapes originated by Kuo Hsi. Ch'ien Hsuan is said to have drawn inspiration in his delicate studies of birds and flowers from Chao Ch'ang. Kao K'o-kung worked from the forms of Mi Fei's landscapes.

Labeled as the "four great masters," Huang Kung-wang, Wu Chen, Ni Tsan and Wang Meng were particularly responsible for the glorification of an ideal highly valued in Chinese aesthetics—the ideal of "literary men's painting" (*wen jen hua*). For these men painting was neither for money nor for a supporting patron. Painting was self-expression; expression of a self, however, which was allied to time-honoured Chinese ideals—freedom from officialdom, closeness to nature, respect for the past, the simple identification of the learned man with the farmer, fisherman and woodcutter.

Colour was used in Yüan paintings, but painting really communicated its meaning through ink. Landscapes might be empty of people, and enjoyment depended on appreciating the personal quality of the ink brush strokes of which they were made.

On one occasion, Ni Tsan said he did not care whether or not his bamboo looked like bamboo. He was merely expressing his own feelings. Writing such feelings on a painting also became popular at this time, and these moods were often shared by friends whose calligraphy filled the same painting. In this world of personal expression, a fragment, an "ink-play" (***mo-hsi***), a branch, a bamboo, a bird, an old rock or something transient was sufficient. Yet this seemingly offhand thing communicated by the skill of its brush and ink the constant nature of the painter.

Ming Dynasty (1368–1644).—In China's long history only three times have the Chinese themselves ruled for an extended period a united China. In this respect the Ming takes its place beside the Han and T'ang periods. Thus, back of much Ming painting was a confident, sure expression that reaffirmed the Chinese way of life. There were two "schools": the Wu (from Wu-hsien, modern Soochow) and the Che (from Chekiang province). Another classification codified past Chinese painting as either Northern (academic and precise) or Southern (individual and free). This period paralleled much of the western Renaissance, but it was hardly an age of exploration. In painting it was more properly a time of confident, sensitive evaluation of what it meant to be Chinese. At its close appeared detailed technical catalogues on painting methods, the writing of which extended into the succeeding dynasty: *Treatise on the Paintings and Writings of the Ten Bamboo Studios* (1633); *Mustard Seed Garden Painting Manual,* i (1679), ii and iii (1701).

Shen Chou (1427–1509), leading spirit of the Wu school, was the ideal scholar-painter-poet. He lived on the family estates near Soochow, but not as a recluse, for friends were constantly coming and going, and he himself was a delighted traveler. His style varied, for he was often imitating one or another of the old masters. Yet despite variety, Shen Chou had a sureness of brush stroke, a positive order to the composition, inventiveness and often delicate colour that told of his own powerful, subtle personality.

Few escaped Shen Chou's influence, yet the Wu school boasted other masters: Wen Cheng-ming (1470–1559), a man of Confucian integrity and Shen Chou's most famous pupil; Wen Cheng-ming's son Wen Chia (1501–83) and nephew Wen Po-jen (1502–75); the often delicate Lu Chih (1496–1576); and the bolder Ch'en Shun (1482–1539 or 1483–1544).

Although not orthodox scholar-painters, two great painters, T'ang Yin (1470–1523) and Ch'iu Ying (16th century), were linked to the Wu school as coming from Soochow. Both studied under the same master, Chou Ch'en, and both were influenced by academic strains of painting, particularly the skilful craftsmanship of Ch'iu Ying.

In the Ming, pure academic traditions were revived in the work of important court artists. The emperor Hsuan Te (reigned 1426–35) painted animals; Lu Chi (fl. 1488–1505), birds and flowers; Li Tsai (15th century), landscapes. The latter was reportedly a teacher of the renowned Japanese painter Sesshu. Tai Chin (15th century), as the acclaimed leader of the Che school, was the greatest talent in this general tradition. He often injected a sparkling vitality into the heritage of Ma Yüan and Hsia Kuei, as in two river scenes in the Freer gallery. His closest follower in court was Wu Wei (1459–1508), while Lan Ying (1578–1660) perpetuated Che traditions, with more personal variations, even beyond the end of the dynasty.

By this time the heart of scholarly painting had shifted from Soochow to Sungkiang and there centred on the personality of Tung Ch'i-ch'ang (1555–1636). Although appointed to high government posts, he and his followers Mo Shih-lung (fl. *c.* 1567–82) and Ch'en Chi-ju (1558–1639) sought to rephrase the very personal position of the scholar-painter.

Ch'ing Dynasty (1644–1912).—As the Ming was a proud period, its fall occasioned powerful painter reaction. Chu Ta (1626–*c.* 1705), a member of the Ming imperial family, is said either to have gone mad or feigned madness, acts which saved him from the necessity of conforming with the alien dynasty; and the independent, personally distorted forms of landscapes, birds, flowers, fish or rocks confirm this troubled state of mind. Likewise, Tao Chi (fl. *c.* 1660–1710), also a descendant of the Ming house, painted with a self-imposed "awkwardness" in which a conscious nonconformity became his own personal road to beauty. The basis of his aesthetic he described somewhat mysteriously in his writings, *Hua Yu Lu,* as resting on "a single stroke." These two had been monks; so also was a third independent painter, K'un Ts'an.

Others continued in conformity with political change. The "four Wangs" were famous exemplars of this more conservative tradition: Wang Shih-min (1592–1680), Wang Chien (1598–1677), Wang Hui (1632–1717), Wang Yuan-ch'i (1642–1715). All knew each other. Wang Shih-min, a friend of Tung Ch'i-ch'ang, was the teacher of Wang Hui and the grandfather of Wang Yuan-ch'i. The latter was a great court painter and curator of the imperial collections. All offered endless subtle interpretations and reinterpretations of landscape themes. Wu Li (1632–1718) and Yun Shoup'ing (1633–90) complete a characteristic grouping—the "six masters" of Ch'ing.

The ramifications of Ch'ing painting include other and more individual groups: "eight masters of Nanking" (17th century); "four masters of Anhwei" (17th century); "eight eccentrics of Yangchow" (18th century). Such was the Chinese love for careful classification.

Culture and refinement were maintained among countless other Ch'ing painters, but to the historian seeking meaningful new expression little has yet been revealed. Nor have modern Chinese, however skilled, spoken with an authority to command world-wide attention, and like 20th-century China itself, Chinese painting is linked to the uncertainties that confound an ancient tradition searching for recognition in a new world. (R. E.)

SCREENS

Because of their fragile nature, no screens of great antiquity have survived, but references to them were not wanting in ancient literature. Folding screens were known in China as early as the 2nd century B.C., at which period glass or mica panelings for them were noted as of much value; their transparent nature afforded both enjoyment of an outdoor view and shelter from the elements. Then, in the century preceding the Christian era, screens carved and inlaid with jade and other precious materials seem to have been produced. Already in this early period the art of painting screens was practised, for it was recorded that "Figures of Exemplary Women," illustrating the good or evil effects from right- or wrong-doing, were depicted on a screen. The Chinese artist Ts'ao Pu-hsing (3rd century), having dropped ink upon a screen while painting, turned it into a fly which Sun Ch'uan (A.D. 181–252) tried to brush away. Shih Hu (3rd century) made a folding screen covered with silk and painted with hermits, birds and animals, to which he added a long inscription. Chang Mo (4th century) depicted on screens the Buddhist saint Vimalakirti and a scene entitled "Beating Newly Woven Silk."

In passing, mention may be made of a 14-fold screen in the scroll attributed to Ku K'ai-chih (4th century), owned by the British museum, confirming the accuracy of contemporary accounts that screens consisted of numerous leaves, sometimes as many as 40. In the 5th century, Lu T'an-wei painted a lion and Fang Huai-chen the "Paragons of Filial Piety." Landscapes were not unknown in the early centuries as themes for screens for they are referred to in old poems and other writings. Screens of tapestry, embroidery, crystal and lacquer were also recorded in contemporary literature. Moreover, fine calligraphy inscribing moral teachings or auspicious sentiments was executed on screens from the 5th century, if not earlier. It is said that Fang Hsuang-ling (A.D. 578–648) collected precepts from all sources and inscribed them on screens which he distributed among his children as reminders of proper conduct.

T'ang Dynasty.—In the luxurious days of the T'ang dynasty, screens were in constant demand to adorn palaces and mansions. Those which were bedecked with gold and silver, pearl and tortoise shell, or those of fine textiles woven or dyed, bearing characteristic patterns, must have imparted great splendour to the habitations of rulers and princes.

Horses sent from foreign tributary peoples to the imperial stables furnished themes for screens, and a fabulous animal called *mo,* which was supposed to eat bad dreams, was deemed an appropriate subject for boudoir screens. Then, too, such noted painters as Pien Luan (who treated flowers and birds), Chang Tsao (pines and rocks) and Chou Fang (court beauties) and such accomplished calligraphers as Li Yang-ping and Chang Hsu all decorated screens. Some emperors had about them screens setting forth worthy and moral deeds performed by men of the past, in order that they themselves, as well as their subjects, might derive benefit from these constant reminders.

But for actual examples of T'ang art on screens it is necessary to turn to Japan, where, in the imperial repository called the Shosoin, at Nara, were preserved the personal belongings of the emperor Shomu, which were given to the Great Buddha of the Todaiji by the empress Komyo in 756. The list of donations mentioned 100 screens, to which several more were added, at three different times, between 756 and 758. Among this large number of screens were examples of Chinese, Korean or Japanese origin which included paintings of landscapes, palaces, figures and flowers; others of batik and of block-resist dyeing, figuring birds, animals and flowers; and, in addition, some screens on which Chinese ideographs formed the chief decoration. Of these, few remain, in whole or in part, among them no painted screens. Nevertheless, the pictorial accomplishments of the 8th century may be seen in this collection in a sixfold screen, in each leaf of which is shown a figure of a woman standing under a tree. The subject was originally worked in birds' feathers which disappeared, leaving only the preliminary drawings. Despite the sketchy nature of the drawings of the figures, trees and rocks, mature brush strokes may be detected, the importance of which was so much emphasized in the art of painting in the far east. The screen is probably Japanese, yet its conception and execution were based upon contemporary Chinese patterns.

There are also two sixfold screens in this imperial collection, the chief decorative features of which are Chinese inscriptions in large characters. One contains a precept for a ruler, consisting of 48 Chinese ideographs, each written twice, once in the *chuan* (seal) style and once in the *hsing* (running) style. The backgrounds of this screen are of silk dyed in green and red—alternating in the six panels—bearing designs of conventionalized clouds, birds, animals, trees, plants and rocks, all in white reserve. The screen is very likely Chinese, one of many gifts sent to the Japanese court from China, although it is said that at one time there was discovered upon it a Japanese date corresponding to the year 751—a fact lacking substantiation. In the orient, use of writing for a decorative scheme was no less common than was employment of a picture for the purpose. Indeed, good calligraphy was considered an art of as great importance as good painting, both being the result of brushwork and both presenting images of mental conception.

Sung, Yüan and Ming Dynasties.—In the Sung period, the practice among prominent masters of painting and inscribing screens was not abandoned. Painters such as Tuan Yuan, Yen Hsiao, Wen T'ung and Hsu Tao-ning are known to have expressed their art thus; and noted calligraphers applied their brushes after the time-honoured custom. The most significant branch of the art of the Sung period was the so-called Idealistic school of painting, which was closely followed by the artists of the Yüan and Ming dynasties. Painters of this school attempted to express in their works certain noble thoughts and ideals. A landscape painting, for example, was an essay which suggested the sublimity of nature and invited the beholder to identify himself with it. The inherent love of nature of the orientals, coupled with the teaching of Ch'an (Zen), produced artists who showed remarkable aptitude for depicting natural phenomena. Artists developed marked individuality and their paintings were characterized by purity and suggestiveness. For their themes, the painters of the Idealistic school chose, besides landscapes, birds, animals and even withered trees and weathered rocks, all of which ordinarily were treated in monochrome with china ink.

Unfortunately there exists no example of the typical art of the Sung as applied on screens, nor are there any screens dating from the subsequent Yüan and Ming dynasties, in both of which it is recorded that painted and inscribed screens were produced. It is possible, however, that some of the paintings coming from these periods, mounted as single hangings, were once panels of folding screens.

Ch'ing Dynasty.—During the Ch'ing dynasty painting on screens was practised, as indicated by the presence of occasional examples dating from the last few centuries. But it is in screens of applied art that the period excels. As already mentioned, the application of the minor arts to screens began in ancient China. The best known among such screens of recent centuries are the so-called Coromandel screens which were made of wooden panels finished with a coat of lacquer, through which designs such as landscapes, figures, flowers, auspicious emblems, etc., were incised and filled with various thick, opaque water colours—a technique known from the Ming dynasty. A large portion, however, of the existing specimens are of the 17th to 19th centuries. "Coromandel" has no bearing upon their provenance but indicates that these screens of Chinese origin were shipped to European countries from the coast of Coromandel.

Other screens in the category of lacquer are those with lacquered panels (sometimes coated with white oil paint) decorated in gold lacquer; and those of red carved lacquer. Screens of carved teakwood construction set with jade and porcelain plaques, or paneled with silks, tapestries or embroideries, are occasionally seen.

(K. T.; X.)

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(R. E.)

CHINESE PHILOSOPHY includes many systems of thought which have developed within four main periods: ancient, to 221 B.C.; middle, from 221 B.C. to A.D. 906; modern, from 906 to the end of the 19th century; and contemporary.

ANCIENT PERIOD: THE CLASSICAL SCHOOLS (TO 221 B.C.)

The most significant development of the ancient period of Chinese thought was the triumph of humanism. During the Shang dynasty (*c.* 1766–*c.* 1123 B.C.) spirits, rather than man, were considered to be the controlling forces in human affairs. There were many kinds of spirits, the highest of which was the Lord (Ti or Shang Ti); they could disperse rewards and punishments, and sacrifices were offered to them. Ancestors, who constituted a special class of spirits, served as mediators. During the Western Chou period (*c.* 1122–771 B.C.), however, man gradually came to replace the spirits as master of his destiny. Though divination was still common, spirits were regulated into a hierarchy and put under the control of sorcerers and witches. The Lord became the nonanthropomorphic Heaven (T'ien). Ancestors rose to become Heaven's "counterparts." The Mandate of Heaven by which dynasties were established and destroyed was no longer dependent on the Lord's pleasure but on man's virtue. The tide of humanism was definitely rising.

Vigorously advancing this tide were the "100 schools" of thought that flourished from the 6th through the 3rd century B.C. and included economists, military strategists, and diplomatists as well as philosophers who traveled from one feudal state to another, advocating their theories, challenging their rivals, and trying to persuade the feudal lords to make them prime ministers. The period was characterized by great variety of opinion, critical spirit, and freedom of expression—a climate remarkably similar to that of ancient Greece. In China, however, the dominant notes of the schools were man and society.

The six schools discussed below were the most important among the 100. With the "burning of books," which was intended to assure the supremacy of the Legalists, in 213 B.C., the Moist and Logical schools virtually disappeared. Others, which had been absorbing the Yin-Yang philosophy, carried on.

Confucianism.—*Confucius' Teaching.*—The tide of humanism reached its greatest height in Confucius (*q.v.*)—probably the first Chinese philosopher and the most learned man in the first part of the Eastern Chou era (771–256 B.C.). He was born in what is now Shantung, north China, into the K'ung family (hence "Grand Master K'ung," or K'ung Fu-tzu, latinized as Confucius; *tzu*, also spelled *tze* and *tse*, is the Chinese term meaning "philosopher" or "scholar"). The family had a noble background but at the time was poor. Bereft of his father at about the age of three, Confucius was brought up by his mother. He was married at about 19 and had a son and a daughter. After holding some minor public offices, he chose teaching as a career. At about 51, he became minister of justice of his native state, Lu, but soon resigned because the ruler failed to carry out reforms he had suggested. He then began 13 years of travel from state to state, with his pupils, to offer advice and assistance in the cause of reform. Finally, disappointed, he returned home to teach and to write.

Man is the keynote of Confucius' teaching. "It is man that can make the Way [*tao*] great," he said. He taught the "three universal virtues" of wisdom, humanity, and courage, which include filial piety, brotherly respect, righteousness, propriety, good faith, liberality, diligence, generosity, sincerity, humility, self-respect, loyalty, eagerness to learn, carefulness in thinking, friendliness in appearance, earnestness in handling affairs, and all possible virtues. He called the man of perfect virtue the "superior man" or "gentleman." Confucius radically changed the meaning of the term gentleman to refer not to birth but to character.

According to Confucius, individual goodness is incomplete unless it serves society. The Confucian doctrine of the Golden Mean signifies not merely moderation but the balanced development of the individual and society. A gentleman, "wishing to establish his own character, also establishes the character of others, and wishing to be prominent himself, he also helps others to be prominent." This is humanity (*jen*), Confucius' most discussed subject, which involves both conscientiousness (the individual) and altruism (society). This is the positive side of the Confucian Golden Rule. The negative side was stated by Confucius as "Do not do to others what you do not want them to do to you."

In government, Confucius taught rule by virtue and moral example instead of by force and punishment. Righteousness is the keynote in both self-discipline and social organization. He sharply contrasted the "superior man," who is guided by righteousness, and the "inferior man," who is motivated by profit. For the regulation of behaviour, he emphasized rites, ceremonies, and other rules of conduct, not merely to restrain activities but also to express the proper state of mind. Names, too, are to be "rectified," for names must correspond to each other the realities they represent; *e.g.*, a man must not be called a king unless he possesses the true qualities of a king.

This intense interest in man and society should not be understood as a humanism that ignores Heaven. On the contrary, Confucius glorified Heaven as "great" and "august." He said that at 50 he knew the will of Heaven and that he obeyed the Mandate of Heaven. But Heaven to him was a moral reality, the source of the moral law, and not an anthropomorphic god who makes decisions for man and interferes with his actions. Heaven reigns but does not rule.

Tseng-tzu and Tzu Ssu.—Confucianism after Confucius developed in two different directions, one social and political, the other psychological and religious, best represented by the *Great Learning* (*Ta-hsüeh*) and the *Doctrine of the Mean* (*Chung-yung*), respectively. The former, attributed to Confucius' pupil Tseng-tzu (505–*c.* 436 B.C.), teaches the "three items" of "manifesting the clear character of man," "loving the people," and "abiding in the highest good" through the "eight steps": investigation of things, extension of knowledge, sincerity of the will, rectification of the mind, cultivation of the personal life, regulation of the family, national order, and world peace. In other words, it teaches the central Confucian doctrine of humanity (*jen*) in application. Here learning is both moral and intellectual. The procedure, from investigation of things to world peace, involves the careful distinction of what is to be done first and what is to be done last.

The *Doctrine of the Mean* has been attributed to Confucius' grandson Tzu Ssu (483–402 B.C.?). It and the *Great Learning* may be later documents, but most likely they contain the doctrines of Confucius' immediate followers. By the Mean here is meant not only moderation, which Confucius often taught, but also the equilibrium of man's nature before it is activated and harmony after it is activated. This nature, endowed by Heaven and, ideally, an expression of the Way of Heaven, is characterized by sincerity of realness (*ch'eng*), which is the quality that transforms and completes things and brings man and Heaven into unity. It is this quality that makes possible the superior man, who is at once wise, humane, and courageous, and the ideal society, in which the "five human relations" are fulfilled: affection between parents and children, righteousness between ruler and subordinates, distinction of function between husband and wife, order between elder and the young, and faithfulness among friends.

Mencius.—These doctrines were largely continued by Mencius (*q.v.*), who at the same time advocated an entirely new doctrine of human nature. Confucius held that in nature men are alike and that they become different through practice. Mencius maintained that man's nature is originally good, for, he said, everyone has in him the "four beginnings" of humanity, righteousness, propriety, and wisdom. Therefore man has innate knowledge of the good and innate ability to do good, as evidenced by a child's natural love for its parents. If one "develops his mind to the utmost," he can "fulfill his destiny." Moral evil and human failure are due to self-neglect, lack of purpose, bad environment, or poor training. Serious efforts must therefore be made to recover our original nature, and learning is none other than to "seek for the lost mind." By developing the original nature, everyone can become a sage, since he is originally "complete in himself." All men are equal.

Since human nature is good, love is an inborn moral quality. But Mencius insisted that the practice of love must begin with one's family and bitterly opposed the Moist doctrine of universal love, in which no special affection is shown one's parents. For this reason he often advocated humanity and righteousness together—indeed he was the first to do so—because righteousness is necessary to enable us to make the necessary distinctions. The two moral virtues are to be the guiding principles in government also. They characterize a "humane government" or the "kingly way," whereas force and profit are the "way of despots." Evil rulers should be replaced, by revolution if necessary.

Hsün-tzu.—Mencius may be said to have represented the idealistic wing of ancient Confucianism while Hsün-tzu (*q.v.*) represented the naturalistic wing. Man's nature, he said, is originally evil, for his desires, if unchecked, inevitably lead to greed and conflict. Goodness is acquired. We cannot rely on the moral nature of man for individual perfection and social order—discipline is necessary, through education, ceremonies and music, law, and the "rectification of names." In his concept of Nature he came close to the Taoists, and in his emphasis on law he tended toward the Legalists; in fact, two of the most powerful Legalists were his pupils. Hsün-tzu and Mencius, in their radical difference, have been compared with Aristotle and Plato, respectively. Possibly Hsün-tzu drew more inspiration from the *Great Learning* while Mencius was more influenced by the *Doctrine of the Mean*. They are agreed, however, in the perfectibility of all men, in humanity and righteousness as supreme virtues, in the necessity for education, and in "humane government." In both of them, as in Confucius and his immediate followers, man is the centre and society the circumference.

Taoism.—This humanistic philosophy was diametrically opposed by Taoism. For this school, the Way (Tao) is not the way of man but the way of Nature. Tao is the course, the principle, the substance, and the standard of all things, to which all of them must conform. It is "nonbeing" in the sense that it is above all being. It is lowly and weak, like water, but is in reality the most honoured and strong, for it benefits all things and overcomes the hardest of them. It "takes no [unnatural] action" and yet all things transform themselves. In short, its concept of life is not man-centred but Nature-centred. When this Way functions in things, it becomes their virtue (*te*), their power or character. By following Nature—that is, by "taking no action"—one will gain contentment, enlightenment, and peace. One will have the virtues of weakness, quietude, spontaneity, simplicity, unity, purity, and constancy, for these are the characteristics of Nature. Government should govern by noninterference. Wars, conventions, and ceremonies are all destructive; they are not natural. These teachings are embodied in the Taoist classic entitled *Lao-tzu* or the *Tao-te ching* ("Classic of the Way and Its Virtue") traditionally attributed to Lao-tzu (*q.v.; see* also TAO-TE CHING).

Chuang-tzu (*q.v.*) carried this naturalism to the extreme. To him, Tao is not merely nature, it is "self-transformed" nature. All things change at all moments and are in opposition to one another. But Tao transforms and combines them into a unity, the One, in which alone harmony and happiness can be found. Therefore the ideal man, the "pure man," will "forget all distinctions," be a "companion of nature" and enter the realm of the Infinite—that is, the life of spiritual freedom. In Taoism, then, the goal is freedom, to be achieved in the realm of Nature.

In many ways Confucianism and Taoism stand at opposite poles. While Confucianism emphasizes being, doing something, human relations, social adjustment, transforming others, and the importance of ceremonies and music, Taoism emphasizes nonbeing, taking no action, the individual, peace of mind, self-transformation, and the rejection of ceremonies and music. But both schools teach such basic virtues as true humanity and genuine wisdom, oppose the use of force and punishment, denounce profit as motivation, esteem individual integrity and social harmony, and exhort people to become sages.

Moism.—The Moist and the Confucian schools were the two most prominent in ancient China. The interest of the Moists, like that of the Confucianists, was focused on human society, but, unlike the Confucianists, they subordinated the individual to the group. Their leader, Mo Ti (*q.v.*), taught "promoting benefits and removing evil," and to this end he praised thrift and denounced elaborate ceremonies. Above all, he condemned war and worked actively to prevent it; he also designed and built some defense installations. Rather than seek war, one should love the parents and the country of one's fellow men as one's own, for Heaven loves all and benefits all, and one should follow Heaven's will. These doctrines of universal love and "obeying the will of Heaven" make Mo Ti the most active promoter of religion in ancient China. Perhaps he even founded a religion, for his followers were organized into a sort of religious secret society. But "benefits" were always his goal. Thus he attacked the belief in fate as unbeneficial but approved the belief in spirits because he thought they helped people to behave properly. He believed that politically the greatest social benefits are to be derived when people "agree with their superiors."

The Logicians.—This school, small and uninfluential, was chiefly interested in such metaphysical and epistemological problems as existence, relativity, space, time, quality, and causes. Its discussion of names and actuality was purely logical and not concerned with their social or moral significance or political effect, as was the case in other schools. Their outstanding representatives, Hui Shih (380–305 B.C.?) and Kung-sun Lung (320–250 B.C.?), held opposite views, the former emphasizing change and the relativity of things, the latter emphasizing universality and permanence and the absolute character of things. Though their logical concepts were primitive, the school was unique in its purely intellectual interests.

Legalism.—Like the Moists, the Legalists valued society above the individual, but they considered that man's nature was basically evil and should therefore be controlled through political measures and "the rectification of names and actualities." Consequently, different Legalists variously advocated law, statecraft, or power, and Han Fei-tzu (d. 233 B.C.) synthesized all these ideas. The Legalists emphasized the present, revolted against antiquity, and taught the application of objective, standardized, specific, and written laws to all without discrimination. They were realists and totalitarians; they put totalitarian measures into practice in the Ch'in state and helped establish the Ch'in dynasty (221–207 B.C.) as the first united empire in Chinese history.

The Yin-Yang School.—The Yin-Yang doctrine simply teaches that all things and events are products of two elements, forces, or principles: *yin*, which is negative, passive, and weak, and *yang*, which is positive, active, and strong. This theory is associated with that of the Five Agents or Elements of Metal, Wood, Water, Fire, and Earth, which succeed one another. Probably the two theories were combined by the school's chief representative, Tsou Yen (340–260? B.C.) The Yin-Yang philosophy, though crude, was extremely influential. It conceives a universe of dynamic forces, always changing but well-ordered and governed by laws in which both contradictions and harmony exist and both unity and multiplicity prevail. Things and history move in cycles, and man and Nature form a unity, both governed by the same laws. This philosophy penetrated practically all ancient schools.

MIDDLE PERIOD: THE DEVELOPMENT OF CONFUCIANISM, TAOISM, AND BUDDHISM
(221 B.C.–A.D. 906)

Confucianism.—During the first decade of the Han dynasty (202 B.C.–A.D. 221), Taoism, Legalism, and Confucianism rivaled each other as the state philosophy. But finally, in 136 B.C., Confucianism became the state ideology, and the Confucian "supremacy" dominated Chinese government, society, education, and literature until the 20th century. In philosophy, however, Confucianism was practically dormant until the 11th century, although three developments are worth noting.

The first is the persistent Confucian interest in human nature. Confucianists offered a variety of theories—that nature is good while feelings are evil (Tung Chung-shu, 179–104 B.C.), that nature is evil while feelings are good (Liu Hsiung, 53 B.C.–A.D. 18), and that it is good in those above average, evil in those below average, and mixed in those of the average (Wang Ch'un [27–97?], Hsün Yüeh [148–209], and Han Yü [*q.v.*]). These theories were attempts to synthesize the opposite theories of Mencius and Hsün-tzu and to harmonize the *yin*, which corresponds to human feelings, and *yang*, which corresponds to human nature.

The second development is the philosophy of the *Book of Changes* (*I Ching*). Attributed to Confucius and earlier sages, this Confucian classic attained philosophical importance only in the Han dynasty. According to its theory, in the beginning there is the Great Ultimate (*T'ai-ch'i*). It engenders *yin* and *yang*, which in turn give rise to the four forms, referring to major and minor *yin* and *yang*. But the word for form (*hsiang*) also connotes symbols, patterns, and ideas. This means that from the interaction of the two cosmic forces, all patterns, ideas, systems, and culture are evolved. Change is constant, simple, and easy, and whatever issues from it is good. In certain respects, change seems to go in cycles, but the far more important aspect is its progressive direction, leading to the development of society, morality, and civilization. The word "spirit" in the book denotes not spiritual beings but natural forces.

The third development was the philosophy of Tung Chung-shu (179–104 B.C.), to whom the universe is not only a well-coordinated system as in the Yin-Yang School, or a process of dynamic transformation as in the *Book of Changes*, but an organic whole. In his belief, things are related not only generally but also in exact details; and things not only change but also activate each other. Man and Nature correspond and can influence each other because the same *yin* and *yang* forces govern them. In short, man is the microcosm, Nature the macrocosm. In Tung Chung-shu's system, human nature and feelings correspond to *yang* and *yin*, and thus Confucian ethics has a basis in nature.

These three developments are characteristic of the syncretic spirit of the period between the beginnings of the Han dynasty (202 B.C.) and A.D. 419, when Confucianism, Taoism, and other currents of thought crossed one another. By the 8th century, however, Confucianism was so weak that Han Yü had to defend the Confucian "way" against that of Buddhism. In this middle period, the light of philosophy shone not from Confucian quarters but rather from Taoism and from Buddhism.

Taoism.—Taoism in the middle period developed more as a religion than as a philosophy, but several philosophical developments may be recounted. From the 4th century B.C. to the 3rd century A.D., the most prominent Taoist philosopher was Huai-nan-tzu (Liu An; d. 122 B.C.). Though his ideas are mostly reiteration and elaboration of Lao-tzu and Chuang-tzu, he kept the fire of Taoism burning at the time when Confucianism had assumed the dominant and exclusive role in government and in the realm of thought. He made the concept of Tao more concrete and the Taoist cosmology more definite, conceiving Tao as originating "vacuity," which produced the universe, which in turn produced *yin* and *yang* and the myriad things. Under the influence of the prevailing syncretism, he incorporated laws, ceremonies, and Confucian ethical ideals in his system.

In the 3rd and 4th centuries Taoism found several forms of expression. There was the fatalistic Taoism of the *Lieh-tzu* and especially of its "Yang Chu" chapter, according to which the universe was mechanical and life transitory and therefore meaningless, to be gone through with pleasure while it lasts. There was the transcendental Taoism of those who sought escape from the troublesome world by engaging in "light conversations" and unconventional living. More positive developments are found in the metaphysics of Neo-Taoism, in which the earlier Taoist concept of nonbeing (*wu*) was transformed into the originally undifferentiated or pure being and also interpreted to mean the real nonbeing instead of the nameless. Significantly, the sage was considered not a person who deserted the world but one of social and political achievements, that is, "sageliness within and kingliness without." More significantly, Confucius, not Lao-tzu, was looked upon as the model.

At the same time, Ko Hung (254–334?), also called Pao-p'u-tzu, attempted to combine Taoist philosophy and religion, on the one hand, and Confucianism and Taoism, on the other. By this time, the Yellow Emperor-Lao-tzu cult had become the popular Taoist religion for the ignorant masses (*see* TAOISM: *Religious Taoism: The Way of the Yellow Emperor*), utilizing Lao-tzu's and Chuang-tzu's isolated sayings about everlasting life to reenforce its primary purpose, the search for immortality on earth. For this belief Ko Hung provided theories, and for the search he set forth concrete formulas for the practice of alchemy. But for personal cultivation he advocated both Confucian and Taoist ethics, and in government he even emphasized Confucian ceremonies. He honoured both Lao-tzu and Confucius as sages. His contribution to the Taoist religion was substantial, that to Taoist philosophy was negligible. Taoist philosophy definitely declined and eventually became a handmaid to Buddhism, though it was not without significant influence on both Buddhism and later Confucianism.

Buddhism.—Many schools of Buddhist philosophy were introduced into China from India. At first, in the 4th century, Buddhist philosophers interpreted Buddhist thought in Taoist terms in an attempt to "match" it to Chinese philosophy. From the 6th century through the 8th, various Buddhist philosophies flourished and developed in China. The Middle Doctrine school (Madhyamika) for example, evolved the doctrine of "two levels of truths," namely, "common truth" and "absolute truth," both of which are to be synthesized as the Absolute or Ultimate Void. Again, the Idealistic school (Yogacara) divided the mind into eight consciousnesses, the last of which contains "seeds" or effects of previous deeds and thoughts which affect future deeds and thoughts, thus producing "transformations" until, with perfect wisdom, all transformations are transcended. These and several others were Indian philosophies that took root in Chinese soil. As for indigenous developments, three phases may be briefly related.

First was the revolutionary doctrine of universal salvation. Hitherto, it had been believed that certain persons, being evil in nature, could not be saved. The revolutionary doctrine that Buddha-nature was all-prevalent, that all people had it, and therefore that all could be saved, eventually became the central teaching of Mahayana Buddhism in eastern Asia. The philosophical basis of this doctrine is to be found in the T'ien-t'ai and Hua-yen schools (Tendai and Kegon in Japan), both indigenous to China. The T'ien-t'ai propagated the doctrine of "threefold truth," to the effect that all things are void because they are dependent on causes, but nevertheless they enjoy temporary existence. Being both void and temporary is the mean, and all three are really one. The result is a "one-in-all and all-in-one" philosophy, which fully supports the teaching that Buddha-nature is in all. (*See* also CHIH-I.) Similarly, the Hua-yen school taught that all things are coexistent and interrelated in a "universe of one truth," all arising at the same time and finally revolving in Thusness, the Absolute Reality, in which fact and principle are harmonized. In short, "one is all and all is one."

However, the most significant development of Buddhism in China was the Meditation school (Chinese, Ch'an; Japanese, Zen [*q.v.*]). Flourishing from the 5th through the 9th century, and starting with the two basic propositions that Buddha-nature is in all and that the Buddha-mind is identical with the human mind, it advocates various ways of penetrating the Buddha-mind, especially "absence of thought," "ignoring our feelings," and "letting the mind take its own course." The most important method, however, is meditation, in which one "directly points to the human mind," "sees his own nature and becomes Buddha," and "achieves salvation in this very body." Ch'an philosophy was divided into a Southern and a Northern school, emphasizing respectively abrupt and gradual enlightenment. The main point was that the mind should be so clear, pure, quiet, and sharp that it can apprehend the great truth of this fleeting universe, and that by thus seeing the Buddha-mind salvation can be achieved. This new horizon, simple as it may appear, profoundly influenced Chinese poetry, painting, religion, and, above all, philosophy, contributing in no small measure to the emergence of Neo-Confucianism.

During the whole course of Buddhist development, there was virtually no cross-fertilization of Buddhist and Confucian thought. Some Buddhists commented on Confucian classics. On the side of the Confucianists, Han Yü attacked Buddhism but Li Ao (fl. A.D. 798) fell under its influence to some extent. Taoism, on the other hand, affected Buddhism appreciably. The Taoist concepts of being and nonbeing were taken over to characterize the Idealistic and Middle Doctrine schools, respectively. The Neo-Taoist discussions on one and many definitely prepared for the emergence of the Buddhist "one is all and all is one" philosophy. And the Zen methods of absence of thought, etc., are literal borrowings from early Taoism.

MODERN PERIOD: NEO-CONFUCIANISM (906–1900)

As popular religions, both Buddhism and Taoism continued to thrive in the 20th century, but as philosophies they disappeared around the 11th. By that time, however, both had made a deep imprint on Chinese thought, and their profound metaphysics and subtle psychology had forced Confucianism to find metaphysical and epistemological foundations for its ethics. These new foundations are what make Confucianism new in the 2nd millennium of the Christian era.

The two basic concepts of Neo-Confucianism are nature and principle—nature, especially human nature, because Confucianism was still primarily concerned with man; and principle because the Neo-Confucianists rejected the Buddhist void and Taoist nonbeing as negative, vague, and mystical, and for them substituted principle (*li*, "law," "reason"), which they regarded as positive, concrete, and rational.

Chou Tun-yi, Chang Tsai, and the Ch'eng Brothers.—The Neo-Confucian philosophy was formulated by Chou Tun-yi (Chou Lien-ch'i, 1017–73), generally considered the founder of Neo-Confucianism. Chou conceived of the universe as proceeding from the Non-Ultimate to the Great Ultimate which engenders *yin* and *yang* and the Five Agents and through them all the transformations and good and evil. According to him "*yin* and *yang* are fundamentally one. Consequently, the many are [ultimately] one and the one is actually differentiated in the many." Furthermore, "the sage settles affairs by the principles of the Mean, correctness, humanity, and righteousness." In this way he assimilated the Taoist nonbeing into Neo-Confucian metaphysics, coupled naturalistic metaphysics with humanistic Confucian ethics, and laid the pattern for later Neo-Confucianism.

Chang Tsai (Chang Heng-ch'ü, 1020–76) identified material force (*ch'i*) with the Great Ultimate. He discarded both *yin* and *yang* and the Five Agents as generative forces, considering *yin* and *yang* as merely two aspects of material force and as such basically one. As substance, before consolidation takes place, material force is the "Great Vacuity." As function, in its activity and tranquillity, integration and disintegration, and so forth, it is the "Great Harmony." But the Great Vacuity and Great Harmony are one. In reality, then, the universe is one, but in all the integrations and disintegrations, its manifestations are many. In the realm of ethics, humanity (*jen*) as the general virtue is one (that is, love for all), but in its various manifestations (that is, in one's various human relations) it becomes many, such as filial piety toward parents, respect for the elder brother, etc. In thus providing a rational explanation for the relationship between the one and many, Chang exerted a tremendous influence on later Neo-Confucianism.

Both Chou and Chang are essentially rationalistic in their approaches. It was the Ch'eng brothers (Ch'eng Hao, also called Ch'eng Ming-tao, 1032–85, and Ch'eng Yi, also called Ch'eng Yi-ch'uan, 1033–1107), who first built their philosophy primarily on the doctrine of principle (*li*). As understood by the brothers, principle is self-evident and self-sufficient, extending everywhere, governing all things. It is universal truth, universal order, universal law, a universal process of creation and production. And it is dynamic and vital. All things are caused by it, and all things possess it. Even a blade of grass has it. Whatever issues from it is good. When it is endowed in things and men, it becomes their nature. Since its endowment in man is the best, man's nature is originally perfectly good.

The way to discover principle is to investigate things. This point was particularly emphasized by Ch'eng Yi, who advocated a number of methods of investigation—induction, deduction, studying history, reading books, handling human affairs, etc. "Self-cultivation requires seriousness; the pursuit of learning depends on the extension of knowledge," he said. This twofold method of intellectual effort and moral cultivation bears a striking resemblance to the Buddhist dual emphasis on meditation and wisdom. Ch'eng Hao emphasized more strongly the idea of production and reproduction as the chief characteristic of the universe. He saw the spirit of life in all things. To him, this creative quality is *jen*. For both brothers, the man of *jen* "forms one body with Heaven and Earth." The basic Confucian virtue is now extended to include the entire universe.

Chu Hsi.—Chou, Chang, and the Ch'engs were the most important Neo-Confucianists of the Northern Sung dynasty (960–1126). The major ideas characteristic of the Neo-Confucian philosophy of this period—the Great Ultimate, principle, material force, the nature of man and things, "investigation of things," and *jen*—were all developed, systematized, and synthesized by Chu Hsi (*q.v.*), the most outstanding Neo-Confucianist.

According to Chu Hsi, the Great Ultimate has no corporeal form but consists of principle. All actual and potential principles are contained in the Great Ultimate; it is complete in all things as a whole and in each thing individually. It is the principle of things that they be actualized; and actualization requires, on the one hand, principle (which is incorporeal, universal, eternal, a priori, always good) and, on the other, material force (which is corporeal, individual, changing, a posteriori, and involves both good and evil), as reality and function, respectively. Principle and material force are directed by the "mind of the universe," which is the universe itself. In man this mind is divided into the moral mind, which is the principle of man's original nature, and the human mind, which is the principle of original nature mixed with physical endowment and human desires. It is the duty of man so to harmonize his nature and desires that his human mind is transformed to become the moral mind. Such transformation is possible because all human minds are essentially the same as the mind of universe and because it is the nature of principle to be realized.

The realization and understanding of principle depends on the "investigation of things," through deduction and induction and through objective observation and intuitive understanding. Understanding of principle leads to the fulfillment of man's nature, which in turn leads to the "establishment" of his destiny. The greatest understanding to be achieved is that of love, which is the mind of the universe expressed in the unending process of production and reproduction of things; the basis of all human goodness; and the key to individual perfection and an ideal society.

The influence of Chu Hsi's philosophy is paralleled in Chinese cultural history only by that of Confucius and Mencius; for many centuries it dominated intellectual life. But strong opposition arose even in his own time, notably from Lu Chiu-yüan (*q.v.*; Lu Hsiang-shan), according to whom there is no distinction between principle and material force. Man's mind is not the function of his nature but principle itself. Lu conceives the mind to be morally self-sufficient and endowed with innate knowledge of the good and innate ability to do good. It is one and insoluble. It fills and is identical with the universe. As such it is identical with principle. It is originally good. Desires are part of it and, therefore, are not different from principle. To investigate things means to investigate the mind. Lu is thus opposed to Chu Hsi at every turn.

Wang Yang-ming.—This line of thought was continued and developed by Wang Yang-ming (*q.v.*; Wang Shou-jen), who, like Lu Chiu-yüan, equated principle with the mind, by which he meant essentially the will. There would be no principle or things if the mind were not determined to realize principle. If the will to be filially pious is sincere, for example, the principle of filial piety will become evident and the fact of filial piety will be realized. Thus things or facts and the mind are the same. Investigation of things does not mean rational and objective study of external objects but "to eliminate what is incorrect in the mind so as to preserve the correctness of its original substance." Since the mind is the same as principle, and principle is good, man is by nature good and therefore has innate knowledge of the good. It is his duty to extend this innate knowledge. If he is true to his nature, he cannot help doing so, for just as he has the innate capacity to know good, so he has the innate ability to do good. Knowledge and action form a unity.

According to Wang Yang-ming, knowledge is the beginning of action and action the completion of knowledge. No one really knows food unless he has tasted it or filial piety unless he has practised it. The ultimate extension is to "form one body with Heaven and Earth," *jen* in the broadest sense. In this simple but bold philosophy, Wang rejected the formalistic, narrow, and over-rationalistic philosophy of Chu Hsi and advocated sincere convictions and forthright action originating from one's own intuitive mind. For about 150 years his school provided China with strong intellectual stimulation and moral vigour. About the beginning of the 17th century, however, the movement lost its vitality and gradually degenerated.

17th–19th Centuries.—The reaction against the Neo-Confucian rationalism of Chu Hsi and the Neo-Confucian idealism of Wang Yang-ming was particularly strong in the 17th and 18th centuries. It advanced in three stages. First, it was expressed in the critical spirit of the 17th century, when Confucian scholars refused to accept anything, much less orthodox interpretations of Confucianism, unless supported by objective, concrete evidence. Then came the practical emphasis in the teaching of Yen Yüan (*q.v.*) and others who stressed the point that theories are empty unless put into practice. Finally, Tai Tung-yüan (Tai Chen; 1723–77) carried the movement to the philosophical level. He perpetuated the traditional idea that the greatest characteristic of the universe is production and reproduction, but he insisted that this process involves human desires without which there can be no production. Hence, desires are good and intrinsic to man's original good nature.

This practical and critical spirit continued to be strong in the 19th century, expressed in two directions—in historical and textual criticism and in the new doctrine of "Chinese learning for substance and Western learning for practical application." Confucianism was now matched with Western thought but was still held to be superior.

However, the practical and critical spirit finally led to the radical political reforms of 1898 under the leadership of K'ang Yu-wei (*q.v.*), the last of the great Confucianists. K'ang maintained that all previous interpretation of Confucianism was wrong, that Confucius was primarily a reformer and that his fundamental doctrine of history was that of progress. Undoubtedly the Western tide of reform had reached China, and Confucianism could not but be transformed. Nevertheless, there was nothing new philosophically in 19th-century Confucianism.

CONTEMPORARY PERIOD

In the 20th century, Chinese philosophy has been concerned with both the introduction of Western thought and the reconstruction of traditional systems.

Western Thought.—The introduction of Western philosophy by mid-20th century had gone through three stages. The first was that of noncritical borrowing. In the first three decades of the century, the works of Darwin, Spencer, etc., were translated, and the doctrines of Haeckel, Kropotkin, Nietzsche, Schopenhauer, Bergson, Eucken, Descartes, James, and others were successively introduced, especially during the "intellectual revolution" which started in 1917. This revolution, led by Hu Shih (*q.v.; see* also CHINESE LITERATURE: *The Literary Revolution and After*), led to the second stage, that of critical selection of Western philosophies. Hu Shih's own choice was pragmatism (*q.v.*), which he strongly propagated. Then in the "polemic of science *v.* life" in the 1920s, leading Chinese intellectuals debated the question whether science could form the basis of a philosophy of life. Finally, in the third stage, various Western systems were established. The strongest of these, of course, was Marxism. Both mechanistic materialism and dialectical materialism (*q.v.*) were promoted in the 1920s and 1930s. In the 1930s Chang Tung-sun (1886–   ) formulated his epistemological pluralism on the basis of Neo-Kantianism, which commanded profound respect among Chinese scholars. Similarly, Chin Yüeh-lin (1894–   ), as the outstanding representative of new realism, was looked upon as a brilliant leader of a new philosophy. Along with these developments, different Western systems—whether logic, aesthetics, moral philosophy, or the systems of Whitehead, Royce, or Carnap—were advocated by earnest if small groups with genuine conviction. All these developments were overshadowed if not terminated by the triumph of materialism.

Reconstruction of Traditional Philosophies.—This was undertaken by both Buddhists and Confucianists. In the 1920s and early 1930s, Ou-yang Ching-yu (1871–1943) sought to revive Buddhist idealism precisely as it had been about ten centuries before. His opponent, Abbot T'ai-hsü (1889–1947), preferred to transform Buddhist idealism with Western thought. Since he was neither a philosopher nor a student of Western philosophy, T'ai-hsü's movement resulted more in practical religious reforms than in intellectual renovation, and, along with Ou-yang's, it declined in the 1930s.

At the same time, Confucianism was revived and reconstructed in two different directions, and in the 1930s these became the two most extensive intellectual currents in China. One direction was represented by Fung Yu-lan (1895–   ), trained in the West, who formulated his "new rationalism" on the basis of the four concepts of principle, material force, the substance of Tao, and the Great Whole. According to him, a thing must follow principle but principle does not have to be actualized in a thing. Material force, being the material of actualization, has the characteristic of existence but itself does not exist either in principle or in the actual world. The concept of Tao means a "universal operation," the universe of daily renewal and incessant change. Finally, the Great Whole, in which one is all and all is one, is the general name for all and not an assertion about the actual world. It is the absolute. In short, all the four concepts are but logical concepts. Basically, Fung's philosophy is a combination of Neo-Confucianism and Western realism and logic. He gave Neo-Confucianism a modern character.

Hsiung Shih-li (1885–   ), on the other hand, attempted to revive and reconstruct the idealistic Neo-Confucian philosophy and the philosophy of the *Book of Changes*. He expressed his "new idealism" in terms of change, which, in its perpetual expansion and contraction, is, he said, the expression of the Cosmic Mind. A former Buddhist, he was influenced more by Buddhism than by Western philosophy, but his Neo-Confucian philosophy was diametrically opposed to Buddhist idealism.

With Fung and Hsiung, especially the former, Chinese philosophy was approaching maturity, since they had transformed both traditional and Western philosophies into something new. Unfortunately, the growth of their philosophies was hindered by World War II and finally had to yield to Communism in 1949. By this time, in China, Communism itself had gone from Marxism through Leninism to Maoism and had become the state ideology. The ideology does not prohibit the study of traditional Chinese philosophy; indeed, books and articles have been published about it, research conducted, and discussions carried on. Many of these were devoted to Confucius and Lao-tzu.

From these activities certain lines of thought have gradually emerged. First, the study of Chinese philosophy must be guided by Marxism. Second, the history of Chinese philosophy is in no way unique but part of the history of philosophy of the whole world and is therefore subject to its principles and methods of study. Third, like the history of world philosophy, that of Chinese philosophy is the story of the struggle between materialism and idealism. Fourth, China's rich tradition of materialism has been emphasized; Chinese naturalistic philosophies have been interpreted in materialistic terms, and minor naturalists or materialists have been magnified. Fifth, the materialistic philosophy in Chinese history is considered primitive and needs to be corrected and perfected by Marxism. Last, only the materialistic elements of Chinese philosophy should be studied as history and as a lesson.

With regard to Confucius and Lao-tzu, writers have been about evenly divided as to whether the sages were idealistic or materialistic and whether or not they represented the interest of the land-owning class. Fung Yu-lan has repudiated his new rationalism in favour of materialistic philosophy but still insists, among other things, that the Confucian *jen* has the characteristic of "universality" and is therefore applicable at all times. Clearly Chinese philosophy has entered upon a new phase.

See also CHINA: *History;* CHINESE LITERATURE; CONFUCIANISM; TAOISM; BUDDHISM.

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CHINESE SCULPTURE. In China the art of sculpture never received the acclaim awarded to painting or ceramics. For the most part the sculptors were nameless artisans working in hereditary guilds to supply the demands of cult and state. Nevertheless, they created works of art which provided inspiration for some of the greatest monuments of Korea and Japan and could hold their own with the best products of the west.

CHINA: *History;* BUDDHISM; and CONFUCIANISM give pertinent cultural and historical information. Specific areas of Chinese sculpture are presented in IVORY CARVING; JADE AND OTHER HARD STONE CARVING; IRONWORK; TERRA COTTA; WOOD CARVING; and POTTERY AND PORCELAIN. *See* also CHINESE ARCHITECTURE; CHINESE BRONZE; and CHINESE PAINTING.

(Since the dates of some Chinese dynasties are disputed, the dates in this article are not always the same as those found elsewhere. In each case, the dates suggested by the author of the article are used.)

PRE-BUDDHIST SCULPTURE

Sculpture had its roots far back in Chinese history, although modern knowledge of the art before 1300 B.C. is limited to a few simple animal carvings in jade and stone.

Shang Dynasty (1523?–1028? B.C.).—The earliest examples of historic date came from tombs in the vicinity of An-yang in Honan province, site of the last capital of the Shang dynasty. Of stone, bronze, jade and ivory, they exhibit an artistic quality and technical competence that indicates sculptural traditions antedating by many centuries the founding of this capital. Little is known of pre-Shang or Early Shang glyptic art, and understanding of the closing centuries of the dynasty is incomplete.

Stone Sculpture.—Fragments of monumental stone sculpture have been found, but more common were animals and human figures relatively small in scale. Their salient characteristics were strict frontality and immobility, coupled, even in the crudest examples, with a feeling of sombre power. Animals such as the elephant and water buffalo, for example, were often rendered in simple, almost blocklike form that gave the impression of being intentionally unfinished, yet managed to suggest the most essential characteristics.

Others, like the marble bird at the Academia Sinica, Taiwan, were composed of carefully integrated carved planes finished with meticulous care. Covering the surface of the marble bird are designs in low relief representing not only feathers but fabulous creatures and geometric patterns. A tigerlike animal appears on the head and back, snakes outline the wings and a stylized animal mask (*t'ao-t'ieh*) was carved on the breast. These zoomorphic designs were found on both human and animal stone sculptures and on almost all contemporary bronze ritual vessels, which would seem to indicate that the bird and the designs on its surface had a religious rather than a decorative purpose. They may be symbols of protection or appeasement. The deep groove in the back of this and certain other Shang carvings points to an architectural function. While no traces of pigment remain, it is possible that all stone sculpture was once vividly coloured. (*See* Plate II.)

Bronze Sculpture.—Bronze casting during the Shang dynasty reached a level of technical perfection that has rarely been surpassed. Among the bronze ritual vessels were some in animal form which contained all the elements of true sculpture. Like the stone carvings, they were frontal and motionless but showed, to an even greater extent, careful observation of nature.

One of the most splendid of these vessels is in the shape of a two-horned rhinoceros—an animal which once may have roamed central China. Made, it is believed, during the final years of the Shang dynasty, it was modeled with a simplicity and understanding that revealed without unnecessary detail the basic traits of the beast, the ponderous body, wickedly sensitive ears and the small but vicious eyes. It was an art of understatement far more expressive than an accurate portrayal showing every hair and crease (Plate I).

Chou Dynasty (1028?–256 B.C.).—For reasons yet unknown, almost no stone carving appeared during the eight centuries that followed the Chou conquest of the Shang dynasty. It is necessary to turn to bronzes for the next phase of Chinese sculpture. The earliest were again ritual vessels in animal form almost indistinguishable from the Shang models that they copied. It was not until the late 10th and 9th centuries that a definite Chou style evolved. Characterized by a powerful and often harsh formality coupled with the use of heavy surface patterns, these animals, despite a decline in technical skill, produced a definite feeling of barbaric splendour. The new style is well illustrated by a bronze tiger (Plate II), one of a pair, designed evidently not as vessels, but as bases or supports. The smooth, well-integrated modeling of the earlier animals was replaced by a stiff formality in which the component parts of the beast were represented as almost independent elements united largely by the powerful low-relief patterns covering the surface.

Late Chou.—By the 7th century B.C. the Chou dynasty, while it continued to lend its name to the era, had sunk to the position of a small feudal state. It was a period of expansion and constant warfare, yet one of great intellectual activity as witnessed by the evolution of the Confucian and Taoist philosophies.

Sculpture, still restricted largely to bronze, returned to the high technical standards of earlier times. The gradual weakening of the old religious beliefs freed this art from its dependence on traditional forms and the wealth of new designs and new techniques bore witness to the strength of contemporary imagination.

Human figures, rarely found after Shang, reappeared. At first crude and ill proportioned, they were soon to be treated with imaginative freedom and marked realism. The use of these small bronzes has not been determined. Some with rigidly extended arms holding short tubes are labeled torch bearers although it is uncertain whether they were intended primarily for the living or the dead. *Ming ch'i* (artificial tomb figures) for the service of the deceased had begun to replace the sacrifice of living victims in Chou times but if these small bronze statuettes were so employed is open to question.

One of the best of these early figures, cast between the 6th and 4th centuries B.C., stands stiffly erect clasping open cylinders in grotesquely enlarged hands. The treatment of the body and garment was severely simple, only the belt and edge of the robe being indicated. In marked contrast, the head was modeled in considerable detail with careful attention to facial structure and the intricacy of the elaborate coiffure. Despite its obvious rigidity, the over-all effect is one of surprising monumentality in a figure under eight inches in height (Plate II).

Handled with more plastic freedom and unexpected realism, is a delightful bronze statuette of a Mongolian maiden bearing on twin staffs a pair of jade birds (Plate II). It came from Chin-t'sun in Honan province together with some of the finest of Late Chou jades and metal works and, on stylistic grounds, is tentatively placed in the 5th or 4th century B.C. Suggestive almost of actual portraiture are the distinctive modeling of the features and the care taken in the styling of the hair and details of dress.

Possibly earlier, but equally successful as an example of sculptural art, is a bronze dragon which once may have adorned the edge of a massive vessel. It shows a skilful combination of imaginative realism and linear formality, the modeling of the head and body in smoothly flowing planes being emphasized by the tense outline of the mane and wings. Unlike the often harsh designs on Early Chou animals, the delicate surface patterns are restrained and provide a textural quality that adds much to the striking reality of this benign creature (Plate IV).

Far to the south at Ch'ang-sha, capital of the state of Ch'u in Hunan province, excavations brought to light a remarkable series of wood tomb sculptures believed to have been made between the 6th and 3rd centuries. Carved as substitutes for human and animal victims, they illustrate a provincial style little influenced by the cultural centres to the north. Standing figures show characteristically large, flat faces, narrow shoulders and elongated bodies. Features and patterns of the robes are painted. Despite the basic simplicity, these carvings show originality and great technical competence (Plate IV).

Ch'in Dynasty (221–206 B.C.).—The era of turmoil following the collapse of Chou hegemony was brought to a close in 221 B.C. when the state of Ch'in, by force of arms, united China for the first time. From this short period were handed down the first important literary references to works of sculpture—the mention of 12 colossal bronze statues of "giant barbarians" placed before the imperial palace at Hsien-yang in Shensi province by command of the first Ch'in emperor. By the 4th century A.D. all these figures had been destroyed and it can be inferred only that metal sculpture on this scale was sufficiently rare to warrant notice. Bronze and hard-stone sculpture on a small scale continued to carry on the stylistic trends of Late Chou.

Han Dynasty (206 B.C.–A.D. 221).—The unification of the empire survived the fall of Ch'in and the subsequent four centuries of Han rule witnessed extraordinary physical and cultural expansion. Contact with the fringes of the western world introduced new ideas and influences while Confucianism, by then the state philosophy, and Taoist folklore began to exert their influence on the arts.

Stone sculpture on a large scale reappeared. Timid and awkward at first, by the second half of the period it became more assured; but not until the 5th and 6th centuries A.D. did it come into its own as the chief artistic medium of the Buddhist religion. While the concept of monumental stone sculpture may have come from the middle east, the character and style of Han stone art were definitely Chinese. The few examples that survive are funerary figures connected with events in the life of the deceased or used to guard the "spirit road" to his underground tomb chamber. The most famous of these is a series of stone animals and fantastic monsters from a tomb site in Shensi province associated with the noted general Ho Ch'ü Ping who died in 117 B.C. A large horse (Plate IV) trampling a fallen barbarian symbolizes, it is thought, the defeat of the Huns in central Asia. Despite the monumental character of the animal, only hesitant use is made of the plastic possibilities of the stone, the feeling being more that of a double relief than a free-standing figure. Here is none of the realization of plastic form so beautifully expressed in the small bronzes of Late Chou.

Of greater sculptural quality were the large stone lions and chimeras that appeared first in the second half of the dynasty and reached their culmination in the 5th and 6th centuries A.D. A chimera from Late Han or even slightly later retains the essentially relief character of the earlier horses by emphasizing the animal's profile. However, the modeling of the head and body is treated with far more assurance, and the rigidity of the early monument is relieved by a strong sense of forward motion and by the splendid linear rhythms in the wings (Plate IV).

The character and vitality of Han culture is seen at its best in a series of stone reliefs from the offering shrines of the Wu family in Shantung province dated between A.D. 147 and 168. Contemporary frescoes may have inspired these low reliefs, which are actually more akin to painting than to the plastic arts. The scene illustrated depicts the unsuccessful attempts of the Ch'in emperor to recover the ritual vessels of the Chou dynasty. The figures are represented for the most part in profile with little attempt to indicate spatial depth. Nevertheless, the crowded composition is skilfully handled, the action replete with humour and animation (Plate V).

In spite of the monumental character of Han stone carving, the most truly sculptural art is found in small objects, in which the Chinese were able to bring out the possibility of plastic form far better than they could when working on a larger scale. This generalization seems to hold true throughout the history of Chinese sculpture except during periods strongly under foreign influence.

One of the best of the small Early Han sculptures is a bronze incense burner supported by a lively figure on the back of a mythical beast. The gnome, leaning on one arm while he turns to stare upward, has broken away from earlier conventions of frontality and can be viewed equally well from all sides. The head is strangely large, but the proportions and articulation of the body are handled convincingly and with subtlety (Plate V).

Equally successful in sculptural terms is a pair of bronze bears, thought to have been cast during the second half of the dynasty. Although a popular subject in Han art, their symbolism and purpose are not fully understood. Possibly they were guardians or objects of cult worship. In any case, the creator of this pair with freedom and understanding caught their essential traits—ungainly stance and shaggy power (Plate V).

BUDDHIST SCULPTURE

FIRST PHASE (4TH TO LATE 6TH CENTURIES)

Five centuries before Christ, the Buddhist religion was founded in India. But not until the 1st century B.C. did it reach China via the trade routes of central Asia. On Chinese soil Buddhism made slow headway against the established native philosophies of Confucianism and Taoism until its espousal by nomad invaders, chief among them the T'o-pa (Toba) Tatars who founded the Northern Wei dynasty and held sway over a large area of north China.

Northern Wei Sculpture (386–535).—No examples of Buddhist sculpture can be definitely proved to antedate the 4th century. The earliest dated examples are a group of small bronze seated Buddhas of the 4th and 5th centuries made in both north and south China but very similar in style. Typical of these diminutive Buddhas is one dated 451 (Plate V). Stylistically it was little influenced by earlier Chinese traditions but received its inspiration almost wholly from the Buddhist art of central Asia. The trade route sculptors were not themselves the originators of this style, for they in turn combined and modified to suit local taste and materials the artistic concepts of two schools of Indian sculpture. The first was the purely Indian school of Muttra (Mathura) in north India; the second, centred in Gandhara in the northwest, was strongly influenced by provincial Roman classicism. (*See* INDIAN ART.)

The large head with its prominent *usnisa* (cranial protuberance of wisdom which is one of the sacred marks of a Buddha) is characteristic of these early figures under central Asian influence, as is the simple and compact modeling of the body. Only in the formal and entirely unrealistic arrangement of the folds of the garment can be sensed a possible Chinese desire for linear patterns.

Central Asia appears to have supplied the earliest and the most important models for Chinese Buddhist sculpture. It is quite possible, however, that central and south China may have received other artistic influences from India by sea or by the southern overland route. Unfortunately, so little has survived that it is impossible to create any definite idea of the Southern school.

Of greater importance were the cave chapels of northern and western China carved out of the living rock in imitation of the Indian and central Asian practice. The earliest, dating back to the 4th century, are thought to have been destroyed by a particularly harsh Buddhist persecution between 444 and 452. In 460 work was commenced on a series of caves at Yün Kang near the T'o-pa capital in Shensi and largely completed by 494 when the capital was moved south to Loyang in Honan province.

The 45-ft. colossal Buddha of cave 20 is typical of the early Yün Kang style. The fullness of the body, the large head and prominent features are reminiscent of central Asian clay images. More difficult to explain is the curious manner of representing the drapery—one in which the folds were treated as flat, bisected bands which fork into points as they curve over the upper arm. This convention appeared on many contemporary clay and bronze figures and its strong linear feeling suggests the dependence of the sculptors on imported drawings of famous Buddhist images. Despite the stiff and rather heavy proportions, there is a feeling of monumentality and sincerity that gives it marked sculptural and religious significance (Plate VI).

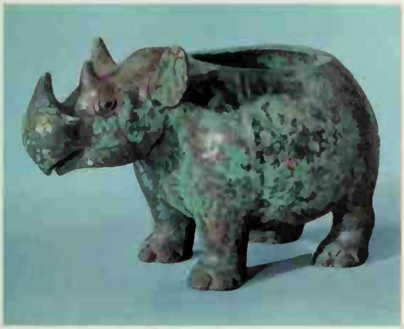
The interior of cave 7 at Yün Kang, hollowed out between 465 and 470, illustrates the elaborate complexity of these early Chinese cave chapels. Every inch of the walls and ceiling was covered with carved and painted figures reflecting a strange mixture of central Asian, Indian, Persian and classical elements (Plate VI). There is little here that is purely Chinese since the T'o-pas, having assimilated Chinese sculpture, were still trying to master the foreign religion and its polyglot art forms and were not yet in a position to express their own interpretation. But the moment was not far off, for even before the capital was moved to Loyang a native style of sculpture began to evolve at Yün Kang.

Characteristics of the Native Style.—The first definitely Chinese style of Buddhist sculpture can be seen at its best at the caves of Lung Men, 10 mi. S. of the new capital. A standing Buddha and attendant Bodhisattvas in cave 3 illustrate this new style during the early years of the 6th century. The proportions of the head became longer and show the typical almond-shaped eyes, arched eyebrows and tight mouth. The bodies still retain some of the roundness of the earlier figures, but more and more attention is paid to the linear patterns of the scarves and drapery folds. Once again is seen the Chinese preference for line rather than plastic form when working on a large scale (Plate VI).

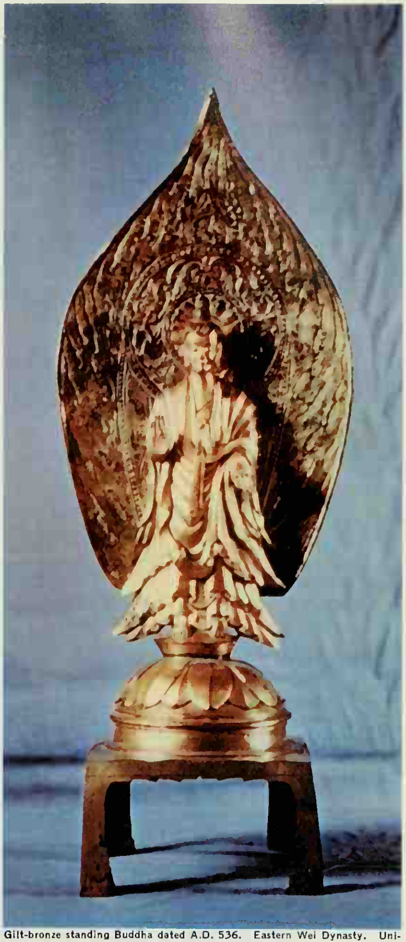
The direction taken by this new Chinese interpretation during the first quarter of the 6th century is illustrated by a small relief carving from Lung Men of Prince Siddhartha in meditation—the historical Buddha before he attained enlightenment. The plasticity and articulation of the body found in the art of central Asia has given way to a much flatter, less realistic portrayal. The skirt is arranged in a beautifully varied series of spade-shaped folds that allowed the sculptor full play for his love of linear design and serve as well to emphasize by contrast the charming simplicity of the seated figure (Plate VI).

The Chinese preference for line rather than plastic form is clearly shown in a small bronze shrine dated 518 portraying the Buddhas Sakyamuni and Prabhutaratna discoursing on the Law. This was a popular subject during the 5th and 6th centuries and was drawn from the *Lotus Sutra,* a text which provided the subject matter for much of the contemporary art. The attenuated deities are almost completely dematerialized, only the heads and hands having any real sense of plastic form. It is the linear harmony and movement in the drapery and the soaring flames of the mandola that express the spirituality of these deities far removed from the human world of flesh and blood (Plate VII).

Eighteen years later (536) a splendid gilt-bronze image of a standing Buddha was cast in Hopeh province. The right hand is raised in the *mudra* ("gesture"), signifying "have no fear," the left is extended palm down to indicate "charity." Again, there is no feeling of the physical body, which is lost beneath the voluminous folds of the robe. But in place of the low, tensely linear modeling of the earlier group, the drapery is treated in somewhat more sculpturesque fashion. Strongly contrasted areas of light and

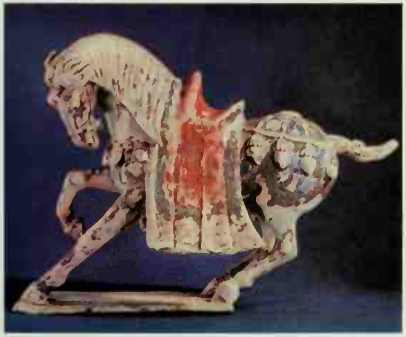


Bronze ritual vessel in the form of a rhinoceros, 11th(?) century B.C. Shang Dynasty. In the collection of Avery Brundage, Chicago, Ill.



Gilt-bronze standing Buddha dated A.D. 536. Eastern Wei Dynasty. University Museum, Philadelphia, Pa.

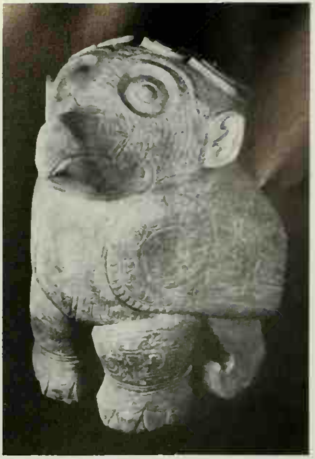
Pottery tomb horse. T'ang Dynasty. Fogg Art museum, Harvard university, Cambridge, Mass.



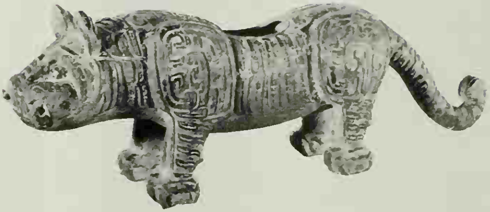
BY COURTESY OF (TOP LEFT) AVERY BRUNDAGE (RIGHT) THE UNIVERSITY MUSEUM OF THE UNIVERSITY OF PENNSYLVANIA; PHOTOGRAPH (BOTTOM LEFT) FOGG ART MUSEUM

SCULPTURE OF THE SHANG, EASTERN WEI AND T'ANG DYNASTIES

CHINESE SCULPTURE

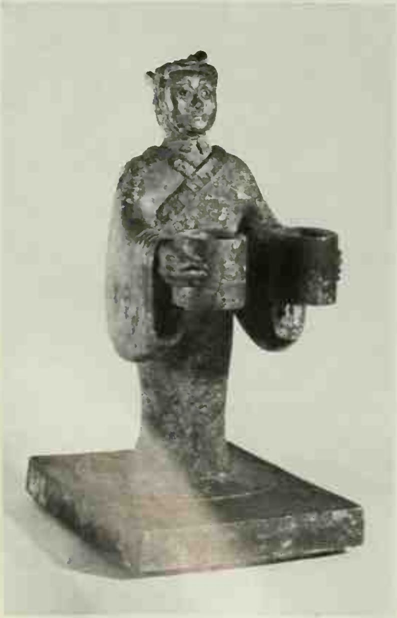


Marble bird; Shang Dynasty

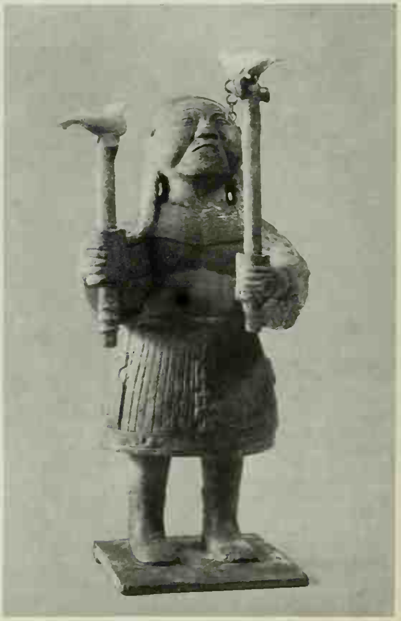


Bronze tiger, *c.* 10th century B.C. (Chou Dynasty)

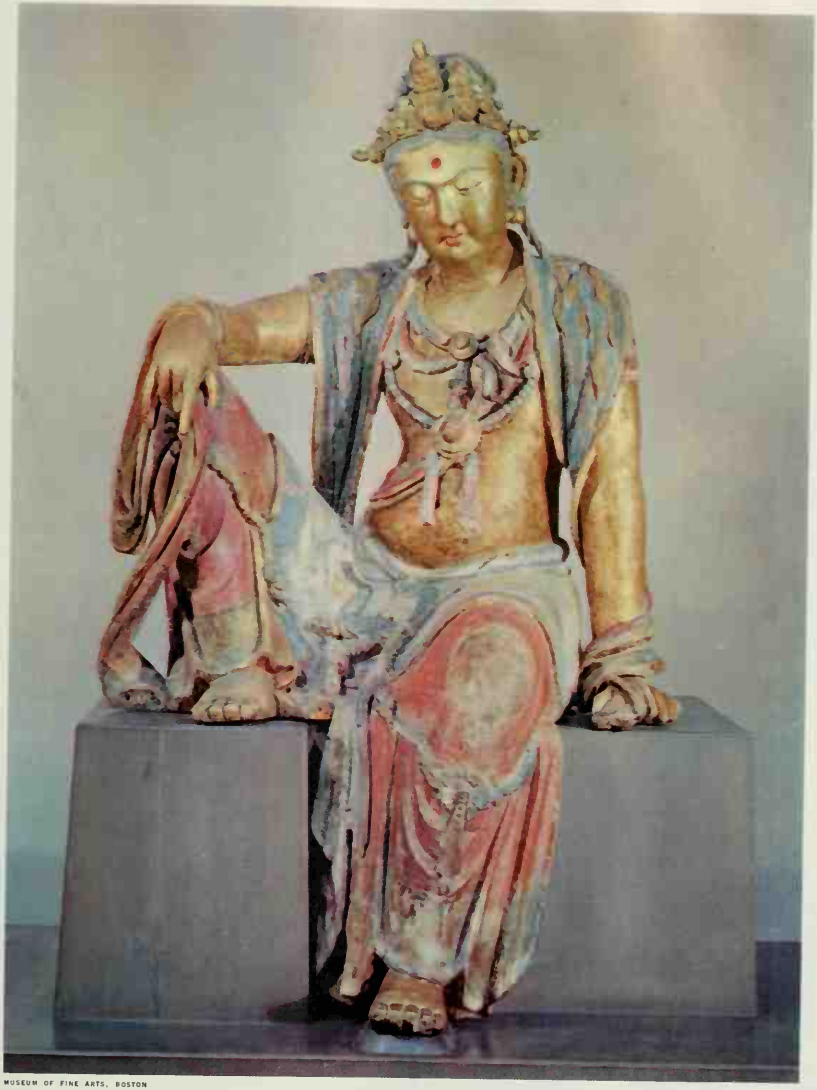
Standing bronze figure, 6th–4th century B.C. (Chou Dynasty)



Bronze Mongolian maiden, 5th–4th century B.C. (Chou Dynasty)



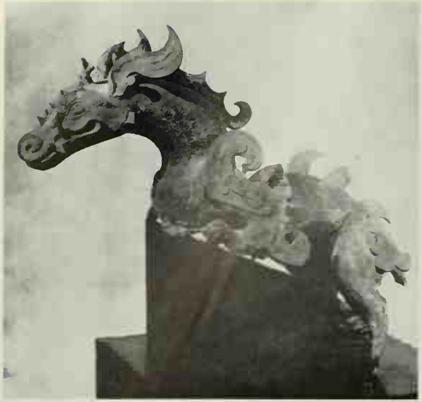
BY COURTESY OF (TOP LEFT) DR. LI CHI, (TOP RIGHT) THE SMITHSONIAN INSTITUTION, FREER GALLERY OF ART, (BOTTOM LEFT) FOGG ART MUSEUM, HARVARD UNIVERSITY, WINTHROP BEQUEST, (BOTTOM RIGHT) MUSEUM OF FINE ARTS, BOSTON



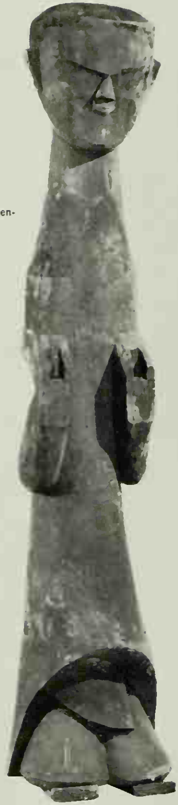
MUSEUM OF FINE ARTS, BOSTON

SEATED BODHISATTVA KUANYIN, WOOD, SUNG DYNASTY (A.D. 960–1279)

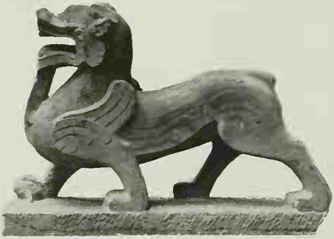
CHINESE SCULPTURE



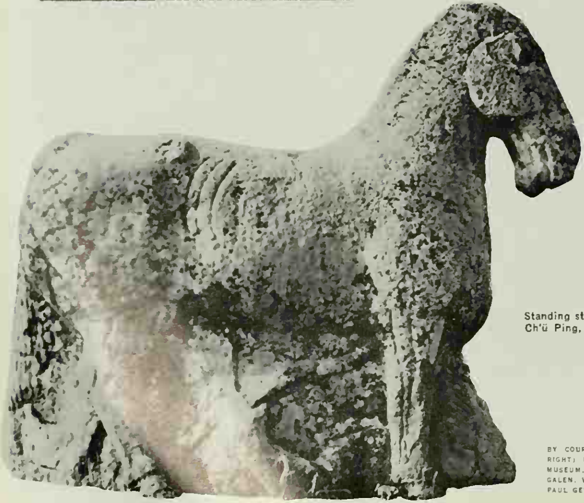
Bronze dragon, 6th–3rd century B.C. (Chou Dynasty)



Wooden tomb figure, 6th–3rd century B.C. (Chou Dynasty)

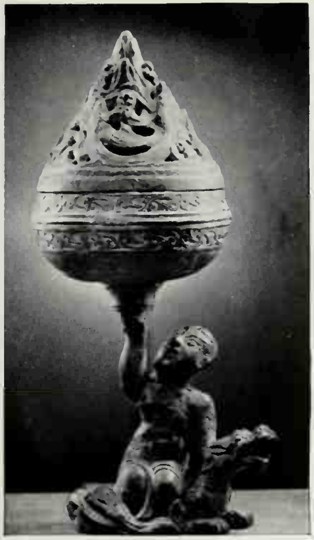


Stone chimera, 3rd–4th century A.D. (Six Dynasties A.D. 221–589)

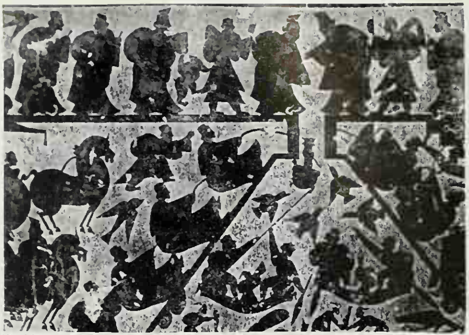


Standing stone horse from the tomb of Ho Ch'ü Ping, Shensi province; Han Dynasty

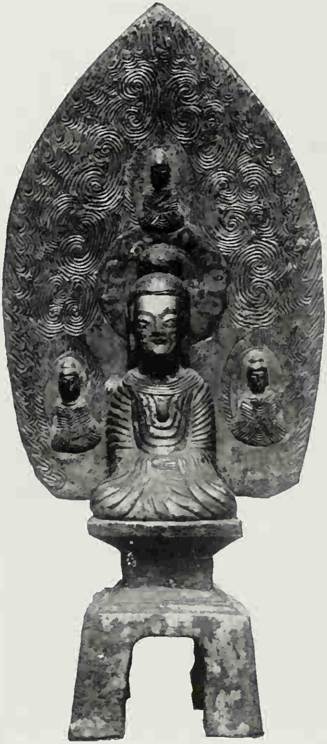
BY COURTESY OF (TOP LEFT) JACQUES STOCLET, BRUSSELS, (TOP RIGHT) EUGENE BERNAT, (CENTRE LEFT) NELSON GALLERY, ATKINS MUSEUM, KANSAS CITY, MO., NELSON FUND, (BOTTOM LEFT) SEGALEN, VOISINS AND LARTIGUE, "MISSION ARCHÉOLOGIQUE EN CHINE," PAUL GEUTHNER, PARIS



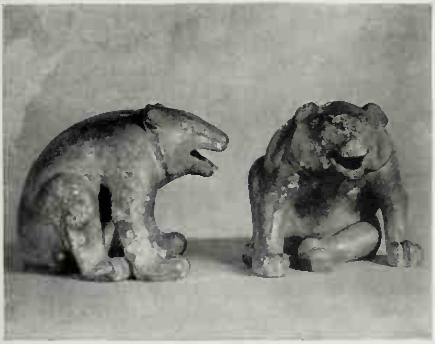
Bronze incense burner, 2nd–1st century B.C. (Han Dynasty)



Wu Liang Tz'u relief (rubbing), dated A.D. 147–168 (Han Dynasty)



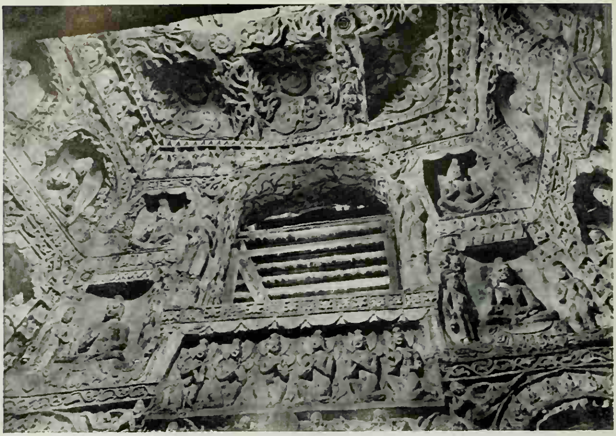
Seated bronze Buddha, dated A.D. 451 (Northern Wei Dynasty)



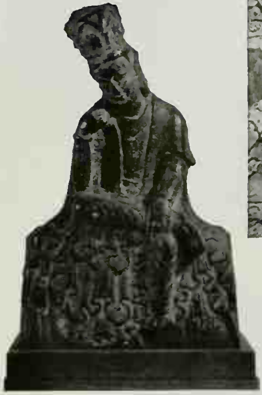
Pair of gilt-bronze bears (Han Dynasty)

BY COURTESY OF (TOP LEFT) NELSON GALLERY, ATKINS MUSEUM, KANSAS CITY, MO., NELSON FUND. (TOP RIGHT) FOGG ART MUSEUM, HARVARD UNIVERSITY, (BOTTOM LEFT) ISABELLA STEWART GARDNER MUSEUM, (BOTTOM RIGHT) THE SMITHSONIAN INSTITUTION, FREER GALLERY OF ART

CHINESE SCULPTURE

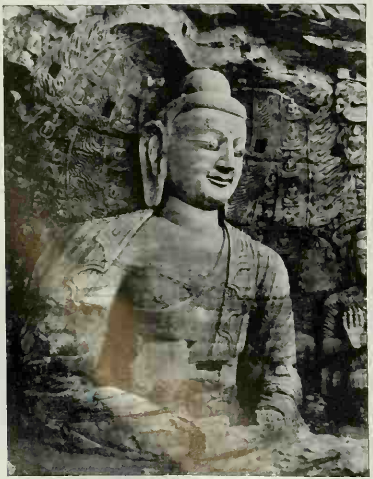


Interior of Cave 7, Yun Kang, Shensi province, late 5th century A.D. (Northern Wei Dynasty)

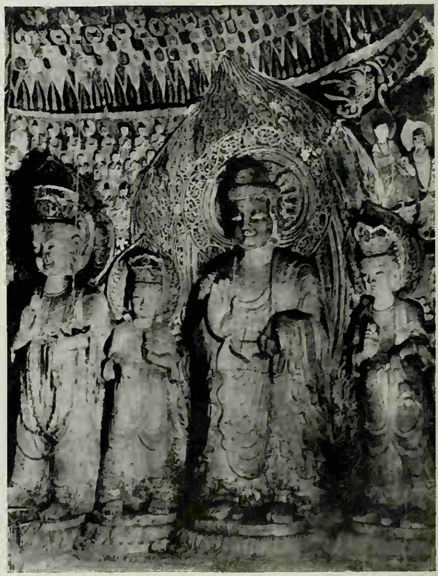


Stone relief of Prince Siddhartha in meditation, Lung Men caves, Honan province, early 6th century A.D. (Northern Wei Dynasty)

Colossal Buddha, Cave 20, Yün Kang, late 5th century A.D. (Northern Wei Dynasty)

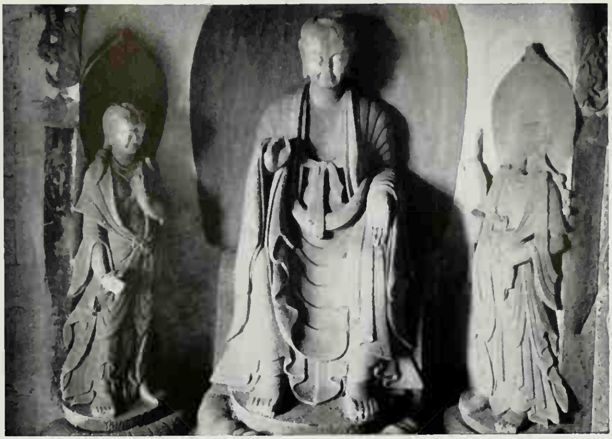


Interior of Cave 3, Lung Men, Honan province, early 6th century A.D. (Northern Wei Dynasty)

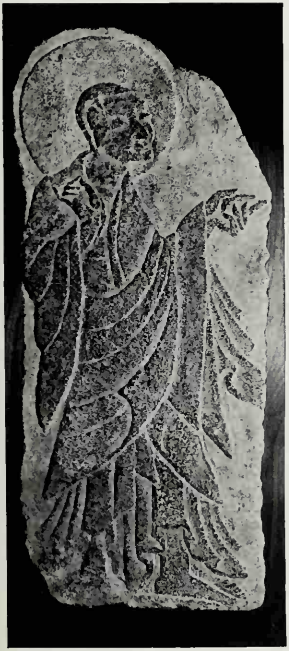


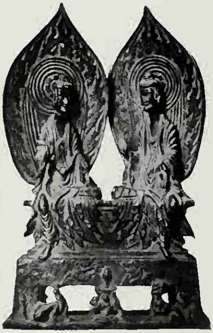
BY COURTESY OF (TOP RIGHT, BOTTOM LEFT) JIMBUNKAGAKU KENKYUSHO; FROM "YUN KANG" BY MIZUNO AND NAGAHIRO, (TOP LEFT) FOGG ART MUSEUM, HARVARD UNIVERSITY. WINTHROP BEQUEST, (BOTTOM RIGHT) FROM "BUDDHIST MONUMENTS IN CHINA" BY TOKIWA AND SEKINO

Stone Buddha and attendant Bodhisattvas, Cave 2, T'ien Lung Shan, Shansi province, 2nd half of the 6th century A.D. (Northern Ch'i Dynasty, A.D. 550–577)



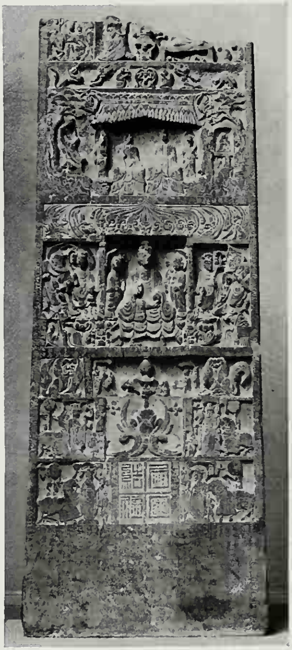
Stone relief of a Buddhist disciple, Cave 2, T'ien Lung Shan, Shansi, 2nd half of the 6th century A.D. (Northern Ch'i Dynasty)





Bronze shrine of Sakyamuni and Prabhutaratna, dated A.D. 518. (Northern Wei Dynasty)

Stone Buddhist stele dated A.D. 554, Shansi province. (Northern Ch'i Dynasty)



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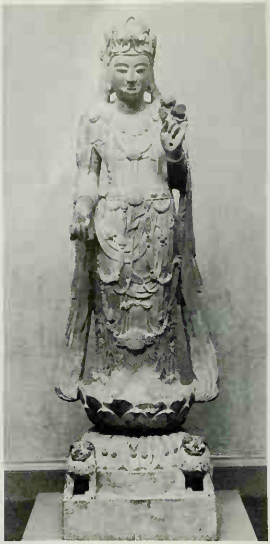
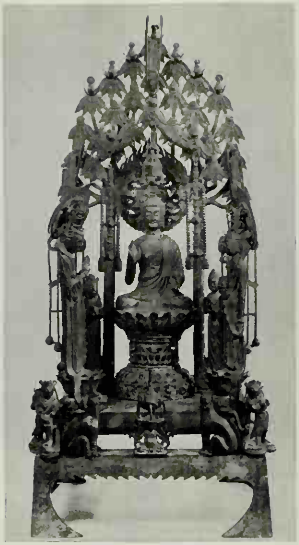
CHINESE SCULPTURE

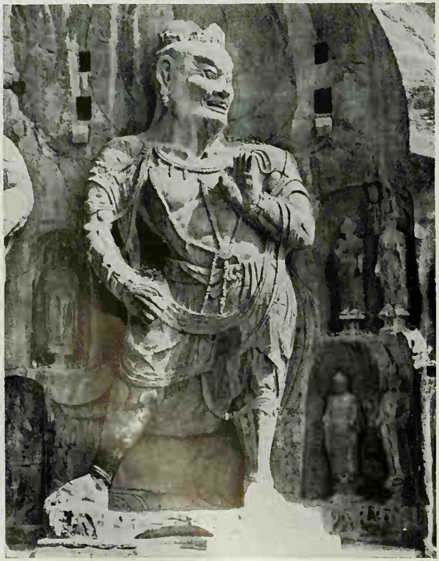
Left: Stone Kuanyin Bodhisattva, Shensi province, *c.* A.D. 570–580. (Northern Chou Dynasty, A.D. 557–581)

Right: Gilt bronze Amitabha shrine dated A.D. 593. (Sui Dynasty, A.D. 589–618)

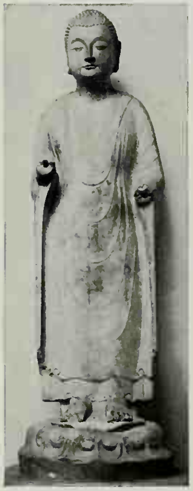




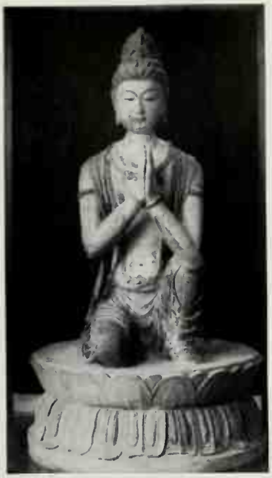
Colossal stone guardian from the caves of Lung Men, A.D. 672–675. (T'ang Dynasty, 618–906)



Stone Buddha Amitabha dated A.D. 577. (Northern Ch'i Dynasty, A.D. 550–577)

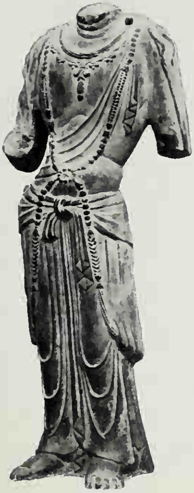


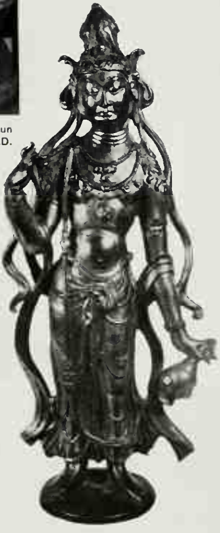
BY COURTESY OF (TOP LEFT, TOP RIGHT) MUSEUM OF FINE ARTS, BOSTON, (BOTTOM LEFT) FROM "A STUDY OF THE BUDDHIST CAVE TEMPLES AT LUNG-MÊN, HONAN" BY MIZUNO AND NAGAHIRO, (BOTTOM RIGHT) ROYAL ONTARIO MUSEUM, CANADA



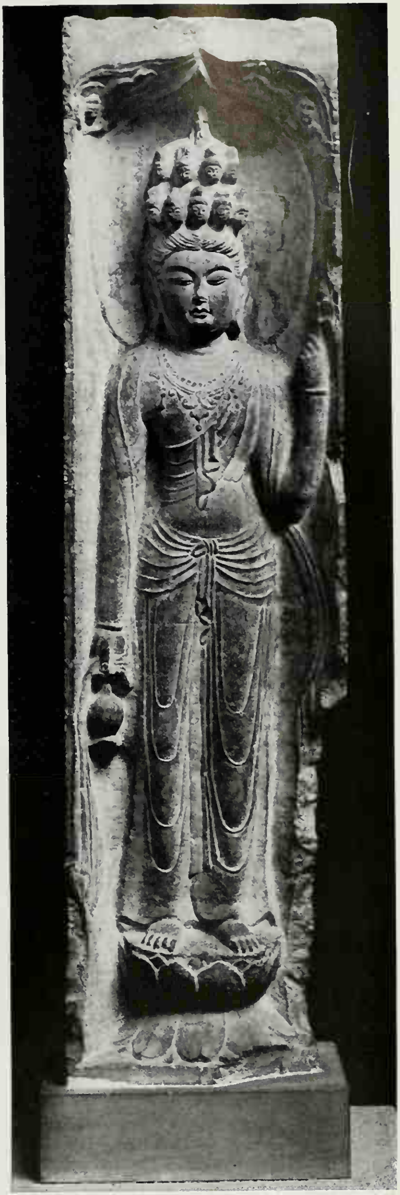
Sun-baked mud Bodhisattva, Cave 143, Tun Huang, Kansu province, early 8th century A.D. (T'ang Dynasty, A.D. 618–906)

Stone torso of a Bodhisattva, 8th century A.D. (T'ang Dynasty)





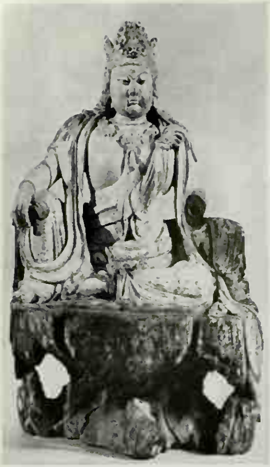
Gilt-bronze Kuanyin, 7th century A.D. (T'ang Dynasty)



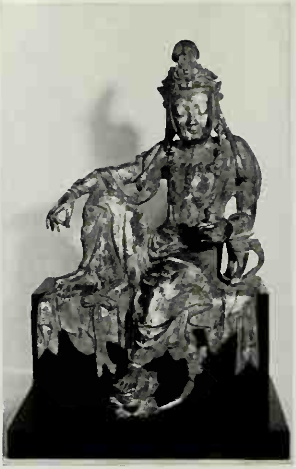
Stone relief of 11-headed Kuanyin, Sian, Shensi province, late 7th or early 8th century A.D. (T'ang Dynasty)

BY COURTESY OF (TOP LEFT, CENTRE) FOGG ART MUSEUM, HARVARD UNIVERSITY, CENTRE, WINTHROP BEQUEST, (RIGHT) MUSEUM OF FINE ARTS, BOSTON, (BOTTOM LEFT) THE SMITHSONIAN INSTITUTION, FREER GALLERY OF ART

CHINESE SCULPTURE

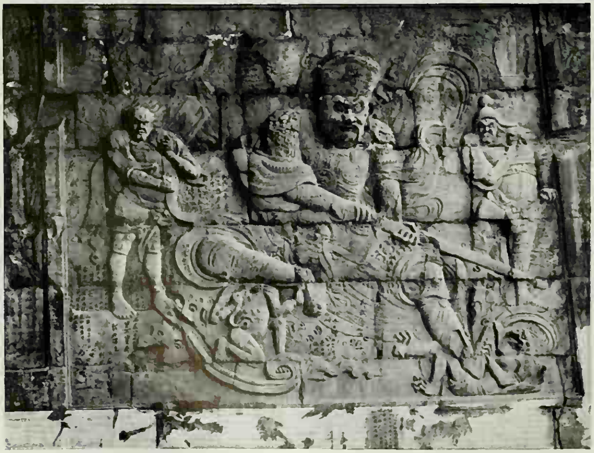


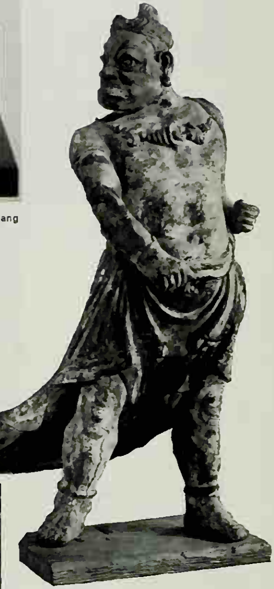
Wooden seated figure of Kuanyin dated A.D. 1385. (Ming Dynasty)



Gilt-bronze Kuanyin, 9th–10th century A.D. (T'ang Dynasty)

Stone relief of a guardian king on the Chü Yung Kuan gate, Hopeh province, dated A.D. 1345. (Yüan Dynasty, A.D. 1280–1368)





Lacquer Buddhist temple-gate guardian, 9th–10th century A.D. (?)

BY COURTESY OF (TOP LEFT) METROPOLITAN MUSEUM OF ART, N.Y., (TOP RIGHT) FOGG ART MUSEUM, HARVARD UNIVERSITY, WINTHROP BEQUEST, (CENTRE RIGHT) MUSEUM OF FINE ARTS, BOSTON; PHOTOGRAPH, (BOTTOM LEFT) © OSVALD SIREN

shade, resulting from the greater depth of modeling, produce a dramatic sense of spiritual power augmented by the flaring triangular folds which impart a sense of weightlessness (Plate I).

This truly Chinese sculptural style reached its peak in the first half of the 6th century and continued with local modifications for another 30 years.

Northern Ch'i (550–577).—The states of eastern and western Wei were supplanted by Northern Ch'i and Northern Chou respectively. The former was ardently Buddhist and produced some of the greatest examples of Chinese religious art. The intense feeling of spiritual conviction, so well expressed by the tense linear style, became somewhat more relaxed by mid-century. A stone stele from Shansi province carved in 554 illustrates the softer, more rounded treatment of form with the drapery assuming somewhat gentler curves. The figures remained in low relief and there was still little attempt to endow them with human attributes of weight and articulation (Plate VII).

Shortly after 560, work was started on a new series of Buddhist caves at T'ien Lung Shan in Shansi province. The style of the earliest caves, for the most part a continuation of earlier Chinese traditions, shows in the high reliefs a growing interest in the problems of three-dimensional form. The seated Buddha of cave 2 is treated almost as a free-standing figure with the marked attenuation of earlier times giving way to greater solidarity and more normal proportions (Plate VII).

Although these craftsmen sought greater plasticity in the main figures, they reverted to an almost completely linear style in the low reliefs on the walls and ceiling as witnessed by the standing figure of a holy man from cave 2. The carving is sensitive and sure and the craftsman reveled in the contrast of flowing curves and jagged outline. A more successful example of this first phase of Chinese sculpture would be difficult to find (Plate VII).

Second Phase (Late 6th to Early 7th Centuries)

While T'ien Lung Shan was vacillating between the linear and plastic, other sculptors, most notably those in the area of Ting Chou and the caves of Hsiao T'ang Shan in Hopeh, were concentrating more directly on the problems of plastic representation.

The result of their efforts was a new style of sculpture, which can best perhaps be called the "second phase." The term "transitional style" is sometimes used to indicate the continuity between the first phase and the developed sculpture of the T'ang dynasty (618–906). However, this is apt to be misleading since this new style as it evolved in Northern Ch'i and the succeeding period of Sui had a definite character of its own.

A standing figure of the Buddha Amitabha, made in the Ting Chou region in 577, clearly illustrates the new tendency. The figure, stiffly frontal, is nevertheless free standing with a definite feeling of weight resulting from the three-dimensional treatment of the body. The thin drapery was handled with great restraint and the face became more human in its proportions (Plate VIII).

This new concept of sculpture was due in part to closer contact with India and in part to the growing popularity of a new Buddhist "Pure Land" sect, whose supreme deity was the Buddha Amitabha. The members of this group were not primarily concerned with the attainment of Nirvana (release from desire and suffering) but with rebirth among the splendours of the Western Paradise which could be achieved merely by evoking the name of Amitabha. The ease of attainment and the immediacy of the gods had a strong appeal which was reflected in sculptural terms by a more realistic portrayal of the Buddhist deities.

Northern Chou (557–581).—This state ruled in northwest China. In 577 it conquered Northern Ch'i only to be overthrown itself four years later by the Sui dynasty. Although the rulers were anti-Buddhist some sacred sculpture was produced, the best in the vicinity of Sian (Sian Fu) in Shensi province. An imposing stone image of Kuanyin (Bodhisattva of Compassion) indicates that the Shensi sculptures even more than those of Hopeh were succumbing to Indian influence. The sensual modeling of the face, the marked S curve of the body in profile and the ornate array of scarves and jewelry were foreign to China. Vivid traces of paint added to the sumptuous, if not very spiritual, quality of the figure. Comparison with dated examples suggests that it was made between 570 and 580 (Plate VIII).

Sui Dynasty (589–618).—The unification of China in 589 was the chief contribution of the Sui dynasty. Although its emperors were ardent Buddhists, neither the quantity nor quality of the sculpture made under their rule was outstanding. The severely simple style of the second phase continued, at times combined with the more florid taste handed down from Northern Chou. There were a number of fine Sui stone carvings, but the most successful examples were the small gilt-bronze figures once part of household shrines.

One of the few to remain intact is a beautiful shrine representing the Western Paradise of the Pure Land sect cast in 593. In the centre Amitabha sits enthroned, flanked by attendant Bodhisattvas, disciples and acolytes. Above rise the jeweled trees that adorn this heavenly paradise and on the lowest level, protecting its approaches, stand guardians and lions. The style of these little figures is direct and simple and there still remains in the formality of the pose and in the facial expression the charm and spiritual conviction found in so many images of the early 6th century (Plate VIII).

T'ang Dynasty (618–906).—A popular revolt ended the oppression of Sui and founded one of the most brilliant eras in Chinese history. At its height, the T'ang empire stretched from Korea to the borders of India, from Indochina deep into Manchuria. Considering the varied influences encompassed by this vast area, it is not surprising that sculpture reached its peak at the same time. Strongly influenced by Indian concepts, the Chinese strove to translate into their own terms the sensuous warmth, freedom and mastery of plastic form achieved by the Gupta and early medieval craftsmen. Figures no longer stiff and strictly frontal but fully articulated, bend and pose in graceful imitation of foreign models. Sculptural art of T'ang is relaxed, worldly, at times self-conscious, entirely confident of its mastery of the faith and ability to express it in visual form.

Unfortunately the materials best suited to the vitality and realism of T'ang (wood, lacquer, clay and bronze) have, with a few notable exceptions, been destroyed by fire, persecution or warfare. Happily in Japan one can still see in images of the 7th and 8th centuries the reflected splendour of these great sculptures. (*See* Japanese Sculpture.) In China the most important relics which survived were small bronzes and stone figures carved for temples and cave chapels.

Third Phase (Mid-7th to Mid-8th Centuries)

Little sculpture appears to have been made during the first half of the 7th century but the latter half was highly productive. It was at this point that the third phase of Chinese sculpture began. What chiefly distinguished this new style was its dependence on India and the growing interest in the plastic possibilities of the sculptural medium.

The most spectacular monument of the 7th century was undoubtedly the group of stone colossuses at the Lung Men caves in Honan, financed by the empress Wu and completed in 675. The main figure, about 35 ft. high, portrayed Vairocana, the Cosmic Buddha. Badly damaged by erosion, the strength and vitality of the group is best illustrated by one of the attendants, a Vajrapani (thunderbolt-bearing guardian) who shows the growing realism of T'ang in its purposely exaggerated anatomy (Plate VIII).

It was during the last quarter of the 7th century and the early decades of the 8th century that the greatest works of T'ang sculpture were created. Craftsmen were active at many of the important cave sites, not only at Lung Men and T'ien Lung Shan in central China but also far to the west in Kansu at Tun Huang and Ping Ling Ssu.

Dating probably from the late 7th century is a stone carving of an 11-headed Kuanyin from the vicinity of Sian in Shensi. The introduction of Tantric Buddhism from India brought new iconographical features, among them many-headed deities such as this. The figure is more formally treated than the colossal guardian, as befits its high station in the pantheon. The stance is restrained, as was much of the Shensi sculpture, with only a slight feeling of asymmetry. It is in the slender and human proportioning and the round, rather sensual modeling of the face that T'ang realism appears most noticeably (Plate IX).

On the western border of Kansu province at the caves of Tun Huang equally great sculpture was being produced in a different medium. The walls of the caves were eminently suited for painting but too soft for sculpture. However, a substitute was found in the local mud which became highly durable when exposed to the sun. Ever since the 4th century, this site had been a flourishing centre for Buddhist art and during the T'ang dynasty it was a hive of activity.

One of the few Tun Huang pieces to have left China is the beautiful kneeling Bodhisattva from cave 143. Fashioned most probably in the early years of the 8th century, the full face and high headdress were typical of T'ang, but the marked slenderness of the figure suggests a style which, because of its distance from the cultural centres, clung to older traditions. The sensitive modeling of the body is emphasized by the elaborately painted designs on the skirt and scarves (Plate IX).

The high point of T'ang stone carving was reached in a series of standing figures (first half of the 8th century). The realization of plastic form and technical competence is shown by the magnificent torso of a Bodhisattva. The tropic sensuality of India appears in the twist of the body and the feeling of resilient flesh, in fine contrast to the metallic quality of the jewelry (Plate IX).

No monumental bronze images have survived, but their undoubted splendour is reflected on a small scale in such figures as the standing Kuanyin cast about 800. The gentle S curve of the body, the aloof countenance and the fluttering scarves create a sense of elegance and refinement rarely surpassed (Plate IX).

Fourth Phase (8th Century and After)

The fourth and last important phase of Chinese sculpture began around the middle of the 8th century and came to an inglorious end in the Ming dynasty. After 750 the quality of Buddhist sculpture began a slow decline and only rarely did it achieve the vitality and breadth of concept of the third phase.

The tendency of the deities to become heavier in proportion and their garments more elaborate and restless is apparent in a small gilt-bronze Kuanyin of the 9th or early 10th century. In much of late T'ang sculpture may be felt a desire on the part of the craftsmen to seek pictorial effects quite unsuited to the medium. Present also is a sense of gentleness, at times almost of sentimentality, which robs these images of their former strength and spiritual conviction (Plate X).

T'ang Tomb Figures.—The popularity of *ming ch'i* for the service of the dead became so great at this time that sumptuary laws were evoked to limit their size and number according to the status of the deceased. Pottery was the favoured material probably because molds could be used to produce quickly the various parts of the figures and animals. The best examples were assembled and finished with skilful care before being glazed or painted. A prancing horse at the Fogg Art museum, Cambridge, Mass., beautifully illustrates the ability of the T'ang craftsman to catch the vigour and tension of an animal in motion (Plate I). This power to recognize and portray only essential features was present in the earliest sculpture of China, but only in this period did it achieve the freedom and vitality found in the tomb figurines. (*See* Pottery and Porcelain.)

Sung Dynasty (960–1279).—During most of the Sung era, north China was in the hands of non-Chinese invaders who swept in after the collapse of the T'ang empire and established the dynasties of Liao and Chin. The Sung rulers maintained an uneasy peace with the north until all of China fell before the Mongols.

Very little actual Sung sculpture has survived, but numerous examples made under the Liao and Chin remain. Wood and dried lacquer were the popular mediums and it is probable that most of the work was done either by Chinese or Chinese-trained artisans, for the style was a continuation of the complex, pictorial tendencies of Late T'ang. An exception to this general trend appears in a delightful guardian of dried lacquer. By wrapping lacquer-soaked cloths around a wood armature, the craftsman was able to achieve remarkable freedom of pose and gesture. Whether actually produced in Late T'ang or the Sung period, this figure retains much of the dramatic power and vitality of the 8th century. Motion in the twisting body is restrained and there is humour and great imagination in the exaggerated grimace (Plate X).

Many of the life-size wood figures produced in the north were fine examples of sculpture, as is witnessed by a seated Kuanyin of the 12th or early 13th century (Plate III). Generally portrayed in an elaborate and lavishly painted rocky setting, these images, despite their often self-conscious gentleness and femininity, had a definite sense of grandeur. Almost all were carved with great technical skill and attained a degree of realism that was characteristic of this era.

At this same time an archaistic revival was taking place in an attempt to recreate the manner of Northern Wei, Sui and Early T'ang. The results artistically were not satisfactory for the carving was generally dry and hard, failing in most cases to recapture the earlier spirit.

Yüan Dynasty (1280–1368).—The conquest of China by the Mongols had little immediate effect on the history of sculpture. With no art traditions of their own, the conquerors were better suited by temperament to destroy than to create. In general the sculptural taste of the 13th century with all its complexity and realism continued with little new being added.

A relief at the Chü Yung Kuan gate north of Peking in Hopeh province representing one of the four *Lokapalas* (guardian kings) was carved in 1345. The concept is dynamic and technically skilful, but at the same time rather overtheatrical. The violent emotion and wealth of minute detail covering the surface appear much better suited to the art of painting (Plate X).

Ming Dynasty (1368–1644).—Sculptural inspiration failed at this point. Vast numbers of religious figures were produced but because of internal weakness in the Buddhist faith the creative spirit was lacking and, with a few notable exceptions, the images were repetitive and without conviction. In a seated Kuanyin dated 1385 some of the spark of earlier Chin wood carving still lingered. But there was added a sense of oppressive power in the heavy roundness of the body and the brooding features. The impression is given that deities such as this were carved with the intent to impress rather than inspire (Plate X).

Rarely after the Ming dynasty was there found any significant Buddhist sculpture in China. Popular taste shifted to works on a smaller scale—jade, ivory or porcelain. The age of monumental carving was dead. (U. P. C.)

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CH'ING (TA CH'ING), last of the monarchical dynasties of China, was originally the name adopted in 1636 by the Manchus to designate their own regime in Manchuria. Under that name the Manchus rose to rule from 1644 to 1912 over what is generally known as the Chinese empire. Politically the Ch'ing, or Manchu, dynasty went through two phases, a long period of growing power and continued expansion lasting almost two centuries and then a century of decline, defeats and compromise. The whole period was marked by Chinese nationalistic movements that at times flared up into bitter rebellions and that finally in 1912 brought an end to Manchu rule.

The dynasty encompassed the reigns of ten emperors, listed below under their reign titles:

1. Shun-chih (1644–61) (given name Fu-lin; posthumous name Chang Huang-ti; temple name Shih-tsu).
2. K'ang-hsi (1661–1722) (Hsüan-yeh; Jen Huang-ti; Sheng-tsu).
3. Yung-cheng (1723–35) (Yin-chen; Hsien Huang-ti; Shih-tsung).
4. Ch'ien-lung (1736–96) (Hung-li; Ch'un Huang-ti; Kao-tsung).
5. Chia-ch'ing (1796–1820) (Yung-yen; Jui Huang-ti; Jen-tsung).
6. Tao-kuang (1821–51) (Min-ning; Ch'eng Huang-ti; Hsüan-tsung).
7. Hsien-feng (1851–62) (I-chu; Hsien Huang-ti; Wen-tsung).
8. T'ung-chih (1862–75) (Tsai-ch'un; I Huang-ti; Mu-tsung).
9. Kuang-hsü (1875–1908) (Tsai-t'ien; Ching Huang-ti; Te-tsung).
10. Hsüan-t'ung (1909–12) (P'u-i).

The rise of Manchu power began with the Japanese invasion of Korea in 1592. The emperor Wan-li of the Ming dynasty, who was suzerain and protector of Korea, sent an army in response to the appeal of the Korean king for assistance. Nurhachi, at the time a minor Jurchen chieftain in the vicinity of Mukden (Shenyang), by provisioning the Chinese commissariat in Korea acquired a fortune in silver, an armament industry and a corps of followers. He organized his Jurchen tribesmen, a hunting people skilled in the tactics of encirclement and swift annihilating attack, into combat groups of archers on horseback and spent the years from 1599 to 1613 in subduing and organizing his neighbouring tribesmen. In 1616 Nurhachi assumed his first Chinese imperial title, after which he defeated a large Chinese army and took several border cities. Under his successor, Abahai, the Manchus continued their expansion, reaching the Amur river in the north, reducing Korea to a tributary kingdom and conquering the Mongols of Inner Mongolia. With increased food supplies available from Korea and with additional manpower and horses from the Mongols, the Manchus formed a military machine known as the Eight Banners. There were in fact 24 banners, or divisions, eight each of Manchus, Mongols and Chinese, the first two providing cavalrymen and the third technical artillery and firearms troops.

First Emperors.—Meanwhile in China a half-century of misrule, military defeats and rebellions culminated in 1644 in the capture of Peking by a Chinese rebel leader, Li Tzu-ch'eng. When the Ming emperor committed suicide, the Manchus, whose army was in readiness, seized the opportunity to chase the rebels out of Peking and take over the government. By adopting the Ming form of government and continuing to employ Ming officials, the Manchus pacified the Chinese populace. Chinese military leaders who surrendered were given ranks of nobility, and their troops were organized into the Lü-ying, or Army of the Green Standard, as distinguished from the Manchu Ch'i-ping, or Banner troops. Chinese armed resistance, however, lasted almost 40 years, until 1683, when an all-Chinese naval force serving the Manchu emperor forced the surrender of the loyalists on Formosa.

The emperor, K'ang-hsi, then turned his attention to the northern frontiers. For decades the Russians had been exploring along the Amur river and conducting raids into Manchuria. An expedition of Manchu archers, Chinese artillerymen and sailors dispatched from Peking in 1684 forced the Russians two years later to abandon their fort at Albazin. In 1689 a treaty was concluded with Russia at Nerchinsk to demarcate the boundary of Manchuria at the north from the Argun river to the northern tip of Sakhalin Island. In 1688, when the then independent Mongol princes were defeated by the Dzungars from the west and sought help from K'ang-hsi, the emperor gave them shelter, defeated the Dzungars in three expeditions and restored the Mongol princes to their realms as vassals. Thus the empire was extended to include Outer Mongolia. In 1720, by forcing out of Tibet the Dzungars who had conquered the country in 1717, the Manchus added Tibet to their domains. Finally Dzungaria itself and Turkestan were conquered (1755–59), adding to the Ch'ing empire an area roughly three times the size of France. In 1792 an expedition was sent to Tibet to fight Nepalese invaders, and Nepal as a result became the last state to accept tributary status under the Ch'ing. By this time the Manchus had wrought an empire that stretched, east and west, from Sakhalin Island to the Ili river and south to the mountain rampart that guards India. In 1912, even after 70 years of foreign encroachment, the territory inherited by the Chinese republic from the Manchus was still three times as large as that governed by the Ming dynasty.

The long period of Manchu expansion was also one of comparative peace and prosperity in China. Under three distinguished emperors who reigned during the more than 13 decades of the K'ang-hsi (1661–1722), Yung-cheng (1723–35) and Ch'ien-lung (*q.v.;* 1736–96) periods, China's population more than doubled. Commerce thrived and handicraft industry prospered. A vigorous trade in tea, silk and porcelain for the European market was conducted by land with Russia and by sea with the European maritime nations, whose traders flocked to Canton. Roman Catholic missionaries were tolerated, and some were even employed as astronomers and artists. The arts of painting, porcelain manufacture and printing flourished in metropolitan centres, particularly Yangchow, Chingtechen, Soochow and Hangchow. In the intellectual realm, scientific methods of philology were independently developed and applied to the criticism of classical texts.

Decline and Fall.—By the 19th century, however, the Manchu army, whose training had been neglected, had lost its earlier fighting quality. The emperors who ruled after Ch'ien-lung, though still conscientious in the performance of their duties, were weak. Internally, population pressure and concentration of land ownership caused increasing unemployment and the growth of agrarian tenancy. Unrest among the people became commoner and more protracted. Banner troops were sent out only as bodyguards at field headquarters of Manchu commanders, and the Chinese army of the Green Standard and, later, gentry-led volunteers came to form the main body of combat troops.

The decline in Manchu power took place at a period when Europe was going through the French Revolution and the Napoleonic Wars, epochal changes from which England emerged as the world's dominant maritime and industrial power. The western nations were making rapid progress not only in economy and technology but also in economic, political and social theory. The 19th century, the great period of Protestant Christian evangelism, saw the development of other evangelical movements as well. Nationalism, capitalism, imperialism, colonialism and socialism were carried around the world along the routes of European traders. The Ch'ing government could meet them with nothing but an uncompromisingly traditionalist chauvinism. Each foreign war fought by the Manchus in the 19th century—the Opium War (1839–42), the Anglo-French War (1856–60), the French War (1884), the Japanese War (1894–95) and the Boxer uprising (1900)—resulted in humiliating defeat for China, and was followed by a short-lived effort at reform and then a relapse into lethargy. The cumulative effect of these defeats was such that the Manchus lost confidence in themselves and the loyalty or consent of the Chinese they governed. In 1912, faced with a rising tide of Chinese nationalism, they gave up, and the long history of imperial China came to an end.

Causes of the Fall.—The course of military conquest and decline, however, is only a partial explanation, symptomatic of more deep-seated causes, of the rise and fall of the Ch'ing. First of all, it was only through the support of the Chinese gentry bureaucracy that the Manchus, never more than a small fraction of 1% of the Chinese in numbers, were able to rule over China at all. As a result, there was throughout the period a finely balanced interdependence between Manchu military rulers and Chinese administrators.

For 2,000 years the primary function of the Chinese bureaucracy had been to collect taxes for the support of the emperor and his army and public works. The additional duties of administering justice and conducting civil service examinations worked toward the same end, for the first principle of the law was the protection of the emperor from treason or disrespect, and one important purpose of the examination system was the elimination of potential nonconformists and rebels. In addition, the selection of officials by examination produced, as a by-product, a political and social stratum of degree holders who did not hold office but who, since they were on terms of social equality with their officeholding peers, served as spokesmen for local interests in normal dealings with the imperial administration. The emperor acted as final arbiter of the system in the settlement of disputes between the civil and the military and between the bureaucrats and the common people; he was also the final point of appeal in cases of injustice or oppression of any kind. During the Ming, few of the emperors gave the bureaucrats complete trust. Most of the time an emperor would select eunuchs to draft orders, conduct intelligence work and act as imperial agents in supervising a provincial administration or even an army in the field. The conflict between bureaucrats and eunuchs led to intrigues and several times to bloodshed, as in the 1620s.

The Manchus, on the other hand, had no use for eunuchs except for menial duties, for the emperor owned several thousand families of bond servants from which able persons could be selected to occupy the essential offices that the Ming eunuchs had held. This was one reason why the bureaucrats, who had been harassed by the eunuchs, found it to their advantage to serve under the Manchus.

A more important reason, however, is to be found in bureaucratic control of taxation. An official serving without interruption in a series of offices involving the collection of taxes could expect in the natural course of events to amass a fortune. A district magistrate, after he had remitted his quota to the provincial treasury and had shared the surtax with his superiors, was permitted to retain the remainder as his share. His superiors, in their turn, had to satisfy their own superiors, and so on, up to the highest ministers and the emperor himself. The system was one under which the bureaucrats came to regard officeholding as an opportunity to amass as much wealth as possible without being caught.

Under scrupulous emperors corruption could be kept under control, but during two periods of the Ch'ing dynasty, avarice at or near the top resulted in notoriously widespread corruption throughout officialdom. The first period came between 1780 and 1798, when the Ch'ien-lung emperor's favourite, Ho-shen, was in power. The burden of excessive bribes demanded from high provincial officials was passed, step by step, to the people; the result was a demoralized government and discontent among the populace. Even after Ho-shen was removed in 1799, a general rebellion of religious sects in the northern provinces and piracy on the southeast coast necessitated more than ten years of continuous warfare at tremendous cost not only to the treasury but to the vitality of the Manchu regime itself.

The second period of extreme corruption came during the time of the empress dowager Tz'u-hsi, who virtually ruled the country during the reigns of T'ung-chih and Kuang-hsü. During her ascendancy, because of the peculiar difficulties of feminine rule in China, the eunuchs regained some small portion of political influence. Tz'u-hsi's personal demands, in comparison with those of Ho-shen, were not excessive, but the cumulative effect of four decades of venality under her rule proved disastrous to China at the very time that efforts to westernize required an honest administration. Since an "able" bureaucrat of the later part of the Ch'ing period was one who could satisfy his superiors' demands, hold office for a term without causing loud complaint from the people, and yet manage to make a profit, all the modern enterprises under direct or indirect control of the officials failed to develop as they should have; capital and profits were drained off through the manipulations of the men assigned to their management. In sharp contrast, the efficient management of imperial offices by foreigners who had been employed in accordance with treaty provisions—offices such as the maritime customs and the postal service—should have made the officials realize the need for change in the administration; yet venal practices continued unmodified to the last day of the dynasty. The conclusion has been drawn by some that by suppressing the T'ai P'ing, Nien, Muslim and other rebellions in the middle of the 19th century, Chinese officialdom maintained the tottering Manchu regime beyond its natural span and exacted as its reward a larger share in both the management and the profits of the empire.

It must be noted that from the very beginning of the Ch'ing period some Chinese officials refused to compromise their national principles. Some committed suicide when the Manchus triumphed; others joined the Buddhist priesthood. A large number took up arms and fought the Manchus, and in 1683, when the last armed Chinese resistance on Formosa ended, many escaped to the South Seas. Through secret organizations they managed to transmit the old Chinese nationalism to future generations. Known collectively in English as the "Triads," the secret societies flourished in Singapore, Java and other areas, as well as in south China, and were partially responsible for the T'ai P'ing rebellion, which lasted from 1850 to 1864, and for many local uprisings in Formosa and in several mainland areas between 1721 and 1912. The Manchu emperors were aware of this situation, and in the 18th century conducted a bloody inquisition. The secret societies in foreign lands and in the concessions of Shanghai and other treaty ports, however, were out of their reach. When Sun Yat-sen began preaching nationalism in the 1890s and plotting local rebellions, financial and organizational aid came largely from the overseas members of these old anti-Manchu secret societies.

Protestant missionaries of the 19th century unwittingly contributed to the downfall of the Manchus by their translation of the Bible into colloquial Chinese, by publications giving views on social, economic and political reforms, and by giving free education to the poor. The reformers of 1898 based their program partly on knowledge of the west gained through missionary books and periodicals. After 1900 missionary schools became the models for the government's new educational system and provided an impetus for sending students abroad to study. However, the freedom of thought and discussion in foreign lands, especially in Japan, gave some of the students, most of whom came from the gentry-official class, a chance to develop ideas of nationalism, constitutional government and democracy. Significantly, it was a missionary-educated thinker, Sun Yat-sen, who provided leadership for this group of awakened Chinese youth as well as for the members of the secret societies, and who became the nemesis of the Manchu dynasty.

While Sun Yat-sen advocated nationalism and democracy, the officials, even the more progressive, were willing to try at most a constitutional monarchy. Yet after the revolution of 1911–12 forced the Manchus to abdicate, the bureaucrats, like their predecessors in 1644, changed loyalties without hesitation, trimmed off their pigtails and became avowed republicans. The Manchus were gone, but new masters with military power needed tax collectors and apologists, too. *See* also CHINA: *History;* MANCHUS.

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CHINGFORD, a municipal borough (1938) of Essex, Eng., which under the London Government Act 1963 was amalgamated on April 1, 1965, with Leyton and Walthamstow to form the new London borough of Waltham Forest (*see* LONDON). Chingford municipal borough is a residential area between the rivers Lea and Ching, on the southwestern outskirts of Epping Forest. Pop. (1961) 45,787. Area 4.5 sq.mi. The parliamentary constituency is Epping. Queen Elizabeth I's half-timbered hunting lodge at Dannet's Hill is an Epping Forest natural history museum.

CHINGLEPUT, a town and district of Madras state, India. The town is 37 mi. S.S.W. of Madras city. Pop. (1961) 25,977. Its name means "town of red lotuses." The most prominent building is the fort, used since 1887 as a trades school for juvenile offenders. It was built by the king of Vijayanagar (*q.v.*) in the late 16th century after the decline of that empire, but about 1640 it fell to the Muslim sultanate of Golconda. It was captured in 1751 with French support by Chanda Sahib, son-in-law of the nawab of Carnatic (*q.v.*), but was taken by Robert Clive (*q.v.*) a year later.

The town is on the main road and Southern railway line from Madras to Tiruchirapalli. A branch runs northwest to join the Madras-Bangalore line at Arkonam.

Chingleput District surrounds, but excludes, the city of Madras. Pop. (1961) 2,196,412. Area 3,031 sq.mi. District headquarters are at Saidapet, a southern suburb of Madras. The district has mainly loamy soils, with red sandy ground in the northwest and gray sands along the coastal strip. In the south is the Palar river, dry part of the year; irrigation depends largely on tanks fed by the three months' cold-weather rain. The main crop is paddy, followed by millets and some peanuts. Chromepet, 16 mi. S.W. of central Madras, owes its existence to the chrome tanning industry and is the seat of the Madras Institute of Technology.

The district's historic sites include Kancheepuram (*q.v.*), Mamallapuram (Mahabalipuram) and St. Thomas's Mount (*see* Madras). Mamallapuram (or "Seven Pagodas") on the coast south of Madras was founded by the Hindu Pallava king Narasimha-varman (d. A.D. 674). Surviving monuments include the famous *raths* or monolithic shrines and the huge sculptured relief "The Descent of the Ganges from the Himalaya," with life-size figures of men and animals (including elephants). The *raths* (*rath*, "car" or "chariot") are a group of eight Shaivite shrines, each cut from a huge boulder. The largest is about 40 ft. high.

Later monuments at Mamallapuram include three masonry temples built in the early 8th century by Narasimha's successor Rajasimha, of which the most notable is the Shore temple.

(G. Kn.)

CHINGOLA, the civil and government township which is associated with the Nchanga copper mine, Western province, Northern Rhodesia, Africa. The Nchanga mine maintains its own purely residential township, while Chingola provides government, educational, industrial and trading services for both townships; recreational facilities are abundantly provided by the mine township. Pop. (1961) 43,580.

Begun in 1943, Chingola, 5,000 ft. above sea level in densely wooded country, became a municipality in 1957. It is linked by a branch line to Rhodesia railways and by macadamized roads to all towns of the copper belt.

CHINGPAW, a Tibeto-Burman people and language in eastern Assam (India), northern Burma and southwestern Yünnan (China). The closest affinities of the language are to Burmese, Bodo-Naga and Kuki-Chin. The major dialects in Burma lie largely within the Kachin state, as follows: Tsasen (Hukawng valley westward into Assam, where it is known as Singpho), Duleng (vicinity of Putao), Hkahku (Sumprabum and the Triangle), Htingnai (west of Mogaung) and Gauri (Bhamo and the northern portion of the former Shan state). Chingpaw speakers, originally hill folk, have now borne the language into the towns and cities of northern Burma, and it may be the medium of instruction in schools up to the third standard (grade). In recent times it has become common practice to equate Chingpaw with the Burmese appellation Kachin (*q.v.*), although the latter subsumes not only Chingpaw speakers but those whose languages are the more distantly cognate Maru (Maru, Hpon, Atsi, Lashi, Maingtha), Nung and Lisu.

Hill-dwelling Chingpaw practise rotational cultivation, with double cropping of rice, millet, corn (maize), yams, beans and pumpkins. Under Chinese and Shan influence some have taken up wet-rice agriculture. Skilful weavers, the women retain colourful local costumes, while the men tend to adopt the dress of the lowland. A Chingpaw village may comprise between 10 and 20 houses, several such villages, each under a headman, forming a larger polity under a chief. In autocratic villages the chief is the youngest son within the founding patrilineage; in democratic communities he may be a self-made leader. In offerings to the spirits, it is only in the former that the major religious festival can be performed, but all villages may have priests and mediums.

See John F. Embree and William L. Thomas, Jr., *Ethnic Groups of Northern Southeast Asia* (1950); E. R. Leach, *Political Systems of Highland Burma* (1954). (T. St.)

CHIN HILLS, a constituent hill group of the mountain arc stretching from the Arakan Yoma northward to the Patkai hills, between Burma and India. This mountain arc, compressed at either end, has advanced farthest toward the west in the centre where the long parallel folds are most numerous and the arc broadest. The Chin hills form the highest part of this central stretch. They consist simply of a succession of long narrow troughs and ridges, from 7,000 to 10,000 ft. high, with little flat land either in the valley bottoms or on the ridge tops. There is a marked contrast between the humid tropical conditions of the deeply cut valleys and the cooler temperatures of the ridges. This contrast is reflected in the vegetation. Above 3,000 ft. the tropical forest gives way to oak and pine woods which in turn give way above 7,000 ft. to the rhododendron. A migratory form of agriculture, the *taungya* system, is practised in these hillside woods where the greater part of the population is centred. Clearings are made and the wood burned for fertilizer. Such clearings are cultivated for two or three years and then abandoned. Bamboo, bracken and elephant grass then spring up with such vigour that natural reafforestation is impossible. The main crop cultivated by this method is jowar millet, contrasting with rice in the plains of Lower Burma. Some rice is grown in the Chin hills on the lower slopes on terraces constructed with the help of felled timber.

The north-south trend lines of Indochina as a whole have permitted the populating of the region with Mongoloid peoples coming down from the north and have hindered east-west movement of both peoples and culture so that the valleys are peculiarly isolated. The Arakan Yoma-Patkai mountain arc exemplifies these features. It constitutes a frontier zone between Indian and Burmese cultures and its hill tribes remained independent of British administration until the close of the 19th century. The Chin hills, lying on the Irrawaddy side of the watershed, were eventually occupied to prevent raids by the hill folk on the plains of Burma. They were then administered primarily with the object of preserving the peace and of building up a sound government on the basis of the tribal system. The substitution of peaceful agriculture for raiding produced changes in the distribution of population; the defensive hill sites were deserted and population became concentrated on the more easily cultivable land. The whole of the southern part of the Arakan Yoma-Patkai mountain arc from the Chin hills southward into the Arakan Yoma is occupied by the Chin peoples who belong to the southern Mongoloid race group and are linguistically a branch of the Tibeto-Burmans. This was recognized by the creation of the Chin Hills special division when Burma became independent in 1948. The division comprises the old Chin hills proper (10,377 sq.mi.; pop., 1941, 186,405) and also the former Arakan hill tracts.

(P. M. R.; L. D. S.)

CHIN HILLS SPECIAL DIVISION. Under the constitution for the Union of Burma drawn up in 1947 provision was made for the recognition of the special interest of the Chin peoples (*see* Chin) living in the tangle of forested hills between India and Burma. Lacking the cohesion of the Shans, Kachins and Karens, now forming autonomous states within the Union of Burma; the Chins do not form a state, but their territory has been constituted a special division and their interests are the concern of the minister for Chin affairs in the cabinet. The division comprises broadly the Chin hills (*q.v.*) proper, now known as the Northern Chin Hills district, and the former Arakan hill tracts, previously part of Arakan and now known as the Southern Chin Hills district, together with the former Pakokku Hill tracts. Total area 13,903 sq.mi. Some parts of the division, including Mt. Victoria (10,018 ft.), rise to more than 8,000 ft. The main centres are Falam and Tiddim in the north and Paletwa in the south. Efforts are being made to bring the division into closer touch with Burma proper by the construction of roads and there are all-weather airstrips at Kalemyo and Kyauktu. The total population in 1956 was estimated at 230,115 living in 11,314 villages, but only 265 of these villages had over 50 houses so that the provision of 275 schools was a creditable performance. (L. D. S.)

CH'IN-HUANG-TAO (CHINWANGTAO), former treaty port on the shores of the Gulf of Liaotung in Hopeh province, northeast China, was opened to foreign trade in 1901. Pop. (1953 census) 186,800. The port has an artificial harbour that was developed by the Kailan mining administration for the export of coal from the Kailan mines, 60–100 mi. W. of the port. Export trade originated almost entirely from the coal field and comprised not only coal but also coke, firebrick and cement manufactured at T'angshan, the industrial town built on the coal field. Ch'in-huang-tao had the largest glass factory in China. As the only ice-free port of north China, it developed an important transit trade by rail for Tientsin and south Manchuria, since the town is on the main rail line between Manchuria and north China. After 1931 the port became an important centre of Japanese smuggling into north China. Guarded by the U.S. marines in 1945–46, the port was undamaged at the end of World War II.

Under the Chinese Communists the city developed considerable light and handicraft industry after 1952. The Kailan mines were confiscated and their production notably increased, so that by 1958 they were the largest coal producer in the Chinese Communist industrial program, with further production increase planned. Coal mining in 1958 was carried on at other points nearer the port, notably at Shih-men-chai, to the north, since the region produces very good bituminous coal. (J. E. SR.)

CHINNAMP'O is the chief port of northwestern Korea, 34 mi. W. of P'yongyang, on the estuary of the Taedong river. Floating docks overcome the handicap of the high tides of the shallow Yellow sea. Heavy industries, notably a copper and gold refinery, and light industries, such as rice milling, were developed during the days of Japanese control (1910–45). North of the city along the coast are some solar-evaporation salt pans. Eight miles east of the city on the Taegon estuary is Kyomipo, an iron and steel centre. The population of Chinnamp'o was estimated at 75,000 in 1958. (S. McC.)

CHINON, a town of western France, in the *département* of Indre-et-Loire (*q.v.*), is situated on the banks of the Vienne, 46 km. (28.6 mi.) S.S.W. of Tours by road. Pop. (1954) 4,602. It lies under a rocky height crowned by ruins of the famous castle, its narrow, winding streets containing many turreted houses of the 15th and 16th centuries. Of its oldest church, the Romanesque St. Mexme, only the façade and nave are left. The church of St. Stephen dates from the 15th century, that of St. Maurice from the 12th, 15th and 16th centuries.

The castle, which has undergone considerable modern restoration, consists of three separate strongholds. That to the east, the Château de St. Georges, built by Henry II of England, has almost vanished, only the foundation of the outer wall remaining. The Château du Milieu (11th to 15th centuries) includes the keep, the Pavillon de l'Horloge and the Grand Logis, where the first meeting between Joan of Arc and Charles VII took place. Of the Château du Coudray, which is separated by a moat from the Château du Milieu, the chief remains are the Tour du Moulin (10th century) and two later towers. A statue of Rabelais, who was born in the vicinity of the town, stands on the river quay.

Chinon is on a secondary railway from Tours to La Roche-sur-Yon. Cooperage is the chief industry, but there is a nuclear power reactor nearby.

Chinon (Caïno) existed before the Roman occupation of Gaul, and was from early times an important fortress. It was occupied by the Visigoths, and subsequently, after forming part of the royal domain, came to the counts of Touraine, the counts of Anjou, and then to Henry II of England. It was won back to France by Philip Augustus in 1204, after a year's siege. In World War II Chinon was occupied by the Germans from June 1940 until Aug. 1944.

CHINOOK, an important American Indian people who held the Columbia river and adjacent territory from the mouth to The Dalles. Their culture was a localized form of the Northwest Coast type, with plank houses, good canoes, trade, slavery and potlatch distributions of property, but without secret societies or totemic art. The language is distinctive, and a selection of words from it, much simplified phonetically and with the grammar obliterated, forms the basis of the Chinook jargon. This trade language contains also French, English, Nootka and other Indian ingredients and prevails from California to Alaska. The Chinook were organized by settlements rather than tribes; some of their divisions are known as Clatsop, Wasco and Wishram. Estimated at 16,000 in 1805, they decreased (from disease) to a twentieth in the next 50 years and in the early 1960s numbered perhaps 200–300, known under different names on several reservations containing ethnic mixtures.

See also INDIANS, NORTHWEST COAST.

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CHINOOK, the name given to a warm dry wind on the east side of the Rocky mountains in North America blowing from a westerly direction, primarily in winter. Winds of the same type occur in other parts of the world, and are known generally as foehn winds. The word chinook was first used at Astoria, Ore., to represent a warm moist wind blowing off the Pacific ocean, because it came from the direction of the Chinook camp near the mouth of the Columbia river. The modern chinook is presumably the same Pacific air after some of its moisture has condensed over the west slopes of the mountains. This makes the air warmer and drier as it descends the east slope of the Rockies, where it undergoes compressive heating and drying. When the chinook reaches the western Great Plains of the United States or Canada in winter, it often replaces the cold, dry continental air normally prevailing there. It is called "the snow eater" because it causes a rapid disappearance of snow on the ground by melting and evaporation. A chinook is likely to occur when a strong low-pressure area farther north is moving eastward. Sometimes the frontal boundary between chinook and continental air masses oscillates due to minor disturbances traveling along the front. An example of remarkably rapid temperature changes from this cause occurred on Jan. 22, 1943, at Rapid City, S.D., on the east side of the Black hills. Morning temperatures shifted back and forth between 10° to 15° F. and 55° F. several times, the most rapid change being a 44° temperature rise in only 15 min. *See* also WIND. (E. M. Bs.)

CHINQUAPIN, the name given to several North American shrubs or small trees belonging to the genus *Castanea* of the Fagaceae (*q.v.*; beech family). The most important of these is *C. pumila*, a shrub or small tree found chiefly in dry soils from New Jersey to northern Florida and westward to southwestern Missouri and eastern Texas. In Arkansas and Texas, where it attains its best development, it occasionally reaches a height of 45 ft. and a diameter of 30 in. It is closely related to the chestnut, *C. dentata*, from which it differs in its much smaller leaves, which are white-woolly beneath, and its usually solitary nut, which like that of the chestnut is very sweet and edible.

On the Pacific slope the name chinquapin is given to two species of *Castanopsis*, a genus closely allied to *Castanea*. Golden chinquapin (*Castanopsis chrysophylla*), found from southern Washington to southern California, is a magnificent tree which occasionally attains a height of 150 ft. and a trunk diameter of 8 ft. The lance-shaped evergreen leaves, three to five inches long, are clothed beneath with minute golden-yellow persistent scales. The fruit is similar to that of the chestnut and contains one or two hard-shelled nuts with a sweet kernel. The wood is reddish-brown, straight grained, easily worked and takes an excellent finish, yet it is not extensively utilized. The bark, although devoid of tannin, is sometimes used to adulterate that of the tanoak (*Lithocarpus densiflorus*), with which it is often associated in the forest. Bush chinquapin (*C. sempervirens*) is a small spreading shrub of dry mountain slopes in California. Some authorities regard it as a variety of the golden chinquapin. (E. S. Hr.)

CHINTZ, a word derived from the Hindu *chint,* "spotted or variegated." This name was given to a kind of stained or painted calico produced in India. It is now applied to a highly glazed printed calico, commonly made in several colours on a light ground and used for hangings, covering furniture, etc.

CHIOGGIA, a town in the Veneto region of Italy, in the province of Venezia, is situated 24.1 km. (15 mi.) S. of Venice, of which it is a suffragan diocese. Pop. (1957 est., comm.) 48,902. The town rises on a lagoon on one of the islands along the coast of the Veneto and is crossed by three parallel canals. It is joined to the mainland by a bridge and by a railway from the Polesine which ends at Rovigo, 37 km. (23 mi.) away, and is connected to Venice by water and by road.

The 11th-century cathedral, rebuilt in the pseudoclassical style to the design of Baldassare Longhena, contains paintings of the Venetian school. S. Martino has a valuable polyptych by Paolo Veneziano (1349) and S. Domenico (13th century, renovated in the 18th century) contains the "St. Paul" of Vittore Carpaccio. Also of note are the column of the charming Piazzetta Vigo with its Byzantine capital and the episcopal square with its 18th-century statues. The town is the birthplace of the painter Ambrogio Marinetti (1710–96), called Il Chioggiotto.

The main commercial activity is fishing and the fishing port is one of the largest in Italy. Through the port, also, Istrian stone is imported and products of the kilns of the Polesine and herbs cultivated in the vicinity are exported. There is a naval construction yard.

The town is perhaps the Fossa Clodia mentioned by Pliny. Destroyed by the invading barbarians, it became part of the duchy of Venice and reproduced in the commune the duchy's methods of administration. In 1797 invading French troops made Chioggia a free port in competition with Venice.

The Naval War of Chioggia.—This war (1378–81), so called from the decisive action at Chioggia, marked the last phase of the economic rivalry between the two great maritime republics of Genoa and Venice (*qq.v.*). Genoa, backed by the king of Hungary and Francesco da Carrara, lord of Padua, had defeated the Venetian army under Vettor (Vittorio) Pisani at the battle of Pula. The Genoese then sent into the Adriatic 50 galleys and other ships under Adm. Pietro Doria. They took Chioggia and began to harass Venice from there, while Carrara did the same from the mainland. Barriers were thrown across the Venetian canals and Pisani, made commander of the Venetian fleet, manned every vessel in the arsenal with pressed men. After several encounters at the entrance of the port of Chioggia, the Genoese made the mistake of setting fire to a Venetian sailing ship which sank at the mouth of a canal, trapping the Genoese galleys. The Venetians themselves then sank a number of other ships loaded with stones in the canal, making the blockade more thorough. Carlo Zeno, recalled from his mission of harassing Genoa's colonies in the east, then arrived with a substantial reinforcement of 15 galleys. The Genoese, tormented by hunger, drove the inhabitants of Chioggia from the town in order to conserve supplies. But even so, food was insufficient. Doria had died in battle, and his successor treated with the Venetians, who demanded unconditional surrender. On June 24, 1380, 4,000 men, reduced to skeletons by hunger and hardship, the miserable remnant of what had been the most powerful marine force in the Mediterranean, gave themselves up. The war dragged on through 1380 and ended on May 20, 1381, with the peace of Turin, brought about by the mediation of Amadeo VI of Savoy.

See I. Tiozzo, *Chioggia* (1926); V. Lazzarini, *Due documenti della guerra di Chioggia* (1864). (M. T. A. N.)

CHIOS (Gr. Khios; Ital. Scio), an island of Greece on the west coast of Asia Minor, about 30 mi. long from north to south and from 8 to 15 mi. broad. Pop. (1951) 64,672. The north and west are mountainous with steep coasts; south and east there is fertile, open country. The capital, Chios, on the east coast, has a small, safe harbour. Pop. (1951) 24,361. The climate is healthy. Oranges, olives and even palms grow freely and the figs were famous in antiquity, but wine and gum mastic have always been the principal products. The latter, collected from a wild shrub, gives flavour and name to a popular Greek liqueur (*mastikha*). Antimony, calamine and marble are worked; there is a tanning industry and considerable coasting trade. The island, which is of volcanic origin, has no real water course, and its irrigation is entirely artificial. Severe earthquakes have occurred, particularly in 17 B.C. and 1881.

The ancient city lies beneath the modern and little is known about it. Six miles to the north is Dascalopetra, or "Homer's Seat," a rock-cut shrine of Cybele. At Ayion Gala in the northwest the British excavated an Early Bronze Age cave. In the south both British and Greek archaeologists have explored the important temple of Apollo Phanaios (at Fana), and at Emporio British excavations (1951–55) uncovered an Early Iron Age fortified town, an archaic town and sanctuary and a late Roman basilica and fortress. At the centre of the island is the monastery of Nea Moni, founded 1042–56, with fine 11th-century Byzantine mosaics. In the town there is an impressive medieval *castro*.

Homer was reputed to have lived in Chios, and it was the home of the school of bards, the Homeridae. Glaucus of Chios was supposed to have invented iron welding in the 6th century B.C. and Dexamenos of Chios was a noted gem engraver of the late 5th century. The island's coins are characterized by the sphinx and wine jar. Of the antiquities which have left the island the most famous are the head in the style of Praxiteles now in the Boston Museum of Fine Arts and the Hellenistic bronze horses now surmounting the façade of St. Mark's, Venice, which were removed in the 5th century A.D. from Chios to Constantinople and thence to Venice in 1204.

Mycenaean settlement on Chios may be referred to the Greek legends about Oinopion. It was resettled by Abantes from Euboea, and in the 8th century B.C. was admitted to the Panionic league.

The Chian colony at Maronea on the coast of Thrace reinforced the wine trade of the mother city. Like Miletus, Chios in 546 submitted to Cyrus I of Persia as eagerly as Phocaea resisted him. When Miletus revolted, 100 Chian ships joined in offering desperate opposition at Lade (495). Persian reprisals were severe and temporarily successful, for Chian ships, under the tyrant Strattis, served in the Persian fleet at Salamis. However, Chios joined the Delian league (formed 478–477) and long remained a firm ally of the Athenians, retaining political independence and a navy of its own. In 412 the island left the league. In 384 it entered a second alliance with Athens, but in 357 again seceded. It was reputed one of the best-governed states in Greece for, although it was governed alternately by oligarchs and democrats, neither party persecuted the other severely. Late in the 4th century, however, civil dissension left it a prey to Idrieus, the dynast of Caria (346), and to the Persian admiral Memnon (333). During the Hellenistic age Chios retained its independence, supported the Romans in their eastern wars and was made a "free and allied state." Under Roman and Byzantine rule the island's industry and commerce were undisturbed, its chief export at this time being the Ariusian wine of the northwest coast (Ariusia).

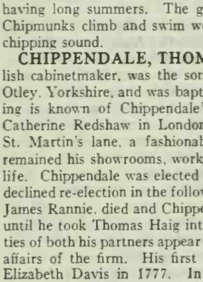
After temporary occupations by the Seljuk Turks (1089–92) and by the Venetians (1124–25, 1172, 1204–25), Chios was given in fief to the Genoese family of Zaccaria. In 1346 it passed definitely into the hands of a Genoese *maona* or trading company, which was organized in 1362 under the name of the Giustiniani and alone exploited the mastic trade. The Greeks, however, were allowed to retain their rights of self-government. In 1415 the Genoese became a tributary to the Ottomans and, in spite of occasional secessions which brought severe punishment (1453, 1479), the rule of the Giustiniani was not abolished until 1566. Capture by and reconquest from the Florentines (1595) and the Venetians (1694–95) temporarily injured the island's prosperity. In 1822, during the Greek War of Independence, a large number of the Christian inhabitants were massacred or sold into slavery by the Turks. Many of the survivors fled to Syros and founded its prosperous carrying trade. But Chios' natural resources made its recovery certain. The island passed quietly from Turkish to Greek rule during the Balkan War of 1912. It was occupied by Germany between 1941 and 1944. (J. Bo.)

ALLAN D. CRUICKSHANK FROM NATIONAL AUDUBON SOCIETY

CHIPMUNK (TAMIAS STRIATUS) OF EASTERN NORTH AMERICA

terrestrial squirrel. Two genera are known; *Tamias*, with one species, *striatus*, occurs over eastern United States and Canada, and *Eutamias*, with many species, occurs in western North America east to the Great Lakes region and south to northern Mexico and also in central and eastern Asia. The body is four to six inches long and bears longitudinal dark stripes on the back and usually a dark stripe crosses the eye. In the eastern chipmunk the central stripe is bordered by brownish lines and the two outermost stripes are separated by wider whitish lines. The hip region is coloured reddish-brown, and the four-inch tail is bushy. The den is in a burrow excavated by the chipmunk. Chipmunks live in loose colonies; sometimes several share a burrow but only rarely the same grass-lined nesting chamber. They relish seeds, berries and tender vegetation but sometimes eat animal food. Seeds are commonly stored underground for use in winter and are carried in the capacious cheeks. Because of their food habits chipmunks occasionally become a nuisance in gardens but can easily be controlled by trapping, poisoning or fumigation. Two to eight young are born in spring or summer; a second litter, usually smaller, is often produced in areas having long summers. The gestation period is about a month. Chipmunks climb and swim well. The call is a shrill chirring or chipping sound. (K. R. Kn.)

CHIPPENDALE, THOMAS (1718–1779), celebrated English cabinetmaker, was the son of John Chippendale, a joiner of Otley, Yorkshire, and was baptized there on June 5, 1718. Nothing is known of Chippendale's early life until his marriage to Catherine Redshaw in London in 1748. In 1753 he moved to St. Martin's lane, a fashionable cabinetmaking district. There remained his showrooms, workshops and home for the rest of his life. Chippendale was elected to the Society of Arts in 1759, but declined re-election in the following year. In 1766 his first partner, James Rannie, died and Chippendale continued the business alone until he took Thomas Haig into partnership in 1771. The activities of both his partners appear to have been limited to the business affairs of the firm. His first wife died in 1772 and he married Elizabeth Davis in 1777. In 1779 Chippendale died of tuberculosis and was buried on Nov. 13 at St. Martin-in-the-Fields, London.



BY COURTESY OF THE METROPOLITAN MUSEUM OF ART, N.Y., ROGERS FUND, 1908

CHIPPENDALE SIDE CHAIR (C. 1740–50)

Chippendale, though head of an important firm, was not the leading cabinetmaker of his day and his exaggerated posthumous reputation is attributed largely to his work *The Gentleman and Cabinet Maker's Director*, first published from St. Martin's lane in 1754. This folio, the most important collection of furniture designs published in England up to that time, illustrated almost every type of mid-18th-century domestic furniture. The first and second (1755) editions contained 160 plates; the third edition, published in weekly parts from 1759 to 1762, had 200. The designs represent the fashionable furniture of the period. The rococo style, adapted from the French *rocaille*, predominates, characteristically employed in the many designs for mahogany chairs with intricately pierced splats and elaborately carved case furniture. Other designs show essays in the Chinese and Gothic taste, some to be carved in softwood and ja-

by Chippendale, it is now accepted that many were the work of employed designers, notably H. Copland, who had previously published designs in the rococo style. M. Lock, who had published rococo designs with Copland, was employed to provide special designs for clients. Original drawings for plates in the *Director* are preserved in the Victoria and Albert museum, London, and in the Metropolitan museum, New York.

Chippendale's name is given indiscriminately to great quantities of mid-18th-century furniture, but, in fact, only comparatively few pieces can be assigned with certainty to his workshop: it should be realized that Chippendale, once established as head of a large firm, did not make furniture himself. Even pieces that resemble designs in the *Director* cannot be attributed to his firm without further evidence, for the designs were available to contemporary cabinetmakers, some of whose names appear in the original list of subscribers. In certain cases, where a piece corresponds to a *Director* plate and where the original owner was a subscriber to the *Director*, or is known to have employed Chippendale, a tentative attribution may be made, as with a fine mahogany chair at Arundel castle, West Sussex, an unusual bookcase at Wilton house, Wiltshire, and the furniture from the Chinese bedroom at Badminton, Gloucestershire, now in the Victoria and Albert museum.

From the 1760s onward, influenced by Robert Adam, Chippendale adopted the new neoclassic style. Existing bills for work carried out by his firm at Nostell priory and Harewood house, Yorkshire, during this last phase of his career, not only identify the fine mahogany and marquetried satinwood furniture in the neoclassic taste which he supplied to these houses, but also show that as "cabinet-makers and upholsterers," his firm undertook all branches of interior decoration. The superb satinwood and inlaid commodes and other furniture at Harewood house, Yorkshire, are masterpieces of the cabinetmaker's craft and on them Chippendale's reputation may safely stand.

Thomas Chippendale (*c.* 1749–1822), eldest son of the above, succeeded his father and until the retirement of Thomas Haig in 1796 the firm traded under the title of "Chippendale and Haig." Though declared bankrupt in 1804, the younger Chippendale continued the business at St. Martin's lane and opened an additional shop in the Haymarket in 1814, which was removed to Jermyn street in 1821. The firm continued to make high-quality furniture as well as undertaking such work as upholstery and paper hanging. Fine Regency-style furniture supplied by the firm to Harewood and to Stourhead house, Wiltshire, can be identified from existing bills. Like his father, the younger Chippendale was a member of the Society of Arts and is known to have exhibited five pictures at the Royal Academy between 1784 and 1801. He died in 1822.

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(J. E. Le.)

CHIPPENHAM, a market town and municipal borough in the Chippenham parliamentary division of Wiltshire, Eng., on the Wiltshire Avon, 20 mi. S.W. of Swindon by road. Pop. (1961) 17,525. Chippenham (Cippanhamm, Chipeham) was the site of a royal residence where, in 853, Aethelwulf celebrated the marriage of his daughter Aethelswith with Burgred, king of Mercia. The town was occupied by the Danes during their invasion of 878, and in 933 was the meeting place of the witan. In Domesday Book Chippenham appears as a crown manor. The town was governed by a bailiff in the reign of Edward I; it was incorporated in 1554 and sent two members to parliament until 1867 and one until 1885. The London-Bath road crosses the Avon at Chippenham by a stone bridge of 20 arches. St. Andrew's parish church, originally 12th-century Norman, has been enlarged in different styles. The grasslands of the neighbouring Cotswold hills reared the sheep which gave Chippenham its fame as a woolen centre from the 16th century. This trade has declined and the town is a centre for milk distribution and processing. Other industries are bacon curing, food processing, tanning, furniture making and electrical and railway engineering. A weekly cattle market is held.

one of the important Algonkian Indian tribes of Canada and the United States. *See* Ojibwa.

CHIPPING CAMPDEN, a market town of Gloucestershire, Eng., lies near the northern edge of the Cotswold hills, 29 mi. N.E. of Gloucester by road. Pop. (1951) 2,619. It is noted for the beauty of its buildings of Cotswold stone erected by medieval wool staplers; outstanding structures include the 15th-century market hall, the house of a great wool merchant, William Grevel (d. 1401), a range of almshouses and the Perpendicular "wool" church of St. James.

In 1173 the manor passed to Hugh de Gondeville, and about 1204 to Ralph, earl of Chester, both of whom granted charters to the town. Throughout the 12th–14th centuries Campden (*Chipping*, "market") was an important centre of the wool trade, many sheep being raised on the Cotswolds, but its importance dwindled when the staple was taken to Calais, France. John Ruskin and William Morris reintroduced weaving by bringing their guild of handicrafts there from London. Campden was incorporated in 1605, but was never represented in parliament. The corporation was abolished in 1885. In the Restoration period the "Campden Wonder" took place, when the Perrys (a woman and her two sons) were hanged for the presumed murder of William Harrison, who later returned with a curious story of kidnapping that has never been substantiated.

CHIPPING NORTON, a municipal borough of Oxfordshire, Eng., is 20 mi. N.W. of Oxford by road. Pop. (1961) 4,241. It stands 650 ft. above sea level on the slope of a northern spur of the Cotswolds. The wide main street is flanked by 18th-century houses in Cotswold stone. The church of St. Mary the Virgin, rebuilt in the 15th century in the Perpendicular style, is one of the beautiful Cotswold "wool" churches. The almshouses, erected in 1640 and internally modernized, are also examples of local architecture. The guildhall is a fine example of Cotswold medieval building. A castle existed in the middle ages, but only grass-covered mounds remain. From 1302 to 1366 Chipping Norton returned two representatives to parliament. In 1606, when James I granted its charter of incorporation, it was one of the five most important towns in the county. Local occupations are mainly agricultural, although there are a tweed mill, a provender mill and an ironworks.

CHIQUIMULA, a department in eastern Guatemala, bordering Honduras and El Salvador. Its area is 917 sq.mi., and its population (1957 est.) 143,843. Its capital is Chiquimula. The predominantly Indian population raises maize, beans and wheat, and pastures beef cattle. There are also some plantations that grow coffee, sugar cane and rice. Access is by highway to Zacapa in the Motagua valley and by rail to Zacapa or southward to San Salvador. Trails, impassable in wet weather, connect it with Copán in Honduras. (P. E. J.)

CHIQUITOAN, an independent linguistic stock of South American Indians, so called from the Chiquito, who are the best known of its tribes. The stock occupies a considerable area in eastern Bolivia, in the forested hilly country on the northern border of the Chaco. In recent times they have held the area between the headwaters of the Guaporé on the north and the hills on the northern bank of the Otuquis river on the south, and between the San Miguel river in the west and the Paraguay in the east. It is probable that they formerly extended farther west to the foothills of the Andes and may have been forced eastward as a result of the displacement of peoples caused by the invasion and settlement of the Chiriguano in the early 16th century. The Chiquito were a rather warlike and mainly nomadic hunting and fishing folk of simple culture. Their name, meaning "little ones" in Spanish, was given them on account of the very small doorways of their tiny thatched huts, through which one had to crawl on hands and knees. They seem to have had some palisaded strongholds and to have used poisoned arrows. Some of the tribes made good pottery and simple textiles. They had no canoes. Monogamy was the rule except for the chiefs, who were not hereditary but chosen for valour and ability. The youth before marriage lived apart in a special house. The shamans appear

ligious ceremonies.

See Alfred Métraux, "Tribes of Eastern Bolivia and the Madeira Headwaters" in *Handbook of South American Indians*, ed. by Julian H. Steward, Bureau of American Ethnology Bulletin 143, vol. 3, pp. 381–395.

CHIRCHIK, a town in the Uzbek Soviet Socialist Republic, U.S.S.R., lies on the Chirchik river 20 mi. N.E. of Tashkent. Pop. (1959) 65,000. It is an important industrial centre producing nitrogen fertilizer and related chemicals, agricultural machinery and chemical industry equipment. It also possesses a large hydroelectric station and there are shoe and clothing factories. The town, which has several technical colleges, was developed industrially in the 1930s on the site of Kirgiz-Kulak village in Tashkent *oblast*. (G. E. Wr.)

CHIRICO, GIORGIO DE (1888–), Italian painter, whose remarkably imaginative paintings suggested the mood of early 20th-century Italy and had a marked effect on the Surrealist movement. Born of Italian parents in Volos, Greece, on July 10, 1888, Chirico entered the Munich Academy of Fine Arts at 18. His early style was influenced by the painting of Arnold Böcklin and the philosophy of Nietzsche. Moving to Paris in 1911, he created his famous style of boldly painted enigmatic objects and simplified architecture set in strongly accentuated perspectives. By 1915 he was in the Italian army, but ill-health freed him from most military duty. With Carlo Carrà at Ferrara he practised a modification of his earlier manner called the *scuola metafisica*, marked by a generally denser and more arbitrary arrangement of his unusual forms. After World War I he adopted a more realistic and romantic style that was less widely admired.

See J. T. Soby, *Giorgio de Chirico* (1955). (J. C. Se.)

CHIRIQUÍ, a province in western Panamá bordering the Pacific ocean. Pop. (1960) 186,801; area 3,460 sq.mi. David, the provincial capital (pop. 22,694), is in the centre of agricultural areas. North of David in highland valleys are coffee and orange growing districts; south and east are the most important cattle grazing areas of Panamá. West of David, banana plantations developed by the United Fruit company produce most of the bananas exported from Panamá. Agricultural districts are connected by railways with Pedregal, important in coastwise shipping, and Puerto Armuelles, from which bananas are exported. (C. F. J.)

CHIROMANCY, the art of telling character or fortune by studying the lines of the hands. *See* Palmistry.

CHIRON, in Greek mythology, one of the centaurs (*see* Centaur), the son of Cronus and Philyra, a sea nymph. He dwelt at the foot of Mt. Pelion, and was famous for his wisdom and knowledge of the healing art. He offers a remarkable contrast to the other centaurs in manners and character. Many of the most celebrated heroes of Greece were brought up and instructed by him. Accidentally pierced by a poisoned arrow shot by Hercules, he renounced his immortality in favour of Prometheus, and was placed among the stars as the constellation Sagittarius.

CHIROPODY, the diagnosis and treatment of conditions affecting the feet. *See* Podiatry.

CHIROPRACTIC is a system of treatment of human diseases and injuries based on the premise that the nerve system controls all other systems and all physiological functions in the body; that interference with the nerve control of these systems impairs their function and induces disease by rendering the body less resistant to infection or other exciting causes. The chiropractor treats by adjustments and manipulation of the structures of the body, especially the spinal column, to restore normal nerve function. D. D. Palmer began the practice of chiropractic in 1895.

CHIROPTERA, the order of mammals containing the bats. The forelimbs on these animals are modified into a wing so that they can truly fly. The name of the order is derived from Greek and means "hand wings." *See* Bat; *see* also references under "Chiroptera" in the Index volume.

CHIRU (*Pantholops hodgsoni*), an antelope of Tibet and extreme northern India; it lives at elevations of about 12,000 to 18,000 ft., which are above the usual agricultural areas. They are grayish fawn colour with white undersides. The males have a blackish face and a somewhat swollen muzzle, showing affinity with the saiga in adjacent territory. The sharp horns of the males reach a length of 28 in., and the height of the animal at the shoulder sometimes may be slightly over 30 in. Although it may weigh as much as 120 lb., the chiru can normally outrun dogs or wolves. The only call recorded is a bleat. In mating habits the chirus resemble some other herd animals, such as the wapiti, in that the male gathers a harem of 10 to 20, becomes thin with lack of feeding and wages serious battles with rivals. The females seem indifferent and require much herding by the male to keep the group together. Mating takes place in the autumn and fawns are born in May.

This animal has been held sacred by some Tibetans and the meat is not eaten by lamas (though it is tasty to others who hunt it); the blood is supposed to have medicinal properties, and the future is said to be foretold by the knobs on the horns. A side view of the chiru, with a single horn aspect, caused some people to strengthen their belief in the unicorn. (O. J. M.)

CHISHOLM, HUGH (1866–1924), whose intellectual and organizing abilities were shown in his editorship of the *Encyclopædia Britannica*, particularly in the 11th edition, was born in London on Feb. 22, 1866. Graduating from Oxford in 1888, he became assistant editor of the *St. James's Gazette* in 1892, and editor in 1897. In 1900 he joined the *Times* as co-editor of the new supplementary volumes constituting the 10th edition of the *Encyclopædia* (1902), and as editor in chief (1903) he was responsible for the new (11th) edition (1910–11), and for the *Britannica Year-Book 1913*. He was city editor of the *Times* from 1913 to 1920, when he reassumed editorship of *Britannica* for the new supplementary volumes of the 12th edition (1921–22). He died in London on Sept. 29, 1924. *See* also ENCYCLOPAEDIA.

See Herman Kogan, *The Great EB* (1958).

CHISLEHURST AND SIDCUP, an urban district (1934) of Kent, Eng., which under the London Government Act 1963 was divided on April 1, 1965: the northern part was joined with Bexley, Erith, and Crayford to form the new London borough of Bexley, and the southern part with Bromley, Beckenham, Orpington, and Penge to form the new London borough of Bromley (*see* LONDON). The urban district includes the old village of Mottingham and the industrial Cray Valley (paper mills, sand and gravel, telephone and cable works, etc.). Pop. (1961) 86,892. Chislehurst is 300 ft. above sea level, almost surrounded by commons and woods; Petts Wood is National Trust property. Chislehurst caves are of unknown origin. The church contains tombs of the Walsinghams, Bettensons, and Sydneys. Napoleon III and the empress Eugénie lived at Camden House (now a golf club) built in 1609 by William Camden the antiquary. The mortuary chapel of St. Mary's Catholic Church for several years contained the body of the emperor, for whom it was built.

CHISWICK: *see* BRENTFORD AND CHISWICK.

CHITA, an *oblast* of the Russian Soviet Federated Socialist Republic, is in the Transbaikalia region of the U.S.S.R., bordering on the Mongolian People's Republic and northern China. Pop. (1959) 1,036,387. Area 166,602 sq.mi. The *oblast* displays marked relief, consisting of a complex series of mountain ranges, plateaus, valleys and depressions, with a general southwest-northeast orientation. The area has been affected by uplift, rifting and fracturing in every major geological folding period.

The major range is the Yablonovy in the west and north centre of the *oblast*. The greater part of Chita *oblast* is drained by the rivers which unite to form the Amur, notably the Argun and the Shilka. The latter is formed by the confluence of two sizable rivers, the Ingoda and the Onon. The north is drained by the tributaries of the Lena (*q.v.*), the largest of which is the Vitim. Most of the *oblast* is covered by coniferous forest, dominated by Dahurian larch, with podsol soils often underlain by permafrost. In the more extensive depressions of the south and southeast, there is forest steppe and steppe vegetation, developed on black earth and chestnut soils. The climate, although varying locally with relief, is severely continental, with an annual range of about 80° F. and extremely cold winters. The *oblast* has a January average of −14° F. Rainfall is low, from 16 in. on the higher areas to 10–12 in. in the lowlands, with a marked late summer maximum. Winter snow cover is very thin, which, together with low spring rainfall, often affects crops adversely.

In 1959 there were 49,109 inhabitants in the Agin-Buryat National *Okrug*, which lies within the *oblast*. Apart from the Buryats there are some Yevenki or Evenki (Tungus) living in the north. The bulk of the population are Russians. Cossacks first entered the area about 1650 and in 1653 founded Irgenski Fort near the modern town of Chita and in 1658 founded Nerchinsk, which became a major trading centre with China. The 1689 treaty of Nerchinsk with China halted the Russian advance into the Amur basin and the Chita region remained a frontier zone until the mid-19th century, when the Amur area was occupied. Russian settlement was slight until the discovery of gold in 1830 and reached large proportions only after the coming of the Trans-Siberian railway in 1897. This railway, which traverses the *oblast*, is still the main axis of communication. The *oblast* was formed in 1937 after dissolution of the East Siberian Territory. In 1948 its eastern part was added to Amur *oblast*.

In 1959 there were 9 towns and 40 urban areas, with 564,289 inhabitants, or 54.4% of the total population. Apart from Chita (*q.v.*), the administrative centre, the main towns are Petrovsk-Zabaykalski in the west, and Nerchinsk and Sretensk in the Shilka valley.

The *oblast* is rich in mineral resources and the most important sector of the economy is mining, particularly of gold (chiefly at Balei), silver, tin, zinc and lead. By the 1960s iron and copper reserves were being exploited. Coal and lignite are mined and production in the early 1960s amounted to more than 3,000,000 tons, about half coming from the Chernovskoye field. Metallurgy is concentrated in Petrovsk-Zabaykalski. Other industries include machine-building at Chita, shipbuilding at Kokui, near Sretensk, and timber mills and metal works along the Trans-Siberian railway. Timber working is important and widespread. Because of the relief and climate, agriculture is not well developed, despite considerable plowing in 1954–56 under the virgin lands scheme, and livestock rearing, especially of sheep, is dominant. Fox and squirrel furs are exported from the *oblast*. (R. A. F.)

CHITA, a town and *oblast* centre in the Russian Soviet Federated Socialist Republic of the U.S.S.R., stands on the Chita river, near its confluence with the Ingoda. Pop. (1959) 171,816. Founded in 1653 as the Cossack Irgenski fort, Chita derived its early importance from trade with China. The improvements in draining and leveling carried out by the Dekabrists (*q.v.*), exiled to Chita after the plot of Dec. 1825, developed it into a prosperous settlement, but it displayed marked development only after the coming of the Trans-Siberian railway in 1897. Chita has locomotive and rolling stock repair works, sawmills, a meat-packing and a flourishing sheepskin and leather industry. Its educational facilities include medical and pedagogical institutes. Near the town the former Chinese Eastern railway branches off to Harbin and Mukden, thus making the town a most important junction. (R. A. F.)

CHITAL (AXIS DEER), a medium-sized deer (*Axis axis*) of India and Ceylon. Among the most beautifully marked deer, it has a reddish-fawn coat heavily spotted with white. Antlers, three-tined, distinguish the males.

Chitals live in herds in the jungle and seldom venture far from water.

See also DEER. (L. H. M.)

CHITALDRUG (CHITRADURGA), a municipality and district in Mysore, India. The town of Chitradurga, the district headquarters (pop. [1961] 33,336), is 118 mi. N.W. of Bangalore and has a considerable trade in cotton. It possesses massive fortifications erected under Haidar Ali and Tipu Sahib toward the close of the 18th century; and to the west are remains of a city of the 2nd century A.D.

Chitaldrug is the terminus of a railway from Chikjajur on the Hubli-Bangalore line of the Southern railway.

CHITALDRUG DISTRICT has an area of 4,185 sq.mi. and a population (1961) of 1,094,128. The rainfall is low, and the Vedavati or Hagari river, in whose valley the town lies, is mostly dry in the hot season. Vanivilasa Sagara dam has been constructed on the river and a considerable area brought under irrigation. Rice and sugar cane are the chief irrigated crops, and cotton is the dry crop. Minerals found in the district include copper, lead, gold and iron ore.

Several parallel chains of hills, reaching an extreme height of 3,800 ft., cross the district; otherwise it is a plain. The largest town in the district is Davangere (56,018) with cotton factories and trade in cotton and grain. Educational facilities include a degree-granting college and an engineering college affiliated to Mysore university.

CHITARRONE: *see* LUTE.

CHITIMACHA, a tribe of American Indians living on the shores of Grand lake and the banks of Grand river in Louisiana at the time the French settled that region. The Chitimachan linguistic group included three tribes: the Chitimacha, Washa and Chawasha. The name comes from the Choctaw *chuti,* "cooking pot," and *masha,* "they possess" ("they have cooking vessels").

They called themselves *Pantchpinunukansh,* "men altogether red," a designation apparently made after the coming of the whites. War with the French over the murder of the missionary St. Cosme in 1706 was concluded by presentation of the head of the murderer. They were monogamists, and women had authority in their government. In 1950 there were an estimated 120 Chitimacha on reservations in southern Louisiana.

See also MUSKOGEAN INDIANS.

CHITON, common name for, and a genus of, a small mollusk of the order Polyplacophora and the class Amphineura (*q.v.*). *See* MOLLUSK.

CHITRAL, a princely state comprising the most northerly portion of the Malakand agency in the tribal areas (after 1947 called "frontier regions") of West Pakistan. It is bounded north and west by Afghanistan, the Wakhan valley dividing it by 12 mi. from the U.S.S.R., and is therefore of strategic importance; to the east it is bounded by Gilgit agency, to the south and southeast by Dir state and Kalam in the Swat Kohistan. Area 5,727 sq.mi. Pop. (1961) 113,057. Chitral is a scenic region of deep valleys and lofty ranges, with snow-covered mountains and rich pine forests. It includes the Tirich, Turikho and Mulikho valleys in the west and Yarkhun valley in the northeast. The valleys are extremely fertile, and wheat, barley, maize (corn) and rice are grown. Chitral also produces excellent walnuts and fruit, including grapes, apricots and mulberries; these form an important element of diet. There are some minerals, including iron ore, lead, copper, manganese and antimony. The chief exports are daggers, sword belts and embroidered cloth.

The capital town, Chitral (Chitrar or Kashkar), is 128 mi. N. of Peshawar on the Chitral river, in a valley which is barely 2 mi. wide. It can be reached by road from Nowshera, via Mardan, Malakand, Dir and the Lowarai pass (10,230 ft.), which is open for motor vehicles during the summer. It is connected with Gilgit by the Shandur pass (12,250 ft.) and is linked with Peshawar by air service.

The dominant tribe inhabiting the main valley are the Khos, whose language Khowar (known as Chitrali) is the lingua franca of the state. They are believed to have migrated from the Oxus region. The aboriginal Kafirs occupy only some remote valleys. Many of them have become Muslims and are called sheikh. The Chitralis are born horsemen; polo is the national game and is played throughout the state.

The valley is said to have been subdued by the Chinese in the 1st century B.C. and was ruled by them for several centuries. Muslims from Afghanistan first entered Chitral early in the 11th century A.D. and converted the population to Islam, the people of upper Chitral being members of the Isma'ili sect.

The present ruling family claim descent from Baba Ayub, said to be a grandson of the Mogul emperor Babur (*q.v.*). Baba Ayub settled in Chitral early in the 17th century and entered the service of the chief, who was of the same family as the rulers of Gilgit. When this line became extinct the great grandson of Baba Ayub, Mohtram Shah (also known as Shah Kator I) became chief and was the first to adopt the title of Mehtar ("prince").

Pursuing their policy of asserting control over the northwest passes between India and Russia, the British established an agency in Gilgit in 1889, with a subsidiary at Mastuj for Chitral. A British garrison was maintained until the state acceded to Pakistan following the partition of the subcontinent in 1947. His Highness Mehtar Saifur Rehman took over the government in 1953. He died in an air crash in 1954 and was succeeded by his son Saiful-Mulk Nasir, then a minor.

The CHITRAL RIVER rises in the Hindu Kush in the north of the state and, flowing southwestward into Afghanistan (where it is called the Kunar), joins the Kabul river 5 mi. E. of Jalalabad after a 300-mi. course.

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CHITTAGONG, the chief port of East Pakistan, and the name of a district and division of that province. The port was known to the civilized world from the earlier centuries of the Christian era and to Arab sailors by the 10th century A.D. It was the Porto Grande of the Portuguese and Venetian voyagers and was described by João de Barros in 1552 as "the most famous and wealthy city of the Kingdom of Bengal." It has been generally identified with the city of Bengala described by Portuguese and other writers.

Conquered by the Muslims in the 14th century, Chittagong passed to the Arakanese in the next century. The piratical raids of the Arakanese and their Portuguese mercenaries led to the dispatch of a strong force by Shaista Khan, the Mogul governor (nawab) of Bengal, who in 1666 occupied the district. Chittagong was ceded to the East India company by Nawab Mir Kasim Ali in 1760.

The port is on the right bank of the Karnaphuli river, about 12 mi. from its mouth, and is picturesquely situated with varied scenery of river and sea, green hills and plains. Many houses are built upon little hillocks. It has a healthful climate, the temperature rarely rising above 85° F. between February and June, and the heat is mitigated by sea breezes. The town is the terminus of the Pakistan Eastern railway, connecting it with Dacca via Comilla. It is linked by air with Dacca, Cox's Bazar, Rangoon and Calcutta. Pop. (1961) 364,205. It has a splendid natural harbour. Tea, jute and jute manufactures constitute the principal exports. After the creation of Pakistan in 1947 much trade was diverted there from Calcutta, and the port was considerably improved. In the early 1960s it was capable of handling approximately 2,000,000 tons of cargo annually and could provide berthing facilities for 20 ships at a time—four times the capacity prior to independence.

Life centres around the harbour. The chief buildings include the court buildings on the Fairy hills, on the site of the former Portuguese fort; the Juma Masjid, built on a low hill by Ummed Khan (son of Shaista Khan); and the Circuit house, facing the Niaz stadium. The following colleges are affiliated with Dacca university: Chittagong college, the Government College of Commerce, the Women's college, the Law college, Night college and three other colleges, together with the Islamic Intermediate college, which is housed in a building erected by the Portuguese about 1650. There is a cadet college at Faujdarhat (about 5 mi. distant). Batali hill is a favourite evening resort. The shrine of Ba Yazid (8 mi. from the city) is visited by thousands of devotees. Principal industries include cotton and jute mills, tea and match factories, and engineering works. The industrial area extends for about 10 mi. to the north and northeast. Being the gate of East Pakistan for foreign trade, the town has offices of many foreign firms and banks. It is the headquarters of Pakistan Eastern railway and the railway workshop is located in the nearby town of Pahartali.

CHITTAGONG DIVISION is one of four divisions of East Pakistan. It comprises the five eastern districts of Chittagong, Chittagong Hill Tracts, Noakhali, Comilla and Sylhet. It includes 14 subdivisions of thanas (police units of local administration) and about 17,000 villages. Area 17,032 sq.mi. Pop. (1961) 13,629,650.

Chittagong District consists of a narrow strip of coast with valleys and low ranges of parallel hills, running in a southeasterly direction along the northeast of the Bay of Bengal. The hills are generally formed of strata of sand, clay, shale and a hard gray sandstone of the Tertiary period. The seaboard is composed of hard clay, deposited originally by the tide; where the tide still has access to it the soil is salty. The higher parts of the Chittagong hills are densely forested, while the lower portions are to a great extent covered with brushwood. The forest-clad hills abound in wild animals, including elephants, bisons, tigers, leopards, deer and wildcats. Between the hills lie cultivated valleys, filled by alluvial deposits of sand and clay washed down from the hills. The climate is moist, warm and equable with heavy rainfall (over 100 in. annually), mainly during the summer monsoons. Vegetation is luxuriant and the country is green throughout the year.

Rice, mainly of the winter or *aman* type, is the most important crop; tea is grown on low hills which are unfit for rice cultivation; deep-sea fishing is practised in the bay and every river, lake and ditch swarms with fish. Area 2,705 sq.mi. Pop. (1961) 2,982,931.

Chittagong Hill Tracts District of East Pakistan occupies the hill country between Chittagong district and the Lushai hills in Assam, India. The highest point is 4,034 ft. above sea level. Under the Karnaphuli project a dam was constructed at Kaptai. A paper mill is also located on the bank of the Karnaphuli river at Chandraghona. Most of the hills are covered with forests containing valuable timber, bamboos, canes and a kind of grass known as *sun*.

The climate is hot, humid and unhealthful. The hills are unsuitable for cultivation, and the terracing of slopes is rendered difficult by the lack of stones for revetment. The district produces almost all the cotton grown in East Pakistan. Other important crops are rice and oilseeds. Waterways are the chief means of communication. Cotton-weaving and the making of bamboo nets and baskets are the chief cottage industries. Area 5,093 sq.mi. Pop. (1961) 385,079. About 75% are Buddhists, half of whom belong to the Chakma tribe. The headquarters are at Rangamati. (K. S. Ad.)

CHITTOOR (Chittur), a commercial town and headquarters of Chittoor district, Andhra Pradesh, India, lies 80 mi. W. of Madras. Pop. (1961) 47,876. It has a college affiliated to Sri Venkateswara university, Tirupathi, several high schools, a training school, a hospital and sanatorium. It is a market centre for *gur* (molasses), mangoes and peanuts, and is noted for the manufacture of biscuits and confectionery. *The Indian Express*, a well-known daily newspaper, is printed and published there.

The town has rail and road connections with Madras and Bangalore.

Chittoor District (area 5,855 sq.mi.) was formed from the northern part of North Arcot district. Pop. (1961) 1,914,639. It is in great part hilly, being traversed by spurs of the Eastern Ghats radiating east and south. The surface in the hill country is rocky except for patches of stunted jungle, but the narrow valleys between the hills are fertile and the hills themselves are highly mineralized, showing copper and iron especially. The chief crops are rice, millet and oilseeds.

The temple of Sri Venkateswara on the Tirumalai hills in Chandragiri *taluk* is the most famous in the district and attracts pilgrims from all parts of India. The temple of Siva in Kalahasti town is also famous. (B. S. R.)

CHITTORGARH, a district in the Udaipur division of Rajasthan, India, lies in the southeast of the state. Pop. (1961) 710,132. Area 4,033 sq.mi. Its headquarters is the fortress town of Chitor or Chitorgarh, 65 mi. E.N.E. of Udaipur, famous as the ancient stronghold of the Sesodia Rajputs. The fort, 500 ft. above the surrounding plain and the Gambheri river, existed in the 8th century A.D. It was thrice besieged by Muslim attackers, its defenders preferring death for themselves and *jauhar* (collective self-immolation) for their womenfolk to surrender. The first such siege (1303), when Sultan 'Ala ud-Din Khalji of Delhi sought the beautiful Padmavati, wife of the rana Bhimsingh, is celebrated through the poems of Chand Bardai and Mohammed Jayasi (*see* Hindi Literature). In the second siege (1534–35), by Sultan Bahadur Shah of Gujarat, 32,000 Rajputs died in battle and 13,000 women by *jauhar*. At the third siege (1567) by the Mogul emperor Akbar the story was similar; the great heroism of the chiefs Jaimal and Patta, celebrated in numerous Rajput ballads, was commemorated by Akbar himself. After the loss of Chitor the Sesodia capital was transferred to Udaipur.

The zigzag ascent to the fort is guarded by seven magnificent gateways with guardrooms, largely of trabeated construction. Within the high walls remain the palaces of Jaimal and Patta and of Bhimsingh; of many Jain and Hindu temples that of Vriji, built about 1450 by Rana Khumba, has a large sikhara tower. Most prominent, however, are two exquisitely sculptured Jain towers of the 12th and 15th centuries known as the towers of Fame and Victory. (J. B.-P.)

CHIU-CHIANG (Kiukiang), a former treaty port of Kiangsi province, China, on the Yangtze river midway in its course between the central (Hupeh) basin and the delta. It was a municipality in 1956, though its population, by the 1953 census, was only 64,600. Lying just above the P'o-yang lake debouchment into the Yangtze, Chiu-chiang has been the traditional port of export for the varied products of Kiangsi. The newer occidental port lies just west of the old Chinese city. A rail terminal and passenger transit port, Chiu-chiang has never been a centre of manufacturing. Kiangsi rice, tobacco, cotton and ramie (grass cloth) pass through the port and much Kingtehchen porcelain has traditionally been shipped from there. After 1952 the Chinese Communists used the port as an iron ore collecting and shipping port.

Behind the port rise the ranges of the Chiu-kung Shan, the chief tea-growing district of Kiangsi, for whose black teas Chiu-chiang is the traditional collecting centre. Ku-ling, an important summer resort near the top of Lu Shan, lies 15 mi. S. of the city. (J. E. Sr.)

CHIUSI: *see* Clusium.

CHIVALRY, the knightly class of feudal times. The primary sense in the middle ages is "knights" or "fully armed and mounted fighting men." (*See* also Cavalier; Chevalier.) Thence the term came to mean that gallantry and honour expected of knights. Lastly, the word came to be used in its general sense of "courtesy." *See* also Knighthood, Chivalry and Orders.

In English law chivalry meant the tenure of land by knights' service. The court of chivalry instituted by Edward III, with the lord high constable and earl marshal of England as joint judges, had summary jurisdiction in all cases of offenses of knights and generally as to military matters. When the earl marshal alone presided it was a court of honour deciding as to precedence, coats of arms, etc. From 1737 until 1954 no case was brought before this court. Then, in 1954, the court met with the earl marshal presiding to hear a petition from the Manchester city corporation alleging the improper use of the city's coat of arms by the Manchester Palace of Varieties.

CHIVES (*Allium schoenoprasum*), a small, hardy perennial plant related to the onion, of the family Liliaceae. Its small white, elongated bulbs and narrow, cylindrical, hollow leaves (six to eight inches long) develop in dense clumps. Flower stalks arise, bearing dense, attractive, spherical umbels of bluish flowers above the foliage; they often produce but few seeds. Chives may be propagated by seeds, but is more commonly propagated by planting the tiny bulbs obtained by dividing the clumps. A flowerpot of chives, if judiciously trimmed, can be kept in a sunny window for a continuous small supply of leaves, which are used as a food flavouring. (V. R. B.)

CHKHEIDZE, NIKOLAI SEMENOVICH (1864–1926), Georgian Social Democratic leader, prominent also in Russian politics in the decade preceding the revolution of Nov. 1917, was born at Kutaisi in the Caucasus. In the early 1890s he helped N. Zhordania and others to introduce Marxist ideas into Georgia.

Thanks to nationalist feeling, these ideas soon struck deep root, and Georgia became a stronghold of the Menshevik wing of Russian social democracy. In 1907 Chkheidze was elected to the Russian state duma, where for nearly ten years he led the Social Democratic group, earning a nation-wide reputation as spokesman for the extreme left. In 1917, on the outbreak of the March revolution, he became chairman of the Petrograd soviet of workers' and soldiers' deputies, in which he vainly sought to conciliate both the moderate and extremist elements. His vacillations helped to discredit the original leadership of the soviet, which was soon swept away by the rising tide of Bolshevism. After the November Revolution Chkheidze returned to Transcaucasia, becoming president of the national council (subsequently the constituent assembly) of the independent republic of Georgia, which he represented at the Paris peace conference. When Georgia was occupied by the Bolsheviks (1921) he emigrated to France. On June 13, 1926, at Leuville, near Paris, distressed at the situation in his homeland, he died after attempting to commit suicide.

(J. L. H. K.)

CHLOPICKI, (GRZEGORZ) JOZEF (1771–1854), Polish general, was born at Kapustyn in Volhynia in March 1771. He enlisted in the Polish army in 1785 and fought in the campaigns of 1792–94 before and after the second partition of Poland. He then took service under the French, in their new Polish-Italian legion, and distinguished himself in the Italian campaign of 1797–1805 at the storming of Peschiera and at Mantua. On Polish soil again with the Napoleonic armies, he commanded the first Vistula regiment in 1807. In the Peninsular War he obtained the Legion of Honour for his heroism at Epila and in the storming of Saragossa. He accompanied Napoleon's Grande Armée into Russia in 1812. On the reconstruction of the Polish army in 1814 he was made a general of a division, but four years later, having quarreled with the Russian grand duke Constantine, he resigned.

Chlopicki held aloof at first from the Polish national rising of 1830, but at the request of his countrymen he accepted the dictatorship on Dec. 5, 1830. Lacking faith in the success of the war, he clung to the hope of negotiation with Russia and acted purely on the defensive. On Jan. 17, 1831, he resigned and became nominally a private soldier. Actually, however, he continued his command until, seriously wounded at the battle of Grochow, on Feb. 25, 1831, he was forced to retire from public life. He died in Cracow on Sept. 30, 1854.

See J. C. H. Harbut, *Jozef Chlopicki* (1930); W. Tokarz, *Wojna polsko-rosyjska 1830–31* (1930). (St. He.)

CHLORAL (Trichloroacetaldehyde; CCl_3CHO) is a heavy, oily, colourless liquid, with a pungent odour and taste, the hydrate of which—$CCl_3CH(OH)_2$—is used medicinally. Chloral was first prepared by J. von Liebig in 1832. Chloral hydrate was introduced into medicine in 1869 (at the time when cannabis, alcohol and opium were the main central nervous system depressants) by O. Liebreich on the erroneous assumption that it would be changed to chloroform in the body and thus act as an anesthetic. However, even though it does not change in the body, it does have a depressant action on the central nervous system; the erroneous assumption upon which its use was originally based resulted in the contribution of a valuable therapeutic agent (one of the many instances illustrating the value of serendipity in science).

Chemistry of Chloral and Chloral Hydrate.—Chloral—1½ times heavier than water and with a boiling point of 208° F. (97.8° C.)—is prepared by passing dry chlorine into cooled absolute alcohol. In the presence of an alkali, chloral is changed to chloroform (*q.v.*); in the presence of water, chloral becomes chloral hydrate, a transparent crystalline compound with a melting point of 134.6° F. (57° C.). By condensation with chlorobenzene in the presence of sulfuric acid, chloral is converted into the important insecticide DDT, or dichloro-diphenyl-trichloro-ethane (*see* Entomology: *Principles of Insect Control*).

Pharmacological Actions and Toxicity.—Chloral and its hydrate, the form commonly used, have the ability to produce general anesthesia, but the dose required for this effect is too close to the lethal dose to have practical usefulness. The sedative action of chloral hydrate, which is achieved by giving doses in the range of one or two grams, is the most important action of the drug. After doses in this range sedation occurs in 10 to 15 minutes, and a sleep lasting from five to eight hours ensues within an hour; there is no aftereffect or "hang-over." Since the drug does not usually depress reflexes, it is not very serviceable as an anticonvulsant.

The fatal dose of chloral hydrate for adults by mouth is about 10 g., but care should be exercised in giving even more than 2 g. in a single dose. The usual symptoms of poisoning by chloral hydrate are deep stupor, dilation of blood vessels, fall in blood pressure, fall in body temperature and slowed respiration. Death results from respiratory depression usually within 5 to 10 hours. Acute poisoning can also occur from the combination of liquid chloral and alcohol, which constitutes the so-called "knockout" drops or "Mickey Finn." This mixture has a rapid and potent depressant effect.

The treatment for poisoning by chloral is accomplished by washing out the stomach, maintaining body temperature and administering stimulants to increase respiration and to elevate the blood pressure; artificial respiration is also used.

Medicinal Uses.—The sedative effects of chloral hydrate are similar to those produced by barbiturates (*q.v.*). The drug is frequently administered to patients undergoing withdrawal from morphine, alcohol or barbiturates and to those with delirium tremens (*see* Delirium). Chloral hydrate is one of the least expensive and most effective hypnotics, but its value is frequently neglected in present-day medicine mainly because of the prominence given to the easier-to-take pill barbiturates in medical literature. (K. P. Du.)

CHLORAMPHENICOL (Chloromycetin) is an antibiotic substance originally obtained from cultures of the funguslike actinomycete *Streptomyces venezuelae* and used in the treatment of many infectious diseases. It was the first of the broad-spectrum antibiotics (*q.v.*) to be reported, being characterized and identified by Paul R. Burkholder in 1947. Chemical synthesis of the substance was reported in 1950, at which time the chemical name chloramphenicol was applied to the compound.

Chloromycetin, the registered trade-mark name adopted for the compound by the original manufacturer, has been found to be effective against a wide variety of infectious agents, including both gram-negative and gram-positive bacteria, certain rickettsiae, spirochetes and viruses. It acts to inhibit the growth and multiplication of the microorganisms sensitive to it. Chloramphenicol usually is given orally and is rapidly absorbed from the gastrointestinal tract, diffusing readily into the body tissues and fluids.

Gastrointestinal disturbances and diarrhea are not commonly seen following the administration of chloramphenicol, and, because of the rapid inactivation of the antibiotic in the digestive tract, little inhibition of the normal bacterial flora of the large bowel is observed. In rare instances, the administration of chloramphenicol has been complicated by the development of an aplastic anemia due to depression of the bone marrow by the drug.

(T. W. L.)

CHLORATES: *see* Chlorine.

CHLORINE, a chemical element of the halogen family, is a strong-smelling, greenish-yellow gas. It was prepared first in 1774 by K. W. Scheele from hydrochloric acid and manganese dioxide. Because he was unable to decompose the gas, H. Davy (1810) contended that it was an element and showed further that hydrochloric acid itself contains only hydrogen and the new element, which he called chlorine. Hence in its reaction with manganese dioxide, hydrochloric acid loses hydrogen rather than gains oxygen, as had been believed. Davy's views eventually prevailed, chlorine was accepted as an element, and Antoine Lavoisier's theory that all acids contain oxygen was discarded. The name "chlorine" is taken from the greenish-yellow (Greek *chloros*) colour of the gas. The chemical symbol for chlorine is Cl; its atomic number is 17; and its atomic weight is 35.453.

Chlorine is never found uncombined in nature. Estimated to account for 0.15% of the earth's crust, it occurs most abundantly in soluble chlorides, such as sodium chloride in salt water and rock salt, and in smaller quantities in such insoluble materials

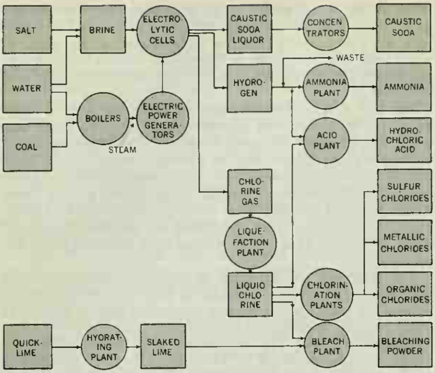


FIG. 1.—THE MANUFACTURE OF CHLORINE AND ITS DERIVATIVES

From left to right: the manufacture of chlorine from salt and water; the principal industrial compounds formed; and the commercial utilization of by-products

as horn silver (AgCl). Chlorine as chloride is an essential constituent of animal life.

Chlorine is an active poison and was the first gas used in chemical warfare in World War I. It causes suffocation, constriction in the chest, tightness in the throat and edema of the lungs after severe exposure. As little as 2.5 mg. per litre in the atmosphere causes death in a few minutes, but less than 0.0001% by volume may be tolerated for several hours. Its strong odour, however, gives warning of its presence at much lower concentrations than are dangerous.

Uses.—Originally the only large consumers of chlorine were the paper and textile industries, and most of the chlorine produced was consumed in the manufacture of bleaching powder for their uses. (*See* BLEACHING; BLEACHING POWDER.) Early in the 20th century began the shipment and use of liquid chlorine, which could be used directly in bleaching, and the proportion used in the manufacture of bleaching powder declined. Chlorine is an effective germicide, and chlorination of municipal water supplies has become general. In some instances chlorine is used to disinfect sewage. The rise of the rayon industry, which employs chlorine for the bleaching of pulp, provided a major outlet for industrial chlorine.

Although the amount of chlorine employed for bleaching and disinfecting was undoubtedly increasing, the fraction of the total chlorine production going into this field was declining because of the tremendous increase in the amount of chlorine consumed by the chemical industry.

Chlorine has become widely used in the production of both organic and inorganic chemicals (fig. 1). Chlorine reacts with carbon disulfide (*q.v.*) to form carbon tetrachloride and sulfur chloride,

$$CS_2+3Cl_2=CCl_4+S_2Cl_2$$

The main uses of carbon tetrachloride are as a solvent, in fire extinguishers and in dry cleaning. Sulfur chloride, also made by combining sulfur and chlorine, is used in the vulcanization of rubber and as a chlorinating agent in organic syntheses. Sulfur chloride was used in the preparation of mustard gas, an important chemical warfare agent in World War I. Another important chlorinating agent, thionyl chloride ($SOCl_2$), is made by the reaction of chlorine, sulfuric acid and sulfur chloride. Thionyl chloride is used to form the acid chlorides of organic acids, which are valuable intermediates in organic syntheses. Chloride combines with phosphorus to form phosphorus trichloride (PCl_3), which may be oxidized by potassium chlorate to phosphorus oxychloride ($POCl_3$), which is another useful chlorinating agent in forming acid chlorides from organic acids. Chlorine and carbon monoxide form carbonyl chloride, or phosgene ($COCl_2$), which has been employed in chemical warfare and is also used in metallurgy to transform certain oxides to chlorides.

A number of metallic chlorides are prepared with the use of chlorine. Anhydrous aluminum chloride is made by the reaction of chlorine with scrap aluminum or with aluminum oxide and carbon. It is used in the petroleum industry and as a catalyst for many organic syntheses. Anhydrous ferric chloride, made similarly, is employed in water clarification. Chlorine is used in the preparation of silicon chloride, from which the silicon synthetics are prepared. Silicon chloride and titanium tetrachloride are used in forming smoke screens. Magnesium chloride ($MgCl_2$) is fused and electrolyzed for the production of metallic magnesium; zinc chloride ($ZnCl_2$) is an essential constituent of dry batteries. Stannic chloride ($SnCl_4$) is used in the textile trade. Its volatility is the basis for a method of recovery of tin from used tin plate.

Chlorine enters directly or as an intermediate into many organic syntheses of industrial importance. Chlorination of organic materials may be done at low temperatures with liquids or in the vapour phase at higher temperatures; the reactions may or may not require a catalyst. Since most organic materials may be chlorinated at different points on the molecule, or to different degrees, the conditions of chlorination must be carefully controlled. For example, the chlorination of a compound containing a benzene nucleus with an aliphatic side chain occurs in the benzene nucleus when the temperature is low in the presence of certain catalysts, but in the side chain at elevated temperatures or in the presence of sunlight.

Of the chlorinated derivatives of methane (CH_4), carbon tetrachloride (CCl_4) has been mentioned. Chloroform ($CHCl_3$) is used as a solvent and in medicine. Methyl chloride (CH_3Cl) is used as a refrigerant. Dichlorodifluoromethane (CCl_2F_2), known as Freon, is used as a household refrigerant. Ethyl chloride (C_2H_5Cl), a derivative of ethane (C_2H_6), is used in the production of lead tetraethyl. Unsaturated hydrocarbons, such as acetylene, combine directly with chlorine to form liquids such as acetylene tetrachloride ($CHCl_2.CHCl_2$) which are largely used as solvents and in dry cleaning.

Chlorinated aromatics serve as intermediates in the dye industry. Chlorobenzene (C_6H_5Cl) is hydrolyzed to produce phenol (C_6H_5OH). The insecticide DDT is dichloro-diphenyl-trichloroethane ($(ClC_6H_4)_2CHCCl_3$). Paradichlorobenzene ($C_6H_4Cl_2$) is used as a moth repellent. Chlorine is an essential raw material in manufacture of many plastics, nylon and synthetic rubber.

For other uses of chlorine compounds, see *Chlorine Compounds,* below.

Laboratory Preparation.—The element may be prepared on a laboratory scale by treatment of hydrochloric acid, or any soluble chloride in acid solution, with strong oxidizing agents such as manganese dioxide, potassium permanganate or potassium dichromate. Concentrated sulfuric acid, however, will not liberate chlorine. The essential change in the preparation of the element from chloride is the removal of an electron from the chloride ion, $2Cl^- = Cl_2 + 2e$. Chlorine may also be prepared by the reaction of a hypochlorite with an acid. Since chlorine is readily available in cylinders of various sizes, preparation in the laboratory is of little practical importance.

For the preparation of chlorine on a large scale, see *Commercial Preparation,* below.

Chemical Properties.—Chlorine is a member of Group VII of the periodic system. While it is essentially an electronegative element, tending to go to the chloride ion of oxidation state -1, chlorine is also known in the $+1$, $+3$, $+4$, $+5$ and $+7$ states of oxidation. Chlorine combines directly with all but a few elements; oxygen, fluorine, nitrogen, carbon and the inert gases being exceptions. The binary compounds thus formed are called chlorides (*see* HYDROCHLORIC ACID AND HYDROGEN CHLORIDE). Many of these reactions occur at room temperature; *e.g.*, with powdered antimony $2Sb+3Cl_2=2SbCl_3$. If free from moisture, chlorine is much less reactive, and higher temperatures are required for reaction, thus permitting the storage of dry liquid chlorine in steel cylinders. Chlorine reacts at high temperatures with certain oxides in the presence of carbon to form chlorides; *e.g.*,

$$Al_2O_3+3Cl_2+3C=2AlCl_3+3CO$$

With water at 0° C., chlorine forms a crystalline hydrate, $Cl_2.8H_2O$, which decomposes on warming. This compound is of historical interest for, while experimenting with the hydrate, Michael Faraday in 1823 discovered that chlorine became liquid under pressure at low temperatures and later succeeded in liquefying a number of other substances which were previously known only in the gaseous state. A solution of chlorine in water contains a small amount of hydrochloric and hypochlorous acid because of the reversible reaction,

$$Cl_2+H_2O=H^++Cl^-+HOCl$$

The equilibrium constant is 4.8×10^{-4} at 25° C. Since the hypochlorous acid slowly loses its oxygen, the solution of chlorine in water is unstable, the chlorine eventually being all transformed to hydrochloric acid. Chlorine is readily absorbed in basic solutions, for the neutralization of the hydrochloric and hypochlorous acids prevents equilibrium being established. The reaction at room temperatures may be represented by

$$Cl_2+2OH^-=Cl^-+OCl^-+H_2O$$

thus producing a mixture of chloride and hypochlorite (*see* BLEACHING POWDER). In hot concentrated alkali, chlorine forms chloride and chlorate,

$$3Cl_2+6OH^-=5Cl^-+ClO_3^-+3H_2O$$

Chlorine is a strong oxidizing agent. In aqueous solution the electrode potential

$$\tfrac{1}{2}Cl_2(g)+e=Cl^-$$

is 1.358 v. at 25° C. Hence chlorine displaces bromine and iodine, which have lower potentials, from bromides and iodides. In aqueous solution chlorine oxidizes and is itself reduced to chloride by such ions as sulfide, thiosulfate, sulfite, ferrous and stannous. Chlorine combines with carbon monoxide to form carbonyl chloride (phosgene), $COCl_2$; with sulfur dioxide to form sulfuryl chloride, SO_2Cl_2; and with nitric oxide to form nitrosyl chloride, NOCl. Many organic compounds are chlorinated by chlorine.

Hydrocarbons react with chlorine by addition of chlorine to double bonds, or substitution of hydrogen by chlorine. In some cases, as with turpentine, the reaction is violent, all the hydrogen is removed as hydrogen chloride, and a residue of carbon is left.

Physical Properties.—Some of the more important physical properties of chlorine are listed below:

Stable isotopes	35, 37
Radioactive isotopes	32–34, 36, 38–40
Electron configuration	$1s^2, 2s^2, 2p^6, 3s^2, 3p^5$
Affinity for additional electron	3.75 ev
Crystal radius of chloride ion	1.81 Å.
Molecular weight	70.91
Density at 0° C. and 1 atm.	3.214 g./l.
Boiling point at 1 atm.	−34.05° C.
Freezing point	−101° C.
Critical temperature	144° C
Critical pressure	76.1 atm.
Critical density	0.573 g./ml.
Vapour pressure of liquid in atmosphere at T° Kelvin	$\log P=-1{,}499.5/T-4.022\log T+15.844$
Heat of fusion	22.9 cal./g.
Heat of vaporization	68.8 cal /g.
Heat capacity of gas at constant pressure and at room temperature	0.226 cal./g.
Heat capacity at T° K	$8.28+0.56\times10^{-3}$ T cal./mol.
Heat capacity of liquid	16 cal./mol.
Entropy at 298.1° K	53.31 cal./mol./degree
Solubility in water at 20° C.	0.09 mol./l. at 1 atm.

CHLORINE COMPOUNDS

Oxides of Chlorine.—Four oxides, chlorine monoxide (Cl_2O), chlorine dioxide (ClO_2), chlorine hexoxide (Cl_2O_6) and chlorine heptoxide (Cl_2O_7), are known. ClO_4 or Cl_2O_8 has been made in solution by the reaction of iodine with silver perchlorate dissolved in benzene. All the oxides are unstable and reactive and cannot be produced by direct synthesis. Chlorine monoxide is made by the reaction of chlorine with mercuric oxide,

$$HgO+2Cl_2=HgCl_2+Cl_2O$$

In an industrial process chlorine monoxide is formed by the reaction of chlorine on solid sodium bicarbonate,

$$2Cl_2+2NaHCO_3=Cl_2O+2NaCl+2CO_2+H_2O$$

It is slightly darker yellow than chlorine, condensing to a liquid at 2° C. and solidifying at −116° C. Chlorine monoxide is the anhydride of hypochlorous acid, readily dissolving in water to form the acid,

$$Cl_2O+H_2O=2HOCl$$

Chlorine dioxide is formed by the action of strong acids on chlorates, best with oxalic acid,

$$2KClO_3+3H_2C_2O_4=2ClO_2+2H_2O+2CO_2+2KHC_2O_4$$

In the industrial preparation of sodium chlorite, chlorine dioxide is first formed by the reaction of hydrochloric acid on calcium chlorate,

$$Ca(ClO_3)_2+4HCl=CaCl_2+2ClO_2^-+Cl_2+2H_2O$$

the accompanying chlorine being removed by absorption on lime. Chlorine dioxide decomposes explosively to Cl_2+O_2. It is a gas with a much stronger yellow colour than chlorine, liquefying at 10° C. and solidifying at −76° C. It is not an acid anhydride, hardly reacting with water and but slowly with alkalies to give a mixture of chlorite and chlorate. Chlorine hexoxide, formed by the action of light or ozone on chlorine dioxide, is a red oil, freezing at −1° C., decomposing slowly at higher temperatures. Chlorine heptoxide, the anhydride of perchloric acid, is formed by removal of water from that acid by phosphorus pentoxide. It is a colourless liquid boiling at 80° C. and freezing at −91.5° C. It explodes with shock.

Hypochlorous Acid and Hypochlorites.—In these compounds chlorine exists in the +1 state of oxidation. Hypochlorous acid, HOCl, is quite weak, the dissociation constant being 4×10^{-8} at 25° C., and unstable, decomposing to hydrochloric acid and oxygen. The hypochlorite ion is stable in alkaline solution. Hypochlorites are formed in solution by the neutralization of hypochlorous acid or by the absorption of chlorine monoxide or chlorine by alkaline solutions. If chlorine is employed an equivalent amount of chloride is formed along with the hypochlorite.

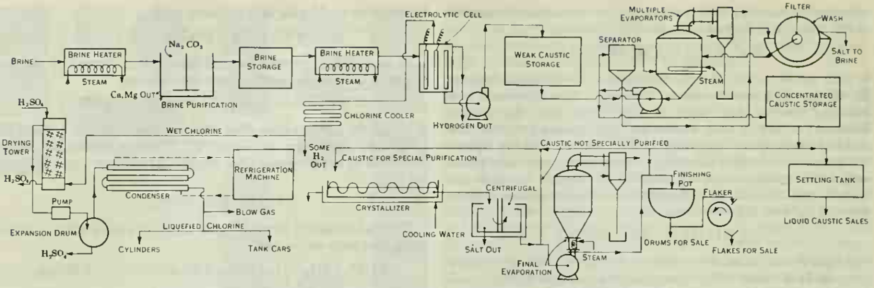
Because of the weakness of hypochlorous acid, hypochlorites are considerably hydrolyzed and preparation of the pure salts is difficult. Only a hydrated calcium hypochlorite, $Ca(OCl)_2.2H_2O$, is available in solid form, although solid sodium hypochlorite has been prepared. Sodium and calcium hypochlorite are widely used in bleaching and disinfecting, their effectiveness being attributed to their oxidizing powers. They are also effective oxidizing agents in preparative chemistry, lead dioxide for example being formed from lead acetate by the action of sodium or calcium hypochlorite in basic solution.

Chlorous Acid and Chlorites.—Salts of chlorous acid, $HClO_2$, are called chlorites and contain the ion ClO_2^-, in which chlorine is in the +3 oxidation state. Sodium chlorite is made by passing chlorine dioxide into alkaline solution containing carboniferous material,

$$4ClO_2+4NaOH+Ca(OH)_2+C=4NaClO_2+CaCO_3+3H_2O$$

Chlorites are generally soluble and stable in alkaline solution. Chlorous acid, although somewhat stronger than hypochlorous acid, is much less stable, and on acidifying a solution containing a chlorite, decomposition to ClO_2 occurs rapidly. Sodium chlorite is employed in bleaching.

Chlorates and Chloric Acid.—Chlorine in the +5 oxidation state occurs in chloric acid and its salts the chlorates. Chlorates are formed in solution by the reaction of chlorine with hot alkalies, or on mixing, at the proper temperature, the anode and cathode solutions resulting from electrolysis of sodium chloride solution. The chlorate is generally separated from the accompanying chloride by crystallization of the potassium salt which is only


Brine
Brine Heater
Steam
Na_2CO_3
Ca, Mg Out
Brine Purification
Brine Storage
Brine Heater
Steam
Electrolytic Cell
Chlorine Cooler
Hydrogen Out
Weak Caustic Storage
Multiple Evaporators
Separator
Steam
Filter
Wash
Salt to Brine
Concentrated Caustic Storage
H_2SO_4
Drying Tower
H_2SO_4
Wet Chlorine
Pump
Expansion Drum
H_2SO_4
Condenser
Refrigeration Machine
Blow Gas
Liquefied Chlorine
Cylinders
Tank Cars
Some H_2 Out
Caustic for Special Purification
Crystallizer
Cooling Water
Centrifugal
Salt Out
Caustic not Specially Purified
Finishing Pot
Flaker
Steam
Final Evaporation
Drums for Sale
Flakes for Sale
Settling Tank
Liquid Caustic Sales

Salt	1.6 Tons	Electricity	2,500 Kw Hr	Per Ton 76% Caustic Plus 1.750 Lb Chlorine and 8,750 Cu Ft Hydrogen (50 Lb H_2)
Sodium Carbonate (58%)	50 Lb	Refrigeration	0.9 Ton	
Sulfuric Acid (66° Bé)	200 Lb	Direct Labour	18 Man-Hr	
Steam	20,000 Lb			

FROM C. L. MANTELL IN "CHEMICAL AND METALLURGICAL ENGINEERING"

FIG. 2.—ELECTROLYTIC CAUSTIC SODA AND CHLORINE

Flow sheet showing the several stages from brine, the raw material, to caustic soda and chlorine, the products

moderately soluble, but other chlorates may be made by either of these methods. A solution of chloric acid ($HClO_3$) may be prepared by adding sulfuric acid to a solution of barium chlorate and filtering to remove the precipitated barium sulfate. By evacuating at room temperature the solution may be concentrated to about 50% $HClO_3$, but in more concentrated solution decomposition is rapid. Chloric acid is a strong acid, hence chlorates are not hydrolyzed in solution. Chlorate ion is stable in neutral or basic solution, but in acid solution chlorates are readily reduced to chloride by such reagents as sulfur dioxide. Potassium chlorate, a white crystalline material melting at 350° C., is unstable with respect to the decomposition $2KClO_3 = 2KCl + 3O_2$, and other chlorates decompose similarly. This reaction is highly exothermic and irreversible, but the decomposition is relatively slow below 400° C. It is markedly susceptible to catalysts; a mixture of potassium chlorate and manganese dioxide decomposes smoothly at moderate temperatures and serves as a source of small amounts of oxygen in the laboratory. A mixture of potassium chlorate and a reducing material such as charcoal or sulfur is dangerously explosive. Because they serve as a concentrated source of oxygen, chlorates are employed in fireworks, matches, etc. Potassium chlorate is claimed to be an effective antiseptic in the treatment of ulcers of the mouth, but in quantity is poisonous. Sodium chlorate is sold commercially for use as a weed killer.

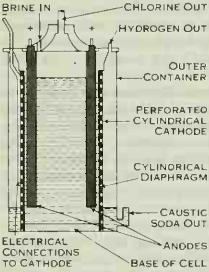

Brine In
Chlorine Out
Hydrogen Out
+
+
Outer Container
Perforated Cylindrical Cathode
Cylindrical Diaphragm
Caustic Soda Out
Electrical Connections to Cathode
Anodes
Base of Cell

FIG. 3.—CYLINDRICAL DIAPHRAGM CELL

Hydrogen is set free at the perforated cathode as the brine percolates through it, leaving caustic soda in solution. The chlorine is set free at the carbon anodes

Perchlorates and Perchloric Acid.—In these compounds chlorine is in its highest oxidation state, +7. Potassium perchlorate may be made by carefully heating the chlorate,

$$4KClO_3 = 3KClO_4 + KCl$$

and separating the perchlorate, which is less soluble than either the chloride or chlorate, by crystallization. Commercially, however, it is made by electrolysis of chlorate solutions at high current density. The perchlorates in general are soluble, their solutions are stable, and even in strongly acid solution are reduced with difficulty. A perchlorate may be distinguished from a chlorate by treating in acid solution with sulfur dioxide, which reduces the latter readily but does not affect the perchlorate. Barium and magnesium perchlorates form stable hydrates and are employed as drying agents to remove moisture from gases. Perchloric acid is made by treatment of potassium perchlorate with sulfuric acid and separation of the perchloric acid by vacuum distillation. While perchloric acid is much more stable than chloric acid, the pure acid decomposes slowly at 92° C. At ordinary temperatures perchloric acid is a liquid with a strong affinity for water. It forms a stable hydrate, $HClO_4.H_2O$, which is a solid below 50° C. although the anhydrous acid only freezes at −112° C. It is commonly sold in 60% solution and finds application in analytical chemistry. It is one of the strongest acids. The concentrated acid is a powerful oxidizing agent and in contact with reducing materials violently explosive, as are the solid perchlorates at higher temperatures. Solid perchlorates lose oxygen on heating as do the chlorates but are somewhat more stable. They may be used in place of chlorates in explosives and fireworks, as they are considered safer to handle.

COMMERCIAL PREPARATION

Almost since its discovery chlorine has been produced on a large scale for use in industry. The long-obsolete Weldon process was first employed, making use of the reaction of hydrochloric acid with manganese dioxide,

$$MnO_2 + 4HCl = Cl_2 + MnCl_2 + 2H_2O$$

by which K. W. Scheele first discovered chlorine. At best, only about one-third of the hydrochloric acid is transformed to chlorine in the process, and the lack of materials in which these corrosive substances could be handled made the Weldon process difficult and expensive.

About 1868 Henry Deacon developed a process by which chlorine was made by the reaction of hydrogen chloride gas and atmospheric oxygen. The reaction employed,

$$4HCl + O_2 = 2Cl_2 + 2H_2O$$

is reversible and incomplete. The rate of reaction was found to be satisfactory when the gases were passed over pumice in contact with cupric chloride, a catalyst, at about 430° C. Under these conditions about 70% of the hydrogen chloride could be converted to chlorine. The hydrogen chloride required in the Deacon process was largely a by-product of the LeBlanc soda process (*see* ALKALI MANUFACTURE). With the decline of the latter, the Deacon process was abandoned, and electrolytic methods became widely used.

Electrolytic Process.—In the early 1960s the electrolysis of brine was the major source of industrial chlorine. A minor source was the electrolysis of fused sodium chloride, in which metallic sodium is the primary product and chlorine a by-product.

Electrolytic chlorine was first produced successfully on a commercial scale about 1890. The following half century saw an enormous increase in the amount of chlorine produced. Technical improvements greatly increased the efficiency of production, but the process remained basically unchanged. The raw materials are salt (NaCl) and water; the products chlorine, sodium hydroxide (alkali or caustic soda) and hydrogen. The change which is brought about by electrical energy may be represented by

$$\underset{\text{salt}}{2NaCl} + \underset{\text{water}}{2H_2O} = \underset{\text{chlorine}}{Cl_2} + \underset{\text{sodium hydroxide}}{2NaOH} + \underset{\text{hydrogen}}{H_2}$$

Although the electrolysis of salt (fig. 2) produces equivalent amounts of both chlorine and caustic soda, the chlorine is regarded as the primary product and the caustic soda a by-product because, without a market for chlorine, the caustic soda so produced cannot compete economically with caustic from the ammonia-soda process.

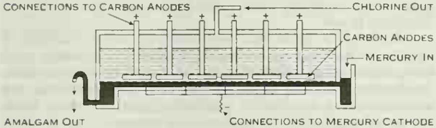


FIG. 4.—PRINCIPLES OF A MERCURY CELL

Mercury, which acts as a cathode, enters the cell at one end, propelled by a mechanical device. Brine flows through the cell in the same direction as the mercury (entrance and exit not shown). The mercury-sodium amalgam formed by the electrolysis leaves the cell and travels to a separate chamber in which it is made the anode, the sodium going into solution as sodium hydroxide. After extraction of the sodium, the mercury returns to the cell and repeats the cycle

Two distinct types of cells are employed, the diaphragm cell (fig. 3) and the mercury cell (fig. 4). In both, the electrolyte is a strong solution of salt (brine). Calcium and magnesium ions are precipitated from the brine before it enters the cell by addition of sodium carbonate, since these ions would otherwise precipitate in the cell and interfere with its operation. Both types employ graphite anodes but differ in the cathode material. Iron cathodes are generally used with the diaphragm-type cell, while a mercury cathode is the distinctive feature of the mercury-type cell. The reaction at a graphite anode is the liberation of chlorine gas,

$$2Cl^- = Cl_2 + 2e$$

Small amounts of oxygen usually accompany the chlorine, thus reducing the efficiency of operation (*see* ELECTROCHEMISTRY).

Diaphragm Cell.—In a diaphragm cell, hydrogen is discharged from the iron cathode. Discharge of sodium does not occur in the presence of water, for the potential required to discharge sodium is much greater than that at which hydrogen is set free. The hydrogen comes from the water, leaving hydroxyl ion in solution,

$$H_2O + 2e = H_2 + 2OH^-$$

The cathode and anode solutions must be kept separate for, with chlorine formed at the anode and sodium hydroxide at the cathode, mixing of the solutions would result in the formation of hypochlorite instead of evolution of chlorine. The diaphragm, commonly made of asbestos paper, serves this purpose. The diaphragm is adjacent to, and supported by, the cathode. Later practice favoured the nonsubmerged diaphragm, where the brine seeps through the diaphragm and is electrolyzed, and the alkaline solution trickles to the bottom of the cell. The cathode liquors average 110 to 120 g. NaOH per litre and 140 to 170 g. NaCl per litre. An outlet above the cathode allows the hydrogen to escape or to be collected. The anode section generally has a concrete cover with an opening for collection of the chlorine.

Some of the diaphragm-type cells in common use in the early 1960s were the rectangular Allen-Moore and Hooker type S (U.S.), the Hargreaves-Bird (British), Krebs (French), Billiter (German) and the cylindrical Vorce (U.S.). The bell jar cell, without diaphragm and with a slowly streaming electrolyte, has been employed in Europe.

Factors influencing the design of cells are the initial cost, life period, purity of product and efficiency with which electrical energy is utilized. Theoretically, the decomposition of aqueous sodium chloride solution requires about 2.2 v., but in operation the voltage drop per cell is found to be from 3.3 to 4.5 v. Hence, although the current efficiency in the modern cell is more than 90%, the energy efficiency is only 50%–60%. The excess voltage required results from energy lost as heat because of the resistance of the electrolyte, which may be minimized by having large electrodes close together, and to overvoltage effects at the electrodes. The overvoltage is largely a property of the electrode material, in the choice of which resistance to chemical action and cost must be considered.

The commoner types of cell operate at 1,000–5,000 amp., but the current density in amperes per square inch of electrode surface is only 0.12–0.50. An average yield per kilowatt hour is about two-thirds pound of chlorine and the same weight of sodium hydroxide. The different types of cell vary considerably in size, from the cylindrical Vorce cell, only 26 in. in diameter, to the Billiter cell, 18 ft. long, 10 in. wide and 2 ft. deep.

The operation of the diaphragm-type cell is accompanied by decreased efficiency because of the clogging of the diaphragm, which must be renewed at intervals of from one month to a year, varying with the different types of cell. In the Hargreaves-Bird cell, steam and carbon dioxide enter the cathode compartment, changing the sodium hydroxide to sodium carbonate. The diaphragm in this cell has a long life which is attributed to the action of the steam.

Mercury Cell.—In the mercury-type cell sodium is discharged into the mercury cathode at the bottom of the cell, and no hydrogen is evolved. Mechanical agitation moves the amalgamated mercury to a separate compartment of the cell where it is made the anode, causing the sodium to go back into solution as sodium hydroxide, while hydrogen is discharged from an ion cathode above. The over-all reaction is the same as with the iron cathode-type cell. The advantage of the mercury-type cell is that the caustic soda solution is free from chloride and may be produced at as high as 50% concentrate in the cell, while in the other cells the caustic soda is more dilute and considerable chloride must be separated to prepare the sodium hydroxide for sale. The disadvantage of the mercury-type cell is the high cost of mercury. The efficiencies reported are about the same as for the diaphragm-type cell. The cells are operated with much greater currents, however, up to 15,000 amp. The original mercury-type cells were developed by H. Y. Kastner (U.S.) and C. Kellner (Austria). Modern versions are the Krebs, Mathieson, I. G. Farbenindustrie and Imperial Chemical industries cells.

A 1945 report from Germany stated that all new installations since 1936 had been of mercury-type cells, presumably because of lower power costs and a plentiful supply of mercury from Spain. The new-type cells are steel tanks from 20 to 40 ft. long, 25 in. wide and 8 in. deep. The sides are coated with rubber, and a thin layer of mercury on the bare steel bottom serves as cathode. The tank slopes to give a mercury flow such that 0.2% of sodium is accumulated at 15,000 amp. The sodium is stripped from the mercury, without electrolysis, in an adjoining compartment. Brine, entering with 310 g. of NaCl per litre, is electrolyzed at from 70° to 90° C. and leaves the cell with 220–270 g. of salt per litre. The loss of mercury is reported to be from 1% to 7% per year.

Distribution.—Chlorine from the cells is freed from moisture by the action of concentrated sulfuric acid, cooled and liquefied by compression. The liquefied chlorine is sold in steel cylinders and tank cars. The large chlorine-caustic soda plants are generally located at points where both salt and electrical power are cheapest. However, some paper mills and rayon manufacturers, which are large users of both chlorine and caustic soda, run their own electrolytic plants. In this case the chlorine need not be liquefied and may be piped directly to the point of use.

See also references under "Chlorine" in the Index volume.

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Inorganic Chemistry (1952); H. Remy, *Treatise on Inorganic Chemistry*, trans. by J. S. Anderson, ed. by J. Kleinberg, vol. i (1956); J. W. Mellor, *Comprehensive Treatise on Inorganic and Theoretical Chemistry*, sup. ii, pt. i (1956). (R. P. S.)

CHLORITE, a group of green, micaceous hydrous aluminum silicates, usually of magnesium and ferrous iron.

Chlorites generally occur as alteration products of other minerals. They are common rock-forming minerals in clastic sediments (composed of pre-existing rocks) and in hydrothermally altered igneous rocks, and are important constituents in metamorphosed rocks, such as green or chlorite schists (*see* SCHIST). The cleavage of the chlorites is prominent but less perfect than that of the micas; and lamellae are softer (hardness = 2 to 3), and are pliable but not elastic. Chlorites are chemically distinguished from the true micas by greater water content (12% or 13%) and the essential absence of alkalis.

The fundamental crystallization scheme of the chlorites accommodates compositions whose empirical formulas may be expressed as $(Si_{4-x}Al_x)\ (Me^{2+}_{6-x}Me^{3+}_x)O_{10}(OH)_8$, where Me^{2+} are divalent metals, Me^{3+} are trivalent, and x may be as great as 2. Co-ordination of the fourfold ions is tetrahedral and of the sixfold, octahedral. Small contents of several divalent metals are frequently present, and in some compositions ferric iron or chromium partially replaces the essential tetrahedral aluminum. Group fundamentals and ranges of specific compositions were reviewed by M. H. Hey (1954).

Chlorites whose compositions conform strictly to the ideal formula are called orthochlorites. Hexagonal outlines are more or less distinct. Many other chlorite compositions, especially those containing ferric iron, are called leptochlorites, and are presumed to have been derived from orthochlorites by oxidation in the solid state with compensating loss of hydrogen. The physical properties of leptochlorites are less regular, and they more frequently include associated impurities. Experimental conversions of ferrous orthochlorites to leptochlorites have been accomplished, probably first by A. N. Winchell (1926).

Orthochlorite species names most frequently used are penninite, clinochlore and corundophyllite for predominately magnesian compositions; and daphnite for the abundantly ferrous iron-bearing.

Chamosite and thuringite are frequently used leptochlorite names, and unusual chemical compositions are often referred to by varietal names, as kammererite and kotschubeite for chromium-bearing members.

A rich polymorphism, based on extension of the principles set forth by S. B. Hendricks and M. E. Jefferson for true micas, exists within the chlorite crystallizations, and even within a given crystal some areas may be uniaxial, others biaxial.

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CHLORITOID: *see* OTTRELITE.

CHLOROFORM (TRICHLOROMETHANE) is a noninflammable, clear, colourless, mobile, heavy liquid with sweet, pleasant, ethereal odour, used primarily as an anesthetic and fat solvent. It was made in 1831 simultaneously by Samuel Guthrie in the United States, E. Soubeiran in France and Justus von Liebig in Germany, but Sir James Simpson of Edinburgh was the first to use it as an anesthetic, in 1847. Chloroform anesthesia, however, was attacked on religious grounds (based on Gen. iii, 16, "In pain you shall bring forth children"), and controversy over it continued until 1853 when John Snow gave it to Queen Victoria during the birth of Prince Leopold, her seventh child.

Chloroform is one of the most potent inhalation anesthetics, a few millilitres being enough usually to produce surgical anesthesia. Chloroform is commonly inhaled from an open mask and can produce deep anesthesia in a few minutes. It is mainly excreted with the exhaled air, and the patient wakes up in 10–15 minutes, usually groggy but with very little nausea or vomiting.

The margin of safety in chloroform use is relatively narrow, and this is probably the reason for the high mortality in inexperienced hands. It has a depressing and undesirable effect on most organs, especially the heart, blood vessels, liver, pancreas and kidneys. The fatalities occurring during induction of anesthesia, termed primary collapse, are most often due to overdosage. Delayed chloroform poisoning is seen when chloroform is given in high concentration with too little oxygen, and occurs most often in patients in poor nutritional condition. When overdosage, high concentration and inadequate oxygenation are avoided, then, and only then, can chloroform be regarded as a useful agent. It does not deserve to be abandoned as a surgical anesthetic, however. It is often the preferred anesthetic in very hot climates because of its high boiling point, in very cold climates because of its high potency, and in the presence of flames, high-voltage electricity and under other conditions where explosive anesthetics would be too dangerous to use.

Chloroform is sometimes used internally as an anodyne, a carminative and in cough medicines. Externally it is used in solutions, ointments or liniments as a local irritant or counterirritant for treatment of such conditions as rheumatism, headache and neuralgia. It is an effective anti-itching agent for insect bites, and in industry has a limited use as a fat solvent.

The chemical formula of chloroform is $CHCl_3$. Specific gravity of the liquid is 1.476 at 20° C. The vapour is about four times as heavy as air. It solidifies at −62° C. and boils at 61° C. (142° F.); critical temperature is 260° C. It dissolves poorly in water (1 ml. in 140 ml. at 20° C.) but easily in animal and vegetable lipoids, alcohol, ether, acetone, gasoline and most other organic solvents.

Chloroform can be prepared from many hydrocarbons (most often from alcohol or acetone), but during the process numerous toxic products may be formed; *e.g.*, phosgene, chlorine, hydrochloric acid and ethyl chloride. Although it is not inflammable, when exposed to flame, heat, light or oxygen it may be decomposed to the same toxic compounds. *See* also ANESTHESIA AND ANESTHETICS.

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CHLOROMYCETIN: *see* CHLORAMPHENICOL.

CHLOROPHYLL, CHEMISTRY OF. The green pigment which is present in leaves and algae is known as chlorophyll. Attempts to prepare the colouring matter of leaves in a pure form have shown that it is not homogeneous. R. Willstätter was able to separate it into four components: two green ones, chlorophylls *a* and *b* ($C_{55}H_{72}O_5N_4Mg$ and $C_{55}H_{70}O_6N_4Mg$); and two yellow ones, carotene ($C_{40}H_{58}$) and xanthophyll ($C_{40}H_{56}O_2$). At the same time, he found that the ratio of the blue-green chlorophyll *a* to the yellow-green chlorophyll *b* is 3:1, while that of xanthophyll to carotene is 2:1. The proportion of chlorophyll $a + b$ to xanthophyll + carotene is about 3:1.

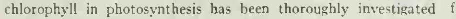
Later work (V. Lubimenko, 1921; A. Stoll and E. Wiedemann, 1938) showed that these pigments are not present in the leaf in the free state but are combined with a protein in the form of chloroplastin. Consequently, they pass into ether from an aqueous solution of the leaf pigment only after splitting the organic complex (called "symplex" by Willstätter, 1934). Chloroplastin is decomposed not only by high concentrations of salt but also by the presence of alcohol or acetone, so that the normal extraction process using these solvents liberates the individual pigments.

The separation of the carotenoids and the chlorophylls is achieved by distribution between suitable solvents, according to the method of Willstätter and Stoll (1913). Later, the technique of chromatographic analysis was employed to prepare the components in a pure state and to test their homogeneity. This led to preparations which careful spectrographic analyses proved to be of uniform composition (A. Winterstein and G. Stein, 1934; G. Mackinney, 1940–42; F. P. Zscheile, 1934–43). The pure chlorophylls are usually obtained as dark-green waxes. Progress in purification has enabled both chlorophylls to be characterized more precisely by their absorption spectra and, finally, to be crystallized, component *a* being obtained in green hexagonal plates and component *b* in dark-green needles (A. Stoll and E. Wiedemann, 1955–59). Crystallized derivatives of both components can be easily obtained after elimination of the phytol and the central magnesium atom (R. Willstätter and A. Stoll, 1913). The methods employed for the identification of the chlorophylls and for their quantitative determination are based upon characteristic absorption and fluorescence spectra (C. Dhéré and O. Biermacher, 1914–36; A. Hagenbach, F. Auerbacher and E. Wiedemann, 1936; A. Stern and co-workers, 1936–38; F. P. Zscheile and D. G. Harris, 1943). In ether solution the absorption maxima correspond to the following wave lengths (A. Winterstein and G. Stein, 1933):

chlorophyll *a*:	663		623		607		577			534	507		494		432 mμ
chlorophyll *b*:		644		614		594		567	542			503		456	

The connection between fluorescence and the part played by chlorophyll in photosynthesis has been thoroughly investigated (J. Franck, 1935–42; A. Kautsky, 1932–39; E. W. McAlister, 1937–41; E. C. Wassink, 1937–46). The essential chemical properties of the chlorophylls and their most important derivatives will be discussed in relation to the formula depicted for chlorophyll *a*. The characteristic features of the structure of chlorophyll are the porphin system, the magnesium atom with its complex linkage and the phytyl radical (R. Willstätter and A. Stoll, 1913).

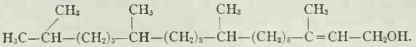
The components of the porphin system were ascertained by Willstätter (1904–12) when he carried out his first work on the degradation of the chlorophylls. The nature of the 16-membered ring system, composed of four pyrrole rings linked by methine bridges (α-δ), was then elucidated by H. Fischer (1915–30), who confirmed the formula suggested by W. Kuester in 1912 for hemin. The stage of hydrogenation of the chlorophyll nucleus is that of the phorbins; *i.e.*, dihydroporphyrins. The chlorophylls, therefore, contain two hydrogen atoms more than the porphyrins, which possess the maximum possible number of double bonds in the ring system. The structure of the porphin system and of the individual substituents was established by H. Fischer by degradation reactions and by the syntheses of numerous porphyrins, including most of those obtained by degradation of chlorophylls.



CHLOROPHYLL *a* AND CHLOROPHYLL *b*. THE DIFFERENCE IN THE TWO STRUCTURES IS INDICATED BY THE AREAS WITHIN THE DOTTED LINES

The discovery that magnesium, bound in the form of a metallic complex, forms an essential component of the molecules of the natural chlorophylls caused great surprise at the time (R. Willstätter, 1904), and this type of magnesium linkage remained unique. It may be that the magnesium has a share in the part played by chlorophyll in the assimilation process. The magnesium atom also constitutes a characteristic difference between the chlorophylls and the blood pigment hemin, which is an iron complex but otherwise possesses a similar structure, including a porphyrin system whose substituents agree closely with those of the chlorophyll porphyrins. When the chlorophylls are treated with acids, the magnesium atom is easily split off, the colour then changing from pure green to brownish green. The magnesium can be replaced by copper, zinc or other metals. The corresponding copper complexes are stable and are used as industrial pigments; *e.g.*, in the soap and cosmetic industries.

The structure of the simple unsaturated alcohol phytol, $C_{20}H_{39}OH$, was elucidated by F. G. Fischer (1928) by total synthesis, which showed it to be an isoprene derivative. It was later shown that phytol, as a structural component of vitamins E and K_1, is connected with special physiological functions.



$$H_3C-\overset{\overset{\displaystyle CH_3}{\diagup}}{C}H-(CH_2)_3-\overset{\overset{\displaystyle CH_3}{|}}{C}H-(CH_2)_3-\overset{\overset{\displaystyle CH_3}{|}}{C}H-(CH_2)_3-\overset{\overset{\displaystyle CH_3}{|}}{C}=CH-CH_2OH.$$

phytol

Before discussing the individual reactions by which derivatives of chlorophyll may be formed, it should be mentioned that chlorophyll *b* differs from chlorophyll *a* only in having an aldehyde group in position 3 in ring II in place of a methyl group; *i.e.*, it has an oxygen atom in place of two hydrogen atoms. Most reactions follow the same course with both components, so that they can be discussed as one. Simple reactions which leave the phorbin system intact and do not alter the relative positions of the substituents include the action of the specific enzyme (chlorophyllase) and the reactions with dilute acids and alkalies (*see* table).

In green leaves, chlorophyll is accompanied by the enzyme chlorophyllase, the quantity of which varies according to the variety of plant. Its specific action is the removal of the phytyl group, which is replaced by water, methyl or ethyl alcohol according to the nature of the medium present (R. Willstätter and A. Stoll, 1910; C. Weast and G. Mackinney, 1940). In this way, chlorophyllides are produced, which still contain magnesium. The reaction is reversible, since chlorophyllase can also be used to introduce phytol (R. Willstätter and A. Stoll, 1910), as well as other higher alcohols (H. Fischer, 1938), into the chlorophyll molecule.

Dilute acids split off the magnesium from chlorophyll and chlorophyllides with the formation of phaeophytin and the corresponding phaeophorbides, respectively. This reaction is also reversible, since it is possible by means of the Grignard reagent (R. Willstätter and L. Forsén, 1911) or magnesium alcoholate (A. Stoll and E. Wiedemann, 1933; H. Fischer, 1934) to reintroduce the magnesium.

By the action of hot alkalies, both the chlorophylls and the phaeophytins and phaeophorbides are converted into tricarboxylic acids by saponification of the phytyl and methyl ester groups and the cleavage of the carbocyclic side ring ($C_6 - C_7$). Thus, the chlorophylls yield the isochlorophyllins, which are converted by acidification into chlorin e_6 in the case of chlorophyll *a*, and into rhodin g_7 in the case of chlorophyll *b*; these end products being also obtained from the phaeophorbides and their esters.

The determination of the structure of the chlorophylls and their primary derivatives was carried out by way of the related porphyrins. These are obtained by degradation of the phorbins with alkali, or by treatment with hydrogen iodide. This reagent reduces only the double bonds. During the subsequent working up, aerial oxidation takes place until the ring system is completely dehydrogenated. As will be described later, at the same time a vinyl group is converted to an ethyl group during the reduction. It therefore follows that the most important phaeoporphyrins formed in this way (phaeoporphyrin a_5 in the *a* series and phaeoporphyrin b_6 in the *b* series) are isomers of the phaeophorbides *a* and *b*. The numerals added as subscripts indicate the number of oxygen atoms present. Phaeoporphyrin a_5 still contains the carbocyclic side ring from C_6 to C_7 which, as an acetoacetic ester group, is responsible for the ready transformation into the tricarboxylic acids chlorin e_6 and chloroporphyrin e_6, respectively.

To confirm this acetoacetic ester grouping, it was essential to demonstrate the presence of an enolizable keto group, which was achieved by the preparation of oxime and benzoyl derivatives of phaeophorbide *a*. By oximation of phaeophorbide *b* it was possible to prove the presence of a further carbonyl group in addition to the keto group, so that a dioxime and two monoximes were obtained in this case (A. Stoll and E. Wiedemann, 1934).

Enolization in the carbocyclic side ring is also proved by the so-called phase test, which is characteristic of the intact chlorophyll molecule. When an ethereal chlorophyll solution is shaken with concentrated alcoholic alkali, the green colour changes suddenly to brown, followed, after several minutes, by a return of the green colour owing to hydrolysis of the carbocyclic ring. Oxidized chlorophyll derivatives, which form even on standing in alcoholic solution, especially on the alkaline side, no longer give the phase test and are known as allomerized chlorophyll derivatives and purpurins (J. B. Conant, 1931–34; A. Stoll and E. Wiedemann, 1932–35; H. Fischer and co-workers, 1933).

The presence of the vinyl group in position *2* of the chlorophyll molecule was proved by hydrogenation and by a specific oxidation reaction (oxoreaction). Its position was confirmed by elimination of the acetyl group thus produced and identification of the resulting porphyrin (H. Fischer and co-workers, 1935).

The green compounds, the phorbins, to which the chlorophylls and their primary derivatives belong, arise from the red porphyrins by the reduction of one of the double bonds in the nucleus. The natural phorbins are further characterized by the above-mentioned vinyl group in place of the ethyl group in position *2*. The fact that the phorbins are dihydroporphyrins was proved by oxidation of their copper complexes (H. Fischer and K. Herrle, 1937; H. Wenderoth, 1939; H. Gibian, 1942). The placing of the two hydrogen atoms in positions 7 and 8 in the pyrrole ring IV followed from the optical activity of chlorophyll derivatives in which other asymmetric centres had been eliminated (H. Fischer and H. Wenderoth, 1940). The optical rotation in acetone is $[\alpha]^{25}_{720} = -262°$ for chlorophyll *a*; and $[\alpha]^{25}_{720} = -267°$ for chlorophyll *b* (A. Stoll and E. Wiedemann, 1933).

In principle, the conversion of porphyrins into green compounds can be achieved by hydrogenation. The main obstacles which have so far prevented a total synthesis of the chlorophylls are the severity of the conditions which have to be employed and the simultaneous reduction of the 2-vinyl group if previously introduced. In the case of simple porphyrins, it has been possible to effect the introduction of hydrogen in the required 7:8 position (A. Treibs and E. Wiedemann, 1928; H. Fischer and H. Helberger, 1929; H. Fischer and H. Wenderoth, 1940). The introduction of magnesium, of the phytyl and vinyl radicals and of the carbocyclic side ring has been carried out successfully.

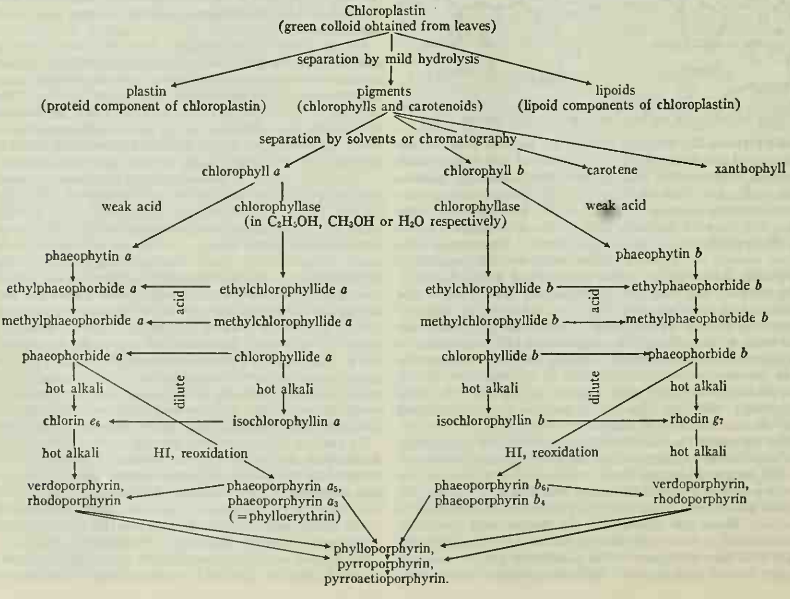
As precursors of the chlorophylls in plants, protochlorophylls were found which are converted into chlorophylls on exposure to light (N. A. Monteverde and V. Lubimenko, 1894–1912). It is probable that these protochlorophylls belong to the porphyrins but otherwise possess the same structure as the chlorophylls (K. Noack, 1928–31; A. Seybold, 1937).

A chlorophyll derivative has been found in photosynthetic bacteria and has been named bacteriochlorophyll (C. B. van Niel, 1932–36). Its structure can be derived from that of chlorophyll *a* by the addition of two H atoms to the double bond in ring II and by replacing the vinyl group in position *2* by an acetyl group (H. Fischer and co-workers, 1937–38). Compared with the spectra of the chlorophylls, the absorption bands of bacteriochlorophyll are shifted into the infrared (C. B. van Niel, 1938).

Only brief reference can be made to the part played by the leaf pigments in the assimilation of carbon dioxide without discussing the many theories relating to this phenomenon. An important result is the confirmation that the assimilatory quotient of the expired oxygen to the assimilated carbon dioxide is always equal to 1 (R. Willstätter and A. Stoll, 1917).

The function of chlorophyll in photosynthesis (*q.v.*) has been defined as that of an energy transformer or of an assimilatory ferment (R. Emerson, 1936; A. Stoll, 1936). The path of the assimilated carbon, from carbon dioxide to the final products, especially in the case of sucrose, was elucidated by M. Calvin and co-workers (1947–52) using radioactive carbon. The intermediates were identified by means of radioautographs and chemical analysis.

The combination of chlorophyll with protein in chloroplastin is of special significance for this function, since only as a result of this combination is chlorophyll able to remain resistant to light (Lubimenko, 1921). Chloroplastins from different plants are not identical. A characteristic of chloroplastin is its great tendency


Chloroplastin
(green colloid obtained from leaves)
separation by mild hydrolysis
plastin
(proteid component of chloroplastin)
pigments
(chlorophylls and carotenoids)
lipoids
(lipoid components of chloroplastin)
separation by solvents or chromatography
chlorophyll a
chlorophyll b
carotene
xanthophyll
weak acid
chlorophyllase
(in C₂H₅OH, CH₃OH or H₂O respectively)
chlorophyllase
weak acid
phaeophytin a
phaeophytin b
ethylphaeophorbide a
acid
ethylchlorophyllide a
ethylchlorophyllide b
acid
ethylphaeophorbide b
methylphaeophorbide a
methylchlorophyllide a
methylchlorophyllide b
methylphaeophorbide b
phaeophorbide a
chlorophyllide a
chlorophyllide b
phaeophorbide b
hot alkali
dilute
hot alkali
hot alkali
dilute
hot alkali
chlorin e₆
isochlorophyllin a
isochlorophyllin b
rhodin g₇
hot alkali
HI, reoxidation
HI, reoxidation
hot alkali
verdoporphyrin,
rhodoporphyrin
phaeoporphyrin a₅,
phaeoporphyrin a₃
(=phylloerythrin)
phaeoporphyrin b₆,
phaeoporphyrin b₄
verdoporphyrin,
rhodoporphyrin
phylloporphyrin,
pyrroporphyrin,
pyrroaetioporphyrin.

toward agglomeration; and even the smallest molecular weights measured by the ultracentrifuge on electrophoretically homogeneous chloroplastin preparations run into several millions (A. Stoll and E. Wiedemann, 1938–47).

See also references under "Chlorophyll, Chemistry of" in the Index volume. (A. Stl.)

CHLOROPICRIN, product of the distillation of bleaching powder with many nitro compounds (*e.g.*, picric acid, nitromethane), may be prepared also by the action of concentrated nitric acid on chloral or chloroform, or by the action of aqua regia (*q.v.*) upon almost any organic substance. The commonest method of preparation (A. W. von Hofmann, 1866) consists of adding a solution (saturated at 30° C.) of one part of picric acid to a paste of ten parts of bleaching powder and water. A violent reaction occurs, and chloropicrin (nitrochloroform, trichloronitromethane), CCl_3NO_2, distills over, generally without external heating. It is a colourless liquid of boiling point 112° C. and of specific gravity 1.692. It is almost insoluble in water but is readily soluble in alcohol; it has a sharp smell, and its vapour powerfully affects the eyes. Chloropicrin has been employed in chemical warfare as a lachrymatory, irritant and lethal agent. High concentrations of this chemical cause fatal lung injuries, and death may ensue from exposure to its action even at low concentrations.

CHLORTETRACYCLINE (Aureomycin) is an antibiotic substance obtained from cultures of the actinomycete *Streptomyces aureofaciens* and used in the treatment of many infectious diseases. Chlortetracycline is the chemical name of the substance; Aureomycin the registered trade-mark.

It was isolated and described by Benjamin M. Duggar in 1948 and was found to be effective against a wide variety of infectious agents including both gram-negative and gram-positive bacteria, certain large viruses, rickettsiae and some protozoal parasites. Chlortetracycline inhibits the growth and multiplication of those infectious agents sensitive to the drug, but only in very high concentration is it capable of directly killing the disease-producing microorganisms. It usually is given orally and is rapidly absorbed from the gastrointestinal tract, diffusing readily into the body tissues and fluids. Chlortetracycline also is available in preparations suitable for parenteral and topical administration.

The systemic administration of chlortetracycline causes gastrointestinal disturbances in some patients; diarrhea due to inhibition of the normal bacterial flora of the large bowel is not uncommon.

The rates of growth of chickens, poults and hogs have been found to increase markedly by the addition of minute quantities of chlortetracycline to their feed. (T. W. L.)

CHMIELNICKI, BOHDAN (*c.* 1595–1657), hetman of the Zaporozhian Cossacks, celebrated for his rebellion against Polish rule in the Ukraine. Educated in Poland, he served in his youth with the Polish and Cossack forces against the Turks. Eventually, however, a quarrel with Daniel Czaplinski, the Polish governor of Czehryn, led to his fleeing, in Dec. 1647, to the Cossack Zaporozhian host, a stronghold of runaway serfs and bandits on the Dnieper river (*see* Cossacks). From there he struck an alliance with the Crimean khan, and in April 1648 the Cossack-Tatar force moved against the Poles. Polish defeats in May at Zheltye Vody and at Korsun were followed by a mass rising of the Orthodox peasantry and clergy in the Dnieper region, dissatisfied with Polish rule and religious policies. The rebel forces then moved into Poland proper, won another victory at Pilawce (Sept. 23) and took Lvov (Lwow), massacring Catholics and Jews and looting on their way. Chmielnicki was at this point still willing to recognize Polish sovereignty, and Poland, to appease him, bestowed on him the title of hetman. In spring 1649, however, armed conflict was renewed. This time the disloyalty of the Tatars compelled Chmielnicki to come to terms. The compact of Zborow signed between the Poles and Tatars (Aug. 8, 1649) secured for Chmielnicki a virtually independent Cossack principality. Even so, the restless Cossacks would not live in peace. War was resumed, and in June 1651 the Poles defeated the Cossacks at Berestechko. Chmielnicki now had to seek help from Moscow. On Jan. 18, 1654, at Pereyaslavl, he put his people under the Russian tsar's authority in return for extensive self-rule. When in 1654 the Russians invaded Poland, Chmielnicki did not offer them military assistance and entered instead into secret negotiations with the Swedes. He was about to betray Moscow by putting the Cossacks under Swedish rule when he died, at Subotov, on Aug. 6, 1657.

A skilful diplomat and military leader, Chmielnicki was also intemperate, anarchistic, incapable of sustained industry and sometimes indecisive at critical moments. His rebellion ruined the once flourishing Dnieper lands, and the Pereyaslavl treaty was the beginning of the end of Cossack liberties, which Moscow gradually restricted and finally abolished.

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CHOATE, JOSEPH HODGES (1832–1917), U.S. lawyer, diplomat, and public speaker, one of the great trial lawyers in U.S. history, was born at Salem, Mass., on Jan. 24, 1832. He was a distant relative of the noted lawyer Rufus Choate (*q.v.*). After graduating from Harvard college in 1852 and from the Harvard law school in 1854 he was admitted to the Massachusetts bar in 1855, and to the New York State bar the following year. He allied himself with the newly formed Republican party and gained early recognition for his strong support of John C. Frémont for president in the election of 1856.

He was associated with many of the most famous lawsuits, including that over the will of Samuel J. Tilden, the Kansas prohibition cases, the Chinese exclusion cases, the income tax cases and the case of Gen. Fitz-John Porter (*q.v.*). In 1871 he became a member of the Committee of Seventy in New York city, which was instrumental in breaking up the Tweed ring. Choate's legal career was remarkable for its length, covering a period of more than 55 years. He never held elective office but was ambassador to Great Britain from 1899 to 1905 and head of the U.S. delegation to the second Hague conference in 1907. As ambassador to Great Britain Choate brought about the abrogation of the Clayton-Bulwer treaty (*q.v.*) of 1850, thus paving the way for the unilateral construction of the Panama canal by the United States. For years Choate was one of the most popular after-dinner speakers in the United States, sharing honours with Chauncey Depew. He died in New York city on May 14, 1917.

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CHOATE, RUFUS (1799–1859), U.S. senator and leader of the Massachusetts bar during the 1850s, was born at Essex, Mass., on Oct. 1, 1799. He graduated from Dartmouth college in 1819. He then spent a year in the law school at Harvard university, followed by study in the law office of William Wirt in Washington, D.C. He was admitted to the Massachusetts bar in 1822 and practised for five years, during which time he also served in the Massachusetts legislature. In 1830 he was elected to the U.S. house of representatives as a Whig from the Salem district. He was re-elected in 1832 but soon resigned to return to his law practice in Boston. In 1841, when Daniel Webster resigned his senate seat to become secretary of state, Choate was chosen to complete the term. In the U.S. senate he made a series of brilliant speeches on the tariff, the Oregon boundary, the Fiscal Bank act and the annexation of Texas. At the close of his term in 1845 he resumed the practice of law in Boston. After Webster's death in 1852 Choate was generally conceded to be the leader of the Massachusetts bar. During the rest of his life no amount of urging could persuade him to abandon the legal profession for public office, except for a short term as attorney general of Massachusetts in 1853–54. He died July 13, 1859 at Halifax, N.S., while en route to Europe. *See* his *Works* (edited with a memoir by S. G. Brown) published in 2 vols. in 1862. The *Memoir* was afterward published separately (1870).

See also E. G. Parker, *Reminiscences of Rufus Choate* (1860); E. P. Whipple, *Some Recollections of Rufus Choate* (1879); Claude M. Fuess, *Rufus Choate* (1928). (F. M.)

CHOBE: *see* Kwando.

CHOCÓ, a department on the Pacific coast of the republic of Colombia, northwest South America, bounded by Panamá on the north. Almost the entire area (18,327 sq.mi.) of the department is covered with dense tropical rain forest, and the average rainfall probably exceeds that of any other equatorial area on earth; at Quibdó, the capital, it is above 420 in. There is no dry season. The scant population of the Chocó (147,380 in 1961) is for the most part Negroid, descendants of escaped colonial slaves who were employed in placer mining on the Atrato (*q.v.*) and San Juan rivers, which are still Colombia's primary sources for platinum. A few Indian groups survive in the more isolated hill areas. White settlers from Antioquia have begun to populate the eastern mountain margins. The vast swamplands of the Atrato are the most formidable barrier blocking completion of the Pan-American highway between Central and South America. (Js. J. P.)

CHOCOLATE: *see* Cocoa.

CHOCTAW, a prominent Indian tribe in southern Mississippi, of Muskogee stock. Their name is apparently a corruption of the Spanish *chato*, "flattened," which referred to their practice of flattening the heads of male infants. They farmed intensively. The Choctaw were allies of the French and enemies of the British and of most of the Muskogeans. In the later 18th century they began drifting west of the Mississippi, and about 1832 the majority moved to what is now eastern Oklahoma, where they remained self-governing and semicivilized until their absorption into American citizenship in 1906. At mid-20th century they numbered about 17,500 exclusive of Negro freedmen included in the "nation," but include many of mixed blood; the original population seems to have been only slightly larger.

See also Muskogean Indians; Oklahoma: *History*.

CHODKIEWICZ, JAN KAROL (1560–1621), Polish general prominent in the wars against Sweden and Muscovy, was born (probably) at Bykhov on the Dnieper and educated by the Jesuits at Wilno (Vilna) and in Germany at Ingolstadt. He was appointed *starosta* ("governor") of Samogitia in 1599 and acting commander in chief of Lithuania in 1601. In the war against Sweden for possession of Livonia he drove the duke of Södermanland (later Charles IX of Sweden) from Riga, took Dorpat (Tartu) in 1603 and destroyed a Swedish army three times larger than his own at Kirkholm (Salaspils) in Sept. 1605. The Polish diet, however, never sent him adequate supplies. After helping to defeat the civil war of 1606–07 in Poland and to relieve Riga when the Swedes were threatening it again in 1609, he was sent to attack Moscow (1612), but his army mutinied for lack of pay and he had to retreat to Smolensk. Reinforced, however, by Prince Wladyslaw (King Sigismund III's son), he took the fortress of Dorohobuz in 1617. After the truce of Deulino between Poland and Muscovy (1619) he was sent to defend the southern frontier against the Turks. He died on Sept. 24, 1621, just after forcing the Turks to raise the siege of Khotin (Chocim). (St. He.)

CHODOWIECKI, DANIEL NICOLAS (1726–1801), German genre painter and engraver of Polish descent, who developed a particular talent for recording the life and manners of the German middle class, was born at Danzig on Oct. 13, 1726. Largely self-taught, he began engraving in 1758. His first popular success was the sentimental painting "Jean Calas and His Family." After designing and engraving several subjects from the story of the Seven Years' War, Chodowiecki produced the famous "History of the Life of Jesus Christ." Few books were published in Prussia for some years without plate or vignette by Chodowiecki. His 2,000 etchings were a record of 18th-century life in comfortable interiors, observed with a kindly humour that lacked the bite of William Hogarth, with whom he was often compared, despite his own disclaimers. He became director of the Berlin academy in 1797. He died in Berlin on Feb. 7, 1801.

CHOERILUS (1) (fl. *c.* 510 B.C.), Athenian tragic poet, with his first performance *c.* 522 B.C., is one of the earliest recorded tragedians, but now little more than a name. One contest (*c.* 498) between Choerilus, Pratinas and Aeschylus was remembered as the occasion when the spectators' wooden seats collapsed. The Suda lexicon gives him the monstrous number of 160 plays, and, more reliably, 13 victories; he was also credited with some innovations in masks and costumes. All that survives is a title, *Alope*, and an elaborate metaphor (unless this is to be attributed to the epic poet Choerilus).

See A. Nauck (ed.), *Trag. Gr. Frag.* (1926).

(2) Epic poet of Samos, of the 5th century B.C. Little that is trustworthy is known of his life. It must have been in his last years that the Spartan general Lysander, according to Plutarch, began taking him around in his retinue, hoping to be immortalized in a poem. The legend that he was originally a runaway Samian slave who attached himself to Herodotus seems to be a reflection of his indebtedness to the historian for the material of his chief work, the *Persika* or *Perseis*, a verse-chronicle of (probably) the rise of Persia and its wars on the mainland and with Greece. The scanty extant fragments include the opening lines in which he regrets the ancient days when all subjects for poetry were new and unused; clearly he felt himself to be in the Homeric tradition in composing an epic on recent history.

See G. Kinkel (ed.), *Ep. Gr. Frag.*, i (1877). (A. M. De.)

CHOIR, a body of singers with more than one voice to a part, formed for the purpose of singing either sacred or secular music, or both, and consisting of boys, women and men either in single groups or combining boys and men in a cathedral choir or women and men in a mixed choir of the kind used in performances of opera and oratorio. The term "boy choir," much used in the United States, refers not to a choir consisting exclusively of boys but to a choir in which the treble parts are sung by boys instead of women. A "mixed choir" is normally composed of women (sopranos and contraltos) and men (tenors and basses) and finds its place in predominantly secular functions, whereas a "male voice choir" is made up either of boys (trebles) and men (countertenors [altos], tenors and basses), heard in cathedrals and collegiate churches, or entirely of men.

The growth of the secular choir coincided to a large extent with the beginnings of opera, in which choruses have always taken some part, even though their contribution may not equal that of the soloists and orchestra in length or importance. In most operas crowd scenes involving peasants, soldiers, apprentices or whatever is most suitable to the subject of the opera provide the opportunity for the composition of parts for a choir, the actual size of which must depend on the size of the theatre and its budget. It has usually been the custom to employ professional singers in opera house choirs, or choruses (as they are more generally called). An oratorio choir, on the other hand, is part of an entirely different tradition, which stems from the augmented church choirs used to provide the choral portions of a given work, whether sung in or out of church. The oratorio choir is the home of the amateur singer, and although there have been, and still are, notable exceptions to this rule, its almost universal application is made a virtual necessity by the sheer weight of numbers customarily employed.

Handel was in the habit of presenting his oratorios and operas with a choir of medium size, but the Handel commemoration of 1784 which took place in Westminster abbey and in the Pantheon in London called for as large a body of singers as could be conveniently found. Of the 525 performers, the choir numbered 274: 59 trebles, 48 countertenors, 83 tenors and 84 basses. This choir was, however, dwarfed by the 2,000 singers who took part in the first Handel festival at the Crystal palace, London, in 1857, while subsequent years of this same festival saw the number creep up to well over 3,000. Even the *concerts monstres* of Berlioz rarely made use of a choir numbering more than 500, although he claims that he once heard, in St. Paul's cathedral in London, a choir of 6,500 at the anniversary meeting of the Charity Children in 1851. It was from such meetings as these, beginning with the meetings of the Three Choirs of Gloucester, Worcester and Hereford (1724 or perhaps earlier), that local choral festivals, widely popular in the 20th century, sprang.

Choirs have taken part in church services from the earliest times, but for many centuries their role was confined to singing plainsong in unison. This kind of choir varied considerably in size and style. In a monastery or nunnery all were expected to take their part in the singing of services, even though (in a small community) there might be no more than 10 or 12 members. In a well-endowed abbey, cathedral, collegiate church or royal chapel, the choir might consist of as many as 50 or 60 trained voices. In England, the medieval system whereby a canon could appoint a substitute (*vicarius*) led to the formation of self-governing colleges of vicars choral, who were usually in deacon's or subdeacon's orders. Below them in rank were clerks of the choir (*clerici chori*), also in minor orders, who were sometimes referred to as "altarists" or "secondaries."

Boys are found in choirs of secular cathedrals where they were trained by the precentor to take part not only in the singing but also in the liturgy. Boys with intelligence and a good voice could progress via thurifer, subdeacon and deacon to vicar choral; and as time went on they enjoyed lodgings and privileges of their own as well as tuition in subjects other than music. At St. Paul's cathedral in the early 16th century there were 12 minor canons, 16 chantry priests (who also sang in the choir), six vicars and ten choristers. Cardinal Wolsey's private chapel consisted of a dean, gospeler and epistler, 10 chaplains, 12 clerks and 10 choristers. At the funeral of King James I the choir of the Chapel Royal was made up of 19 gentlemen of the chapel and 12 children, and with them was the choir of Westminster abbey, an additional 17 men and 10 children.

Apart from plainsong, there was no choral singing in the early church, for when harmony first came into use its relative complexity demanded soloists as interpreters. Italian manuscripts begin, however, to hint about 1430 at the use of a choir for straightforward polyphony, with the direction that sections of the liturgy in three-part harmony are to be sung by the chorus (*i.e.*, by all voices) in contrast to the sections in two-part harmony, marked either *unus* (to indicate one voice to a part) or *duo* (to describe such sections as duets for solo voices). This alternation of soloists and chorus eventually led to the use of two choirs, one on each side of the church, or placed (as at St. Mark's, Venice) in galleries so that psalms, canticles and even masses could be sung antiphonally. Music for divided choirs (*cori spezzati*) was developed in the early 16th century and brought to a splendid peak of excellence in the early 17th by Giovanni Gabrieli. *See* also CHURCH MUSIC; MUSIC FESTIVAL; OPERA. (D. W. ST.)

CHOISEUL, CESAR, DUC DE (1598–1675), French marshal and diplomatist, notable for his loyal services to the crown under Louis XIII and Louis XIV, was a member of the old family of Choiseul, which had its seat in the valley of the Upper Marne. Known at first as the comte du Plessis-Praslin, he served with the army in the siege of La Rochelle and in the defense of the island of Ré against the duke of Buckingham in 1627 and accompanied the French forces to Italy in 1629. He was appointed ambassador at the court of the duke of Savoy in 1630 and was engaged in diplomatic and administrative work in Italy until 1635, when war was declared between France and Spain. He then distinguished himself in the ensuing Italian campaign (he was made lieutenant general of the army in Italy in 1641) and in Catalonia. He was made marshal of France in 1645. During the Fronde (*q.v.*) he remained constantly loyal to the regent Anne of Austria and to Cardinal Mazarin, assisting the prince de Condé in the siege of Paris (Jan.–March 1649) and winning the important victory over Turenne and the Spaniards at Rethel (Dec. 1650). He became minister of state in 1652 and was created duc de Choiseul in Nov. 1665. He was concerned in some of the negotiations which led to the Anglo-French treaty of Dover (1670). He died in Paris on Dec. 23, 1675.

CHOISEUL, ÉTIENNE FRANÇOIS DE CHOISEUL, DUC DE (1719–1785), French diplomat and statesman, the leading and most consistent advocate of France's alliance with Austria and the creator of the Bourbon "Family compact" of 1761 with Spain, was born in Lorraine on June 28, 1719. He was the eldest son of the marquis de Stainville, François Joseph de Choiseul, who was grand chamberlain of Francis, duke of Lorraine. He entered the army and served with distinction in Bohemia, Italy and the Netherlands during the War of the Austrian Succession, attaining the rank of lieutenant general in 1748. His rise to political eminence was facilitated by his marriage, in 1750, to Louise Honorine Crozat (granddaughter of the rich financier and war contractor Antoine Crozat, marquis de Châtel) and by the favour of Madame de Pompadour, whom he had saved from being expelled from the court by a possible rival mistress, the wife of his own cousin, in 1752.

Madame de Pompadour secured for Choiseul his first diplomatic appointment as ambassador to the Vatican in 1753. His main task was to secure from Pope Benedict XIV a modification of the bull *Unigenitus* of 1713, which had made French Jesuits and Jansenists irreconcilable. His success in this mission led to his nomination in March 1757 as ambassador to the court of Vienna with instructions to foster and develop the newly formed alliance with Austria. Together with the cardinal de Bernis (*q.v.*) he was responsible for the conclusion of the second treaty of Versailles (May 1, 1757) which brought France and Austria together in an offensive alliance to recover Silesia for Austria.

On Dec. 3, 1758, Choiseul, having become a duke and peer of France, succeeded Bernis as minister of foreign affairs at a most critical juncture of the Seven Years' War. For the next 12 years he maintained himself as a pluralist in ministerial office. A firm advocate of the Austrian alliance, he yet wished to limit France's financial and continental commitments under the second treaty of Versailles and to pave the way for separate peace negotiations between France and Great Britain. This was the purpose of the third treaty of Versailles (March 1759). Choiseul's conclusion of an offensive and defensive treaty with Spain on Aug. 15, 1761 (the "Family compact"), though it deferred the immediate prospects of peace, provided France with much-needed naval support in the period after 1763.

Choiseul showed skill and resource in the final negotiations leading to the peace of Paris in 1763 and remarkable tenacity in rebuilding France's military and naval strength in the postwar period. During his period of office at the admiralty (Oct. 1761–April 1766) he increased French ships of the line from 40 to 64 and the frigates from 10 to 45, thus providing France with the effective means of intervening decisively against Great Britain during the War of American Independence. As minister of war (Jan. 1766–Dec. 1770) he began a fruitful period of army reform which continued down to the Revolution: he moved recruitment from captains, provided a core of noncommissioned officers and improved the training of professional officers. He also gave his attention to recreating the sources of French commercial strength in the West Indies; to France's strategical interests in the Mediterranean, which he secured by the acquisition of Corsica in 1768; and to plans for the invasion of England. In domestic affairs he used his influence to ensure the resumption of the *Encyclopédie* after its suppression in 1759 and was responsible for the expulsion of the Jesuits from France in 1762.

Between 1765 and 1770 Choiseul encountered increasing opposition from the friends of the Jesuits, from critics of his military reforms and, after 1768, from the chancellor René Nicolas Maupeou (*q.v.*). Madame de Pompadour's death in 1764 removed one of his most powerful supporters, and his enemies won her successor Madame du Barry to their cause. Support from Marie Antoinette, who married the future Louis XVI in 1770, could not offset Madame du Barry's hostility. The final cause of Choiseul's fall from power was criticism of his plans for war with England in 1770 over the Falkland Islands at a time when France was passing through one of its periodical financial crises. He was dismissed from office on Dec. 24, 1770, and exiled to his estates at Chanteloup in Touraine. Allowed to return to Paris in 1774, he never recovered political power. He died in Paris on May 8, 1785. He left some important *Mémoires*, ed. by F. Calmettes (1904).

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CHOISYA, a genus of four to five species of evergreen shrubs native from Arizona to southern Mexico, belonging to the rue, or citrus, family (Rutaceae; *q.v.*), and distinguished by palmately compound leaves of 3 to 13 leathery leaflets, the white flowers bisexual with five petals and ten stamens, and the fruit a five-valved, usually ten-seeded, capsule. One species (*C. ternata*), called Mexican orange, is widely grown in tropical and warm-temperate regions as an ornamental. (G. H. M. L.)

CHOKEDAMP: *see* COAL AND COAL MINING: *Hazards of Mining.*

CHOKWE (BAJOKWE), a Bantu people estimated to number about 600,000, inhabit the southern part of the Republic of the Congo (former Belgian Congo) from the Kwango river to Lualaba, northeastern Angola, and, since 1920, the northwestern corner of Northern Rhodesia. They live in woodland savanna intersected with strips of rain forest along the rivers, swamps and marshlands. They are a mixture of many aboriginal peoples and conquering groups of Lunda origin.

For centuries Chokwe chiefdoms have been tributaries of the Lunda paramount chief Mwata Yamvwa in the Congo. During the latter half of the 19th century they revolted several times and on one occasion gained temporary ascendance. Among the northern Chokwe hunting is very important, and there are privileged corporations of hunters. Hoe cultivation overrides hunting among the southern Chokwe, the staple crops being manioc, peanuts, yams, millet, beans and maize; the southern Chokwe of Angola keep some cattle. The political structure seems to range from tributary chiefdoms with courts modeled on that of the Mwata Yamvwa to autonomous village groups. Villages are compact and arranged into compounds; square huts or circular grasshouses are grouped in circles around the central meetinghouse.

Descent is matrilineal, marriage is virilocal and residence is avunculocal (*see* KINSHIP). Marriage payments are low; polygyny is restricted to the chiefly and wealthy classes; cross-cousin marriages are permitted. Circumcision of boys, the use of initiation masks and elaborate girls' initiations occur throughout the area. The Chokwe are exceptional craftsmen; the carving of masks, statues and stools, plaiting, pottery, basketry and ironwork are much developed. The rites of the mungongi association with dances by stilt-walkers have great significance. *See* also AFRICA: *Ethnography (Anthropology): West Central Africa.*

See H. Baumann, *Lunda* (1935); M. McCulloch, *The Southern Lunda and Related Peoples* (1951). (D. P. BI.)

CHOLA, the name of a south Indian Tamil dynasty, of unknown antiquity antedating the early Sangam poems (probably *c.* A.D. 200). The dynasty originated in the rich Cauvery valley, Uraiyur (now Tiruchirapalli) being their oldest capital.

The legendary king Karikala was the common ancestor through whom small Deccan and Andhra families called Chola or Choda claimed a connection with the Uraiyur family. The Chola country (Coromandel) stretched from the Vaigai river in the south to Tondai-mandalam, the capital of which was Kanchi (Kancheepuram; *q.v.*), in the north. Much of Tamil classical literature and the greater Tamil architectural monuments belong to this period, which also saw the revival of Shivaism (Saivism) and the development of southern Vishnuism (Vaishnavism). Revenue administration, village self-government, and irrigation were highly organized under the Cholas.

Chola kings and emperors bore the titles Parakesarivarman and Rajakesarivarman alternately: their chronology is difficult being based mainly on regnal years. Vijayalaya (*c.* 850–870) began the occupation of the territory of the Pallavas which was extended under Aditya I. Parantaka I (907–*c.* 947), "the destroyer of Madura" (the capital city of the Pandyas [*q.v.*]), defeated Sinhalese invaders and united the lands of the Cholas and the Pandyas between 926 and 942. Coming to terms with the Rashtrakutas (*q.v.*) he took Nellore from them about 940, but the Rashtrakuta king, Krishna III, seized Tondai-mandalam. Rajaraja I (985–1014), an able administrator, protected Vengi (the Godavari districts), and occupied the Gangavadi territory (Mysore state), annihilating the western Gangas. By 996 he had conquered Kerala (the Chera country), and acquired the north of Ceylon. With the booty he built the great Brihadisvara temple at Tanjore. By 1014 he had acquired the Laccadive and Maldive islands. Rajendracola Deva I outdid his father's achievements: he placed a son on the throne at Madura, completed the conquest of Ceylon, overran the Deccan (*c.* 1021), and sent (1023) an expedition to the north which penetrated to the Ganges river and brought back Ganges water to the new capital Gangaikondacholapuram. He conquered kings of Srivijaya and other portions of the Malay peninsula and archipelago.

Rajadhiraja fought the Pandyas and Cheras, and defeated the Chalukya Somesvara I in 1046, but was killed at the battle of Koppam against the same foe in 1054. Virarajendra, who succeeded in 1063, attempted to render the Chalukya empire in the Deccan harmless, but his death enabled Vikramaditya Chalukya to dabble in Chola family quarrels. Kulottunga I, who succeeded in 1070, wisely abandoned the Deccan and concentrated on uniting the whole eastern coast. Intrigues concerning the right to the Pandya throne embroiled Cholas, Pandyas and Ceylon from about 1166. From 1216 the Hoysala kings obtained valuable lands in the Chola country; former Chola feudatories threw off their allegiance; northern powers intervened; and the upheaval facilitated the Pandya conquest of 1257. The dynasty ended in 1279.

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CHOLERA is a term that has been applied to a wide variety of acute diarrheal diseases of short duration. Cholera nostras, simple cholera, European cholera, British cholera and cholera infantum or summer diarrhea of infants are relatively mild enteric diseases characterized by sudden onset, acute diarrhea sometimes accompanied by vomiting, low fatality and recovery in one to five days. These diseases are of diverse, and in many instances uncertain, etiology. Known etiologic agents include the paratyphoid bacilli (*Salmonella*), certain of the dysentery bacilli, especially the Sonne and Newcastle types, and some members of the genus *Proteus.* It is probable that certain of the lesser known enteric bacilli, such as the paracolon bacilli, are causally associated with this kind of disease in man. In many instances these infectious agents are transmitted by food, and differentiation of food-borne infections and food poisoning is not sharp; it is not unlikely that in the past food poisoning such as that produced by ingestion of staphylococcal enterotoxin was classed as simple cholera. These diseases are, however, to be distinguished from the acute, specific and highly fatal infection with *Vibrio cholerae* known as true cholera, Indian cholera or, most commonly, Asiatic cholera. In modern medical literature the generic use of the term cholera fell into disrepute, and came to refer almost invariably to Asiatic cholera. These enteric diseases of man are unrelated to fowl cholera, an epidemic hemorrhagic septicemia of chickens caused by the bacillus *Pasteurella aviseptica,* or to hog cholera, which is of virus etiology; man is not susceptible to infection with either of these agents.

Historical Background.—References to acute, epidemic diarrheal disease are not uncommon in historical literature. As early as the 5th century B.C. Thucydides described the occurrence of such a disease in Athens, and the earliest report in the Indian literature of what may have been cholera is that of Susruta in the 7th century A.D. The earlier descriptions are equally applicable to bacillary dysentery, and it was not until the 15th century that the acute, epidemic diarrheal disease which was probably cholera was described; such, for example, was the epidemic disease that brought about the destruction of Ahmed Shad's army in 1438, and that described by Jacobus Bontius in the Netherlands Indies in 1629. According to the Chinese writers, cholera reached China from India in 1669.

Cholera, however, was probably endemic in India, in the delta of the Ganges river and in lower Bengal, in remotest antiquity. With increasing facilities for travel, the disease spread from India overland through Persia into Russia, and by sea routes to China and the far east on the one hand, and on the other through Arabia into Asia Minor and Egypt and from there into Europe proper. Later it became apparent that there may be an endemic focus of infection in central China, in the valley of the Yüan river which flows into the Yangtze river through Tung-T'ing lake, and from which the disease spread down the valley of the Yangtze and into the coastal areas. Whether this endemic centre was a recent development or only recently discovered is problematical, but it was not associated with the great pandemics of the 19th century and early part of the 20th century.

The first of the great pandemics began in India in 1817, and spread by land to China in 1818, to Ceylon in 1819 and by sea to Mauritius and East Africa in 1820, to the Philippines, China and Japan in 1822 and by land to Persia and Arabia in the same year and from there to Russia through Astrakhan in 1823, but this pandemic did not reach Europe proper. Another pandemic wave began in India in 1826 and followed a similar course, but spread farther, reaching European Russia, via China, Manchuria and Mongolia, and through Astrakhan. It reached Moscow in 1830 and spread from Moscow to St. Petersburg, into Germany and across the North sea to Great Britain, reaching Edinburgh in 1832. The infection was carried from Europe to North America, entering Canada in 1832 and spreading south to Ft. Dearborn (Chicago) and down the Mississippi valley. It appeared concurrently in New York city and Boston and spread south and west, so that by 1836 cholera was present in most of the U.S. and did not disappear until 1838. The pandemic wave occurring between 1840 and 1849 and that of 1863–66 reached Europe by overland routes via Mecca and Egypt and spread to North America, giving rise to the outbreaks of 1867 and 1873. Another pandemic began in India in 1879 and the disease reached Europe through Egypt by 1883, affecting especially the Mediterranean ports of France, Spain and Italy. It was during this epidemic that Robert Koch carried out his studies on the etiology of the disease (*see* below). Another serious outbreak spread from India in 1891 and was carried to Europe by pilgrims returning from Mecca, reaching that continent the following year and primarily affecting European Russia. It was in this outbreak that the Russian composer Petr Ilich Tchaikovsky died of cholera. Still another great pandemic began in 1902, spreading from India to China and the Philippines, and to Europe by 1908 and 1910. With the development of knowledge of the etiology of the disease and efficacious methods of control, no pandemic spread occurred after 1910.

Cholera recurs annually in India in epidemic form and with great loss of life, usually not less than 200,000 deaths per year. The disease has spread into eastern Europe on occasion, for example, during the Balkan War in 1913; there were only a few cases in central Europe during World War I and several small outbreaks in Russia and Poland in the 1920s; an epidemic also occurred in Egypt during the late summer and early autumn of 1947. Epidemic cholera occurs with some frequency in the far east, especially in Burma, Indochina, the China coast and Manchuria, and sporadic cases occur in the Philippines and Indonesia. While the epidemic disease is readily controlled by sanitary measures, these are not available under primitive conditions, and should such preventive measures break down on any large scale, the rapidity of travel customary in the 20th century would make possible the spread of cholera in pandemic proportions in a matter of a few weeks or months.

The Cholera Vibrio.—Although Félix Pouchet reported finding vibrios in the stools of cholera patients as early as 1849, it was not until 1883 that the causal agent of the disease was isolated and studied by the German bacteriologist Robert Koch. From the excrements of cholera patients, first in Cairo and the following year in India, he cultured a small, slightly curved bacillus now known as *Vibrio cholerae*. Its etiologic relation to the disease was suggested by its occurrence in enormous numbers in the stools of infected persons, substantiated by fatal infection of the guinea pig on intragastric inoculation and proved beyond reasonable doubt by accidental laboratory infections of man with pure cultures of the microorganism.

The cholera vibrio is a member of a large group of gram-negative, comma-shaped bacteria that are morphologically indistinguishable from one another. This group is ordinarily divided into two parts, the one made up of the noncholera vibrios and the other of the cholera and choleralike or paracholera vibrios. The former includes a variety of saprophytic forms found in water and soil, together with some species that are pathogenic for lower animals, such as those producing a fatal septicemia in birds, contagious abortion of sheep and the like. The members of the latter group are parasites of man, and the paracholera vibrios have been found with some frequency in association with mild diarrheal disease.

The best known of the choleralike vibrios are the El Tor vibrios, which were first isolated at the quarantine station at Tor, Egypt (*see* map), in 1906 from pilgrims suffering from diarrhea, and afterward were found repeatedly under similar circumstances. The question of the pathogenicity of these vibrios was raised again in the Celebes epidemic of 1938. The disease was identical with true cholera on clinical grounds, but was apparently caused by an El Tor vibrio; the development of the far-eastern phase of World War II prevented detailed study. Epidemic disease of El Tor vibrio etiology appeared in Hong Kong in 1960, and in Manila in 1961, spreading through the Philippines. Although, unlike the cholera vibrio, these bacteria are found in the absence of disease they would appear to be an occasional cause of cholera.

The cholera vibrio is characterized physiologically by its rapid growth, requirement for free access to oxygen, tolerance of alkali and marked susceptibility to deleterious factors in the environment. It may be isolated from contaminated specimens by culture on a medium of high alkalinity. An enriched medium containing defibrinated blood or hemoglobin and adjusted to pH 9.5 is used; the best known of these media are Adolf Dieudonné's medium and that of Col. Edward Bright, G. A. Vedder and W. van Dam. Because of its relatively slight resistance the vibrio dies out in a few days on contaminated leafy vegetables and similar foods and does not persist in water so long as does the typhoid bacillus.

The differentiation of the cholera vibrio from closely related vibrios is of considerable importance. While these vibrios commonly give the cholera-red or nitrosoindole reaction in nitrate-peptone water culture, and usually ferment sucrose and mannose but not arabinose, strains are biochemically heterogeneous and cannot be identified on the basis of cultural reactions alone. They are, however, closely related immunologically in that they contain a common heat stable somatic O antigen and fall into a serologic group designated O subgroup I; provisional identification may be made by agglutination with monospecific antiserum. Certain of the El Tor vibrios are members of this group also, but the El Tor vibrios form a soluble hemolysin acting on goat red blood cells while the cholera vibrios do not. The two may be differentiated by the Greig test in which equal volumes of peptone water culture of the vibrio and a 5% suspension of goat erythrocytes are mixed, incubated and read for hemolysis. The cholera vibrio is, therefore, defined as a nonhemolytic vibrio of O subgroup I. Serologic types of the cholera vibrio, arising from minor differences in the O antigen and demonstrable by the use of absorbed antiserums, were described by Japanese workers in 1913 and 1921. These were designated the Inaba or original type, the Ogawa or variant type, and the Hikojima or middle type. The first two are distinct from one another and the last is related to both end types. These serologic types do not differ in pathogenicity.

Cholera in Man.—Under natural conditions cholera is exclusively a disease of man. Susceptibility of individuals varies widely and is markedly influenced by predisposing factors such as low gastric acidity and gastrointestinal disturbance arising from purging, alcoholism, infection with other enteric bacteria and the like. The vibrio enters the body via the mouth, usually in contaminated water or food, and sets up an infection in the small intestine, seldom penetrating the tissues beyond the superficial layers of the mucosa. The incubation period is short, probably never longer than five days and sometimes less than one. The vibrio does not form an extracellular toxin, but the cell substance is toxic, and with proliferation and disintegration of the vibrios within the lumen of the bowel, the endotoxin is liberated and symptoms appear.

The disease usually develops in three relatively well-defined stages: the stage of evacuation, the stage of collapse or algid stage and the stage of reaction.

The onset is usually abrupt and characterized by a purging diarrhea followed by copious vomiting. The lower bowel is emptied of fecal matter early in the disease, and the stool takes on a typical rice-water appearance, a nonoffensive, whitish, opaque, albuminous fluid containing flakes of mucus and having a slight albuminous odour. The diarrhea is both profuse and frequent, is painless without colic or tenesmus and is sometimes described as a literal pouring away of pints of pale fluid. The stomach is emptied at the onset of vomiting, the vomitus soon assumes the same appearance as the stools and may contain cholera vibrios, and there is exhaustive retching and hiccup. With the cumulative dehydration and loss of fixed base, agonizing cramps occur in the muscles, especially of the legs and feet, and sometimes of the arms, abdomen and back, and the sense of prostration is extreme. This stage lasts from 2 to 12 hours, and its duration is inversely related to the severity of the symptoms.

It passes insensibly into the algid stage characterized by almost continuous purging and vomiting and extreme collapse. The appearance of the patient changes rapidly, the skin becomes lax, wrinkled and cold and clammy to the touch, and the classic cholera facies appears, with eyes sunken, cheeks hollow and cyanosis about the eyes and lips; the voice becomes husky and the expression anxious and apathetic. The blood pressure falls, the pulse cannot be felt at the wrist and the urine is suppressed. Death may occur from circulatory failure or from asthenia.

With cessation of vomiting and diarrhea, the patient enters the third stage of reaction, in which, if the duration of the algid stage has been only a few hours, recovery should occur with restoration of blood pressure, disappearance of cyanosis, and flow of urine.

If the impairment of renal function has been serious with damage to the kidney parenchyma, flow of urine is not resumed, and death may result in four to five days.

The pathology of the disease, sometimes attributed to the action of absorbed toxin, is equally well accounted for on the basis of extreme dehydration, hypochloremia (lowered chloride content of the blood), acidosis and impairment of renal function. The severe dehydration results in a similarity between the patient with cholera and one in shock, but it is not complete because plasma elements other than fluid and electrolytes are not lost in cholera. The specific gravity of the blood rises to as high as 1.064 with polycythemia and disproportionate leucocytosis. The outstanding post-mortem changes are the marked rigidity, with almost immediate stiffening of the limbs after death, and the pronounced dehydration of the tissues, though the body is usually well nourished because of the relatively short duration of the disease. Convalescence is commonly uneventful, with disappearance of vibrios from the stools in ten days to two weeks, but cardiac failure may result from slight exertion. The case fatality rate is usually 40% to 60% in untreated cases, but may be reduced to 10% to 20% by adequate treatment.

Treatment.—Treatment is both symptomatic and specific. The former is directed toward the replacement of fluid, the maintenance of blood and tissue chloride and the counteraction of acidosis. This may be achieved through the intravenous administration of hypertonic alkaline salt solution. Sterile stock solutions of hypertonic saline, alkaline saline, alkaline hypotonic saline and bicarbonate are mixed in proportions indicated by the state of the patient, and the amount administered is determined by the degree of dehydration as shown by the specific gravity and pressure of the blood. Collapse is favourably affected by atropine and beta-hypophamine, and the pain of muscular cramps may be relieved by whiffs of chloroform. Use of morphine and alcohol in any form is avoided. Specific treatment, such as the therapeutic use of anticholera serum and the administration of potassium permanganate or kaolin for neutralization of the toxin, has been disappointing, although cholera bacteriophage by mouth seems to have some small favourable effect. Certain drugs of the sulfonamide group, especially sulfaguanidine, and several of the broad spectrum antibiotics such as the tetracyclines were given extensive trial in Indian clinics without apparent effect on the clinical disease, although the period of vibrio excretion seemed to be shortened; chemotherapy of the disease was of questionable value.

A majority of cases of cholera, especially during an epidemic, can be diagnosed on clinical grounds alone, and during an epidemic all suspected cases should be treated as cholera, and all contacts as potential cases. Diagnosis of the isolated case is more difficult but is more important from the public health point of view. The disease may be confused with fulminating bacillary dysentery, with the algid and choleraic forms of malaria, trichinosis, food poisoning of staphylococcal or streptococcal etiology, mushroom poisoning or poisoning with antimony or arsenic. The bacteriological diagnosis of cholera is dependent upon the isolation and identification of the vibrio. The demonstration of typical vibrios in a gram-stained smear from a flake of mucus is suggestive, and the vibrio may be isolated by culture on a selective medium and identified by agglutination with specific O antiserum and a negative reaction to the Greig test.

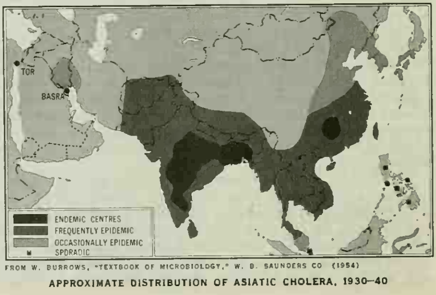
Immunity.—Infection with the cholera vibrio provokes an immune response as indicated by the appearance of bacteriolysins, agglutinins and other antibodies in the blood serum. Immunity to subsequent infection is not of a high order, however, nor does it persist for more than one to two years at the most. Prophylactic immunization was practised almost from the time of the discovery of the cholera vibrio, beginning with the work of Jaime Ferran in Spain and that of Waldemar Haffkine in India. A variety of immunizing preparations was used, including living vibrios, bacteriophage lysate and bilivaccine (vaccine prepared from a liver extract) by mouth as well as the usual type of vaccine.

Modern vaccines consist of suspensions of cholera vibrios killed by heat or phenol in isotonic saline in a concentration of 8,000,000,000 per millilitre and are administered in two parenteral inoculations of 0.5 and 1.0 ml. one week apart. The vaccines used in India contained the Inaba type only, but bivalent vaccines containing equal proportions of the Inaba and Ogawa types are widely used. Immunity appears as early as the third to fifth day after inoculation but is effective for less than a year, and reinoculation should be practised every six months.

The results of prophylactic inoculation have been to some degree conflicting. For example, an extensive immunization program carried out in Indochina in the 1930s apparently produced no immunity to the disease, but field studies in India consistently gave encouraging results. In such a study carried out in Madras during the severe epidemic of 1941–42 the incidence of the disease was reduced more than 90% by prophylactic immunization.

Epidemiology and Control.—The dissemination of cholera is dependent upon connecting links between infected fecal material and the mouths of susceptible persons. The vehicle is most often water, but the disease is also transmitted by foods consumed in the raw state and by direct or indirect personal contact.

The explosive character of the epidemic is attributable to the simultaneous infection of large numbers of persons, as by a common water supply, coupled with the short incubation period, and its dramatic aspect is accentuated by the high case fatality rate. When the epidemic has run its course in a nonendemic area, the disease dies out completely because of the fragility of the vibrio and the absence of the chronic carrier state in cholera, and subsequent epidemics are dependent upon reimportation of the infection.



FROM W. BURROWS, "TEXTBOOK OF MICROBIOLOGY," W. B. SAUNDERS CO (1954)

APPROXIMATE DISTRIBUTION OF ASIATIC CHOLERA, 1930–40

In endemic areas, however, the infection persists in a smoldering form and, while the mechanism of its maintenance is not altogether clear, it is highly probable that it depends on the occurrence of mild cases of the disease transmitted from person to person under the relatively primitive conditions prevailing. For example, in some parts of India water is stored in tanks that serve for the disposal of fecal material and as a source of water for washing and drinking purposes; such water supplies are seldom protected by the usual sanitary measures such as chlorination, filtration or other means of purification. Habitual defecation in open fields about inhabited areas and the use of fresh night soil as fertilizer in truck gardens makes possible the dissemination of the disease by flies and by leafy vegetables and the like.

Under ordinary circumstances spread of the disease into Europe is prevented by inspection at the quarantine stations at Tor and at Basra, Iraq (*see* map), and it is readily controlled by the usual sanitary practices, especially water purification and sewage disposal. This was strikingly illustrated in the Balkan War in 1913 in which infection was widespread in the Bulgarian army about Sofia, but cases in the capital were largely imported and the disease showed little tendency to spread; Sofia was efficiently sewered and had an excellent water supply.

Ultimate control of the disease depends upon the development of a higher standard of living in the primitive parts of the far east, and under ideal conditions cholera could probably be stamped out entirely.

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CHOLESTEROL, a waxlike solid alcohol, is closely related, chemically, to vitamin D, the steroid hormones, and bile acids. (*See* also Hormones, Vertebrate.) Although cholesterol ($C_{27}H_{45}OH$) is present in all animal cells, it is particularly abundant in the adrenal glands, the brain and the spinal cord, and it is produced by the liver and several other organs of the body. Cholesterol appears to be essential to life, although its physiological function is not clearly defined.

Abnormal accumulations of cholesterol are associated with certain pathological conditions, *e.g.*, atherosclerosis (*see* below) and gallstones (*see* Gall Bladder, Biliary Tract and Liver, Diseases of). Atherosclerosis, the major form of "hardening of the arteries," is a disease in which a progressive deposition of cholesterol-containing fatty materials occurs just below the inner surface of the arterial walls. The amount of cholesterol in the diet is not a significant factor in the development of atherosclerosis, since the human liver ordinarily synthesizes approximately twice as much cholesterol as is obtained from foods. Cholesterol is present only in animal fats and not in fats obtained from plant sources. A compensatory system regulates the synthesis of cholesterol in the liver, with increasing dietary intake of cholesterol accompanied by decreasing hepatic synthesis, and vice versa.

Man is uniquely susceptible to atherosclerosis. Blood plasma levels of cholesterol appear to be related to the development of atherosclerosis, and the amount of cholesterol present in human plasma is normally much greater than the amounts observed in other mammals and experimental animals. In humans with very low plasma cholesterol levels, the incidence and severity of atherosclerosis observed is very low. In several species of laboratory animals, it is possible to induce the development of atherosclerosis under conditions which result in artificially elevated levels of plasma cholesterol. Higher plasma cholesterol levels have not been established as the cause of atherosclerosis, however, in spite of the frequency with which the two conditions are associated in human patients. Several factors are involved, including nutrition, age and sex, hormone balance and emotional stress.

Several research scientists have demonstrated that a diet low in fat and total calories is more effective in helping to reduce the plasma cholesterol level than is a low-cholesterol diet. The type of dietary fat and the quality and amount of protein in the diet may also be related to the development of atherosclerosis.

Atherosclerosis is a very complex disease, and its development is affected by several factors, including nutrition. Much more research is needed in order to solve the problems of its prevention, early diagnosis and successful therapeutic treatment. *See* also Arteries, Diseases of.

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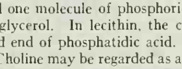
CHOLINE is a constituent of all living cells. It plays a significant role in animal nutrition (*see* Vitamins) and is a constituent of two very different and physiologically important substances, acetylcholine and lecithin.

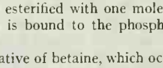
Acetylcholine, a key compound in nerve function, is alleged to be connected with the transmission of impulses along nerves and, furthermore, is specifically released at the endings of a group of nerves called cholinergic, which include primarily the so-called parasympathetic nerves. On stimulation of the nerve acetylcholine is released from an inactive, bound form and is then rapidly converted to the very much less active free choline and acetate by the enzyme cholinesterase. In the subsequent recovery period the choline is recombined with acetate and once more incorporated into the structure of the nerve, which is then ready for the passage of another impulse. Inhibitors of cholinesterase such as physostigmine (eserine) and neostigmine (prostigmin) prolong the lifetime of free acetylcholine and cause symptoms similar to those brought about by administration of acetylcholine itself. The so-called nerve gases act in the same way. These poisons are synthetic derivatives of phosphoric acid, and related nonvolatile materials have been used as insecticides.

Lecithin is a member of a group of substances known as phospholipids, which derive their name from the fact that they contain phosphate in the form of a fatty substance. The phospholipids have both water-soluble and fat-soluble groups. They are consequently good emulsifying agents and important structural components of the cell. Chemically, lecithin is called phosphatidyl choline. Phosphatidic acid contains two molecules of fatty acid and one molecule of phosphoric acid esterified with one molecule of glycerol. In lecithin, the choline is bound to the phosphoric acid end of phosphatidic acid.

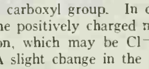
Choline may be regarded as a derivative of betaine, which occurs in plants. Betaine exists as an internal salt, with the positive charge on the nitrogen atom neutralized by the negative charge on the oxygen of the carboxyl group. In choline, since there is no carboxyl group, the positively charged nitrogen atom holds a negatively charged ion, which may be Cl^- or any other anion rather than OH^-. A slight change in the chemical structure of choline may produce highly toxic substances. Thus, removal of the elements of water produces the extremely poisonous trimethylvinylammonium hydroxide or neurine.



Choline



Betaine



Neurine

Muscarine, a very toxic substance isolated from some poisonous mushrooms, is also chemically related to choline.

(B. V.; H. C. F.)

CHOLON, in the Republic of Vietnam, now part of the prefecture of Saigon (*q.v.*), was formerly a separate municipality and the capital of Cholon province. It lies to the west of the city of Saigon, from which it is separated only by the Arroyo Chinois, a small water channel; the urbanized area was linked commercially and physically by streetcars, roads, canals and railway and in 1932 became one political unit, first called Saigon-Cholon and later Saigon prefecture. Cholon itself has an oriental appearance; from its foundation late in the 18th century it has been dominated by immigrants, at first Chinese from Fukien and Canton, then by Annamites and Tongkingese from territories now in the Democratic Republic of Vietnam. While long settlement has blurred racial distinctions, about half the townspeople are of Chinese parentage.

The flimsy, tightly compacted lanes are as much a reflection of immigrant origin as is the typical wood-and-plaster, one-storied house design. The brilliant neon signs of the bazaarlike main street show the old and the modern east side by side. The town is threaded by water channels congested with many kinds of river craft which ply through the maze of distributaries on the Mekong delta and bring to Cholon, whose name significantly means "great market," rice and dried fish products from as far inland as Sisophon and Battambang and forest products from the Oaotian Mekong. Cholon collects, bulks and grades the Asian staples, rice and fish, which are later exported from the international port at Saigon. For several months a year there congregates at Cholon a large floating population living on its junks, used at other times to carry trade goods to the interior. Timber mills, junk-building yards, tanneries and crude dye works (for fish nets) have grown up in the town, as have brick and pottery works using local clays and supplying the huge Indochinese demand for earthenware pots and jars. (E. H. G. D.)

CHOLULA (Cholula de Rivadahia), an ancient town of Mexico, in the state of Puebla (*q.v.*), 8 mi. W. by N. of Puebla, the state capital. Altitude 6,912 ft. Pop. (1950) 11,616. Famed for its many domed churches, Cholula, by legend, has a church for each day of the year. The Royal chapel in the plaza has 48 domes. True to custom, the Spaniards built a church on top of each native temple in this important pre-conquest town dedicated to the god Quetzalcoatl. An imposing pyramid of sun-dried bricks topped by the Chapel of Los Remedios stands 177 ft. high, covering nearly 45 ac. Archaeologists tunnelling through this pyramid built a small railway to aid their excavations which is used also to carry tourists inside. Any historical data in the temple of Quetzalcoatl which once crowned this pyramid was doubtless destroyed in 1519 by Hernán Cortés during his march inland to conquer Montezuma's capital, Tenochtitlán. Cortés estimated that Cholula then had 20,000 inhabitants with as many again in surrounding suburbs. The Cholulans, a textile and pottery trading people, were Nahuatl speakers with a nominal allegiance to Montezuma. The pyramid is believed to have been built by a people inhabiting Cholula before those conquered by the Spaniards. (H. R. Hy.)

CHOLUTECA, a department in southern Honduras, bordering the Gulf of Fonseca and Nicaragua. Its population (149,205 [1961]) is 80% rural. Coastal plain savannas, broad Río Choluteca lowlands and mountains are important agriculturally. Chief products are cotton, sesame with 90% of national output, harvested forage grasses, cattle and swine. Of the department's total area of 1,626 sq.mi. 60% is farmland, of which 48% is pasture and 10% cultivated. A highway traverses the central part of the department, connecting Choluteca city (pop. [1950] 7,075), the departmental capital, with Tegucigalpa by way of the Inter-American highway from near Nacaome. (C. F. J.)

CHOMUTOV (Ger. Komotau), a city of North Bohemia region, Czech., at the foot of the Ore mountains, lies 52 mi. N.W. of Prague on the western tip of a lignite-mining area. Pop. (1957 est.) 32,583. It is thought to have been a Czech settlement in origin, steadily Germanized in the middle ages and remaining German in character until the end of World War II. In the 14th century it was a commandery of the Teutonic knights, and evidence of Chomutov's age and standing are in the arcaded market place, the town hall (originally a castle) and St. Catherine's church. Lignite mining is the major economy of the region, but iron and steel manufacture and paper and glass industries are long established. (H. G. S.)

CHONBURI, a province of Thailand situated on the eastern shore of the upper Gulf of Siam. Area 1,732 sq.mi.; pop (1960) 337,058. It produces a surplus of rice and leads the country in the production of sugar cane and cassava. With nearly 100 miles of coast line, fishing and salt extraction are important occupations. Major industries include fish freezing and processing, sugar refining and liquor distilling. Chonburi, the provincial capital (pop. [1957 est.] 29,734), is known locally as Bangplasoi. South of the capital is a popular seaside resort area centring on Siracha, and at the southern tip of the province is the Sattahip naval base. (G. W. Sk.)

CHONDRICHTHYES, the cartilaginous fishes, includes the sharks, rays (including skates) and chimaeras. They rank as a class, also called Selachii, differing fundamentally from true or bony fishes (Osteichthyes) in having the following characteristics: a cartilaginous skeleton, well-developed jaws, numerous teeth in series, two pairs of appendages supported by pectoral and pelvic girdles and males with external sexual organs or "claspers" attached to the pelvic fin. The skin is armed with placoid scales, toothlike in structure. Five to seven pairs of gill clefts are evident; the spiracle (a vestige of a former pair of gill clefts) is present or absent. The posterior end of the vertebral column is either straight or heterocercal. None of the cartilaginous fishes has an air or swim bladder. Elasmobranch, a term sometimes generally applied to all cartilaginous fishes, refers more precisely to those of the subclass Elasmobranchii (Euselachii), the sharks and rays.

Geographical Distribution.—Whereas sharks are for the most part marine, at least two species of the genus *Carcharhinus* enter the fresh waters of the Ganges, Tigris and Zambezi rivers. The species *C. leucas* is landlocked in Lake Nicaragua; it is also present in other Central American lakes having access to the sea. In addition to the sharks, the sawfishes (family Pristidae) and sting rays (Trygonidae or Dasyatidae) ascend rivers for considerable distances. Sharks are associated with the tropics and they are more numerous both in species and in numbers in the warmer oceans. However, the majority of sharks live and breed in comparatively shallow waters off the continents; other species are pelagic and keep to the open seas.

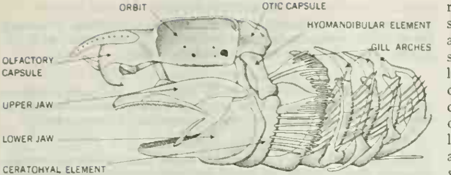
The families Scylliorhinidae (cat sharks, European dogfishes or roussettes), Squalidae (spiny dogfishes, bramble sharks and the Greenland shark), Squatinidae (angelfishes) and Rajidae and related families (the true skates and rays) are bottom-living sharks found in temperate waters.

FORM AND FUNCTION

Body Form.—Sharks and rays are a natural, primitive group, with much divergence in body form. The prevalent conception of a shark is of a cylindrical fish with a transverse crescentic mouth, paired gill slits and prominent lunate dorsal fin. The fantastically flattened and expanded heads of the hammerhead sharks (*Sphyrna*), the excessive length of the upper caudal lobe of the thresher shark (*Alopias*) and the whalelike dimensions of *Rhineodon* and *Cetorhinus* are notably body variations among sharks. Sharks move with a sculling motion of the tail; swift pelagic sharks exhibit a marked development of the upper caudal lobe and a corresponding streamlining of the body and fins. Slower moving forms have more rounded fins, and the caudal lobes are more nearly equal.

The sawfishes, skates, guitarfishes, sting rays, eagle rays and the giant devilfish are much flattened sharks, with more or less disc-shaped bodies and ventral gill openings. The pectoral fins, enlarged and winglike, function as effective swimming organs. Within this group there is considerable variation in the shape of the head, and the tail is sometimes reduced to a filament. A group of chimaeras, the ratfishes, are curious sharklike inhabitants of deep waters or cool seas. Their bodies, covered with smooth skin, end with a long, tapering tail; the males have a forward-projecting organ on the forehead (tenaculum) as well as before the pelvic fins. From the correspondence between habits and form of the fins in living Chondrichthyes, it is certain that *Cladoselache*, a primitive shark of the upper Devonian strata, with broad-based, pointed fins and strongly heterocercal tail, was a pelagic shark and a strong swimmer.

Gill Arches and Jaws.—Chondrichthyes are in many respects the most primitive of the vertebrates, and a study of their struc-



BY COURTESY OF THE ZOOLOGICAL SOCIETY OF LONDON

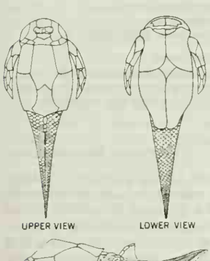
FIG. 1.—SCYLIORHINUS SKULL SHOWING JAWS AND GILL ARCHES

ture and development throws light on the origin of jaws, teeth and limbs. They differ from the cyclostomes (lampreys, etc.) in their method of breathing, water being taken into the pharynx and expelled through gill clefts by the expansion and contraction of the pharynx. The gill clefts are comparatively narrow slits on the head between the eye and the pectoral fin, except in the basking shark (*Cetorhinus*), where they extend from the upper to the lower surface of the body. The usual number is five, but in the frilled shark (*Chlamydoselachus*), the cow shark (Hexanchidae) and one of the saw sharks (*Pliotrema*) there may be six or seven gill clefts. Each successive gill cleft is partitioned by thick interbranchial septa, forming a series of gill pouches, that interconnect the pharynx and gill clefts.

The gill arches, lying in the form of a half loop on the inner edge of the septa between openings leading from the pharynx, are closed or opened by special muscles. All, except the anterior gill pouch, contain paired gill filaments that act as respiratory membranes. These appear as thin red straps from which the name "elasmobranch" (straplike gills) originated. Forward of the gill slits is a vestigial gill cleft, called the spiracle, that is often absent in sharks. This is enlarged in rays through modification in the method of breathing. The rays, in adapting to life on the sea floor, inhale water through the spiracles, expelling it through the gill clefts, thus avoiding the intake of silt or sand, which might clog up the delicate respiratory membranes.

The jaws of Chondrichthyes represent modification of the first two branchial arches into biting jaws; they consist of the upper jaw or palatoquadrate cartilage and the lower jaw or Meckel's cartilage. The upper jaw may be firmly attached but is not fused to the cranium; the lower jaw articulates with the upper jaw and is partly suspended to the hyomandibular arch. In the chimaeras the upper jaw or palatoquadrate is completely fused with the cranium and the supporting element of the hyoid arch is vestigial.

Teeth.—In having the body covered with denticles formed of dentine, the Chondrichthyes resemble the most primitive Agnatha (jawless fishes), the Silurian and Devonian Coelolepidae (*see* CYCLOSTOME). Similar but smaller denticles may occur in the mouth and pharynx, and the true teeth are to be regarded as homologous structures. The teeth are attached to the membrane covering the jaws; this membrane continually moves outward so that, upon injury or loss, the outermost teeth are replaced by others that migrate outward over the jaw.



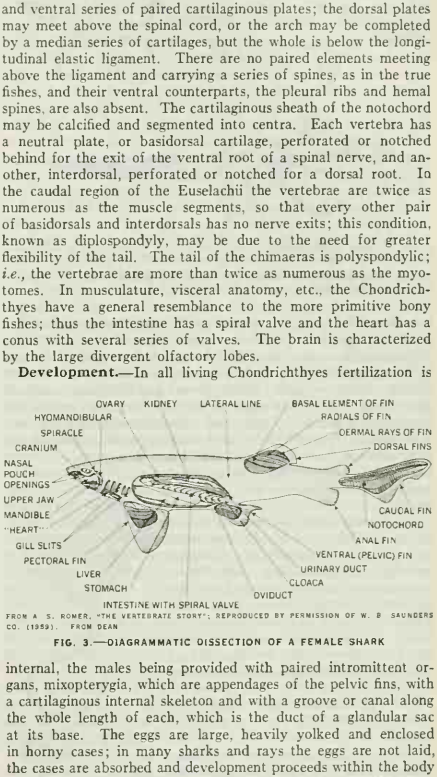
BY COURTESY OF THE PALAEONTOGRAPHICAL SOCIETY

FIG. 2.—PTERICHTYS, AN ANCIENT PLACODERM, AN OFFSHOOT OF THE CHONDRICHTHYES

Fins.—In the Chondrichthyes both median and paired fins are keellike outgrowths of the body strengthened by horny fin rays; their skeleton consists primarily of a series of cartilaginous rods segmented into two principal pieces, basals within the body and radials in the fin; each of the rods has a muscle on each side. A study of the development shows that all the fins begin as longitudinal folds of the epidermis, at the base of which a mesenchyme plate develops; next a double series of buds from the body muscles migrates into the fins, and later the cartilaginous skeleton differentiates out of the mesenchyme plate. From their similar structure and development the conclusion is drawn that the median and paired fins have a similar origin and that they originated as outgrowths of the body. The limb girdles, pectoral arch and pelvis are formed by fusion of the anterior basals, and sharks in which there is no pelvis (*Cladoselache*) are the most primitive.

Vertebral Column.—In Chondrichthyes the vertebral column consists of the notochord and its cartilaginous sheath and of dorsal and ventral series of paired cartilaginous plates; the dorsal plates may meet above the spinal cord, or the arch may be completed by a median series of cartilages, but the whole is below the longitudinal elastic ligament. There are no paired elements meeting above the ligament and carrying a series of spines, as in the true fishes, and their ventral counterparts, the pleural ribs and hemal spines, are also absent. The cartilaginous sheath of the notochord may be calcified and segmented into centra. Each vertebra has a neutral plate, or basidorsal cartilage, perforated or notched behind for the exit of the ventral root of a spinal nerve, and another, interdorsal, perforated or notched for a dorsal root. In the caudal region of the Euselachii the vertebrae are twice as numerous as the muscle segments, so that every other pair of basidorsals and interdorsals has no nerve exits; this condition, known as diplospondyly, may be due to the need for greater flexibility of the tail. The tail of the chimaeras is polyspondylic; *i.e.*, the vertebrae are more than twice as numerous as the myotomes. In musculature, visceral anatomy, etc., the Chondrichthyes have a general resemblance to the more primitive bony fishes; thus the intestine has a spiral valve and the heart has a conus with several series of valves. The brain is characterized by the large divergent olfactory lobes.

Development.—In all living Chondrichthyes fertilization is internal, the males being provided with paired intromittent organs, mixopterygia, which are appendages of the pelvic fins, with a cartilaginous internal skeleton and with a groove or canal along the whole length of each, which is the duct of a glandular sac at its base. The eggs are large, heavily yolked and enclosed in horny cases; in many sharks and rays the eggs are not laid, the cases are absorbed and development proceeds within the body of the mother. Some of these viviparous forms (*e.g., Mustelus*) have a yolk-sac placenta, and in certain rays (*e.g., Pteroplatea*) long uterine villi pass into the spiracles of the young and furnish a nutritive secretion.

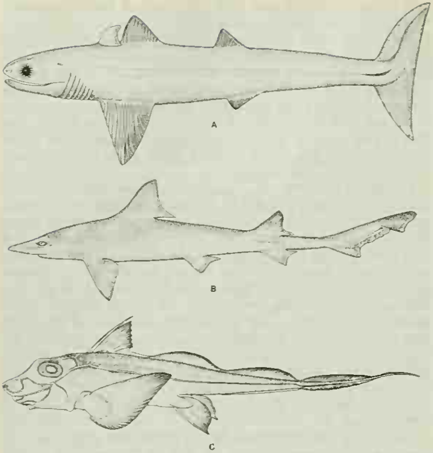


FROM A. S. ROMER, "THE VERTEBRATE STORY"; REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO. (1959). FROM DEAN

FIG. 3.—DIAGRAMMATIC DISSECTION OF A FEMALE SHARK

GEOLOGICAL HISTORY

Paleontology.—Many living genera of Euselachii are of considerable antiquity; all the recent families except the Carchariidae and Trygonidae have genera living today that are found fossil in Cretaceous strata, and such specialized forms as *Squatina* and *Rhinobatus* occur in the Jurassic, together with *Heterodontus*, *Pristiurus* and *Hexanchus*. The curious *Scapanorhynchus*, with



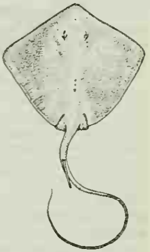
FROM A. S. ROMER, "THE VERTEBRATE STORY"; REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO. (1959). (A) AFTER DEAN AND HARRIS, (B) AFTER GARMAN; (C) AFTER DEAN

FIG. 4.—CARTILAGINOUS FISHES: (A) PRIMITIVE DEVONIAN SHARK (CLADOSELACHE); (B) MODERN SHARK (MUSTELUS); (C) CHIMAERA

long shovellike snout, was discovered in 1898 living in deep water off Japan, but had long been known from Cretaceous rocks. *Protospinax*, a recently described Jurassic shark, appears to stand in the same relationship to *Pristiophorus* that *Rhinobatus* does to *Pristis*. The saw shark (*Pristiophorus*) has the snout produced into a long blade with a series of teeth on each side, and in this resembles the saw ray (*Pritis*); but *Pristis* is evidently a modified *Rhinobatus*. *Protospinax*, a shark with the snout produced and flattened as in *Rhinobatus* but except for the more primitive median fins otherwise similar to *Pristiophorus*, is of some interest.

The Euselachii are not certainly known before the Trias, for the Carboniferous and Permian Orodontidae, Cochiliodontidae, Petalodontidae and Psammodontidae, generally assigned to this subclass, are mainly known from teeth. The Holocephali also date back to the Trias. Of the Paleozoic subclasses only the Pleuropterygii can be regarded as ancestral, the Devonian *Cladoselache* being the most primitive shark known.

The Placodermi.—The researches of Stensiö (1925) have revealed the relationship to the Chondrichthyes of the Arthrodira, a group of Paleozoic fishlike vertebrates in which the head is covered by a shield of bony plates, movably articulated with a bony carapace that protects the anterior part of the body. Below the head shield Stensiö found a cartilaginous cranium wholly or partly invested inside and out by a thin layer of bone. This cranium is of typical Chondrichthyes form, with prominent olfactory capsules; there are no dermal bones (parasphenoid, vomers) below it. It is clear that the Arthrodira are not true fish but an independent offshoot of the Chondrichthyes. It is, perhaps, best to place them in a separate class, Placodermi, which will include also the similarly armoured Paleozoic Asterolepida (*see* PLACODERM).



FROM A. S. ROMER, "THE VERTEBRATE STORY"; REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO. (1959). AFTER GARMAN

FIG. 5.—A STING RAY (DASYATIDAE) SHOWING EXPANDED PECTORAL FINS AND STING ATOP THE TAIL

CLASSIFICATION

Although later taxonomic outlines of the Chondrichthyes or Selachii are available, none surpasses the following modified scheme of C. T. Regan (1906) in comprehension and basic worth.

Subclass Pleuropterygii.

Paleozoic sharks with broad-based, paired fins, the pelvics without any fusion of the basalia, the pectorals scarcely more advanced in structure. *Cladoselache, Cladodus, Symmorium, Cratoselache.*

Subclass Acanthodii.

Paleozoic sharks with a strong spine at the anterior edge of each fin. As in the Pleuropterygii, the paired fins were broad-based, and mixopterygia appear not to have been developed. *Acanthodes*, etc.

Subclass Ichthyotomi.

Paleozoic sharks in which the pectoral basalia form the segmented axis of a biserial fin like that of *Ceratodus* (lungfish); males with mixopterygia. *Pleuracanthus.*

Subclass Euselachii (Elasmobranchii).

These are the modern sharks and rays. Pectoral fin with metapterygium (fused basalia), and with propterygium and mesopterygium, formed by union of proximal segments of anterior radials; pelvic fins with pelvis and basipterygium; males with mixopterygia. Pterygoquadrate free from skull. Hyomandibular articulating with skull and supporting jaws. Gill clefts with separate external openings.

Order Pleurotremi (Sharks).—Pectoral fins free from head; gill openings lateral. Hyomandibular with cartilaginous rays supporting the first half gill. Two halves of pectoral arch well separated above.

Suborder Notidanoidea. Six or seven gill openings. A single dorsal fin above the anal. Rostrum simple.

Family Chlamydoselachidae (*Chlamydoselachus*).
Family Hexanchidae (*Hexanchus, Heptanchus*).

Suborder Galeoidea. Five gill openings. Two dorsal fins and an anal; no fin spines. Rostrum triradiate.

Family Odontaspididae (*Odontaspis, Scapanorhynchus*).
Family Lamnidae (*Lamna, Carcharodon, Alopias, Cetorhinus*).
Family Orectolobidae (*Orectolobus, Chiloscyllium, Stegostonea, Ginglymostoma, Rhinodon*).
Family Scylliorhinidae (*Scylliorhinus, Pseudotriakis*).
Family Carchariidae (*Carcharias, Sphyrna, Galeus, Mustelus*).

Suborder Squaloidea. Five or six gill openings. Two dorsal fins, each typically preceded by a spine, but if these are wanting the anal fin is also absent. Rostrum simple.

Family Hybodontidae (Mesozoic).
Family Heterodontidae (*Heterodontus, Gyropleurodus*).
Family Protospinacidae (Jurassic).
Family Pristiophoridae (*Pristiophorus, Pliotrema*)
Family Squalidae (*Squalus, Spinax, Centrophorus, Somniosus*).
Family Squatinidae (*Squatina*).

Order Hypotremi or Batoidei (Rays).—Pectoral fins produced forward and joined to head; gill openings ventral. Hyomandibular purely suspensory.

Suborder Narcobatoidea. Large electric organs between pectoral fins and head. Suprascapulae united above vertebral column.

Family Torpedinidae (*Torpedo, Narcine*, etc.).

Suborder Batoidae. No large electric organs. Suprascapulae united to vertebral column.

Family Rhinobatidae (*Rhinobatus, Discobatus*).
Family Pristidae (*Sclerorhynchus, Pristis*).
Family Rajidae (*Raja, Psammobatis*, etc.).
Family Trygonidae (*Trygon, Myliobatis, Rhinoptera*, etc.).

Subclass Holocephali

Males with mixopterygia. Pterygoquadrate fused with skull. Lower jaw with one pair of tooth plates, upper with two pairs. Hyoid arch complete, with pharyngohyal. Gill clefts opening into a chamber with one external opening.

Family Squaloraiidae (Mesozoic).
Family Myriacanthidae (Mesozoic).
Family Chimaeridae (*Chimaera, Callorhynchus, Rhinochimaera*).

The three subclasses distinguished by the presence of mixopterygia are evidently derived from a common ancestor, which was not hyostylic, for the presence of a complete hyoid arch in the Holocephali, with a pharyngohyal above the epihyal or hyomandibular, shows that they are not derived from a form in which the hyomandibular articulated with the skull and supported the jaws. In the Paleozoic subclasses the palatoquadrate appears to have articulated with the otic region of the skull; such an articulation occurs in the Hexanchidae and Hybodontidae of the Euselachii, but whether it is primitive or secondary in these is uncertain. Some authors consider the Holocephali to be related to the squaloid sharks, but their tooth plates appear to be formed by fusion, not enlargement, and are therefore not comparable with the enlarged lateral teeth of *Heterodontus*, and the dorsal fin spine is not an enlarged denticle as in the squaloids, but is formed by concrescence of horny rays; moreover, the structure of the hyoid arch, and the separate pelves, preclude the derivation of the Holocephali from the Euselachii.

See FISH; RAY; SHARK; *see* also references under "Chondrichthyes" in the Index.

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(G. A. LL.)

CHONIATES, MICHAEL (*c.* 1138–*c.* 1222), often incorrectly called MICHAEL ACOMINATUS, Byzantine writer and ecclesiastic whose homilies, speeches, poems and correspondence throw considerable light on conditions in Attica and in Athens, and on the events of his day. Born at Chonae (Colossae) in Phrygia, he studied at Constantinople and in about 1175 was appointed archbishop of Athens, where he remained for nearly 30 years. After the capture of Constantinople by the Latins and the establishment of the Latin empire (1204), he retired to the island of Ceos, where he died (*c.* 1222). His most notable writings are his memorial to Alexius III Angelus on the abuses of Byzantine administration, the poetical lament over the decline of Athens, the monodies on his brother Nicetas and on Eustathius, archbishop of Thessalonica, and his panegyric on Isaac II Angelus.

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(J. M. HY.)

CHONIATES, NICETAS (d. 1213), sometimes erroneously called ACOMINATUS, Byzantine author and scholar, who wrote a history covering the years 1118–1206, was born at Chonae (Colossae) in Phrygia. Having been imperial secretary under the emperor Isaac II Angelus, he was governor of the theme of Philippopolis from 1189 and then grand logothete. At the capture of Constantinople by the Latins (1204) he fled to Nicaea and established himself at the court of Theodore I Lascaris. The history (*Chronike diegesis*), in 21 books, was probably revised after the years 1204–06, and there are signs that its author had not finally completed it. It would appear that he had access to John Cinnamus' history and to Eustathius' description of the Norman capture of Thessalonica. Nicetas' history is an important source, particularly for the years 1143–1206, and it contains an additional note on the statues in Constantinople at the time of the Latin capture and looting of the city. He also left speeches, theological works and poems which provide valuable information on the years 1180–1210, particularly on the rise of the Bulgarian empire and the effects of the Latin conquest. His *Thesaurus orthodoxias* is a revision of Zigabenus' *Panoplia dogmatica*.

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(J. M. HY.)

CHOPIN, FRÉDÉRIC FRANÇOIS (FRYDERYK FRANCISZEK) (1810–1849), Polish composer and pianist, was born at Zelazowa Wola, near Warsaw, on March 1, 1810. On his paternal side Chopin was of pure French origin, his father Nicholas Chopin having been born (1771) of French peasant stock at Marainville in the Vosges. At the age of 16 Nicholas traveled to Warsaw in the suite of a certain Weydlich, the steward of important Polish estates, and never saw his native France again. He identified himself with his new country and on June 2, 1806, married Tekla Justyna Krzyzanowska, a relation of the Skarbek family of Zelazowa Wola, with whom he had found employment as a tutor.

Education and Training.—Frédéric was the second of four children. He was brought up in a refined and cultivated, if modest, home and the characteristics of elegance and aristocratic distinction that soon marked his personality and later gave a unique stamp to his compositions derived from this home atmosphere and from the high social circles of Warsaw to which the young prodigy was admitted from his earliest years. The boy's remarkable musical gifts were directed in the first instance by Adalbert Zywny, a Czech established in Warsaw; but his simple instruction in piano playing was soon left behind by his pupil, who discovered for himself an original approach to the piano and was allowed to develop unhindered by academic rules and formal discipline. Chopin's parents were wise enough to insist on their son's receiving a thorough general education, and it was only on the completion of his high school studies that he was placed in 1826 under the able guidance of Joseph Elsner, director of the Warsaw conservatory. Even before he came under Elsner's eye Chopin had shown a deep interest in the folk music of the Polish countryside and had received those ineffaceable impressions that later gave an unmistakable national colouring to his work. At the conservatory he was put through a solid course of instruction in harmony and composition; it was only in piano playing itself that he was practically self-taught.

His Career.—After a preliminary expedition to Berlin in 1828 Chopin made his first real contact with the outside world when he visited Vienna and made his debut there on Aug. 11, 1829. A second concert confirmed his success and on his return home he prepared himself for further achievements abroad by writing his two piano concertos in F minor (1829) and E minor (1830) and other works for piano and orchestra designed to exploit his brilliantly original piano style. His first études (studies) were also written at this time (1829–32) in order to enable both himself and others to master the technical difficulties that were inseparable from his new conception of piano playing. In March and Oct. 1830 he presented his new works to the Warsaw public and then left Poland on Nov. 2, with the intention of visiting Germany and Italy for further study. He had gone no farther than Vienna when news reached him of the Polish revolt against the Russians, and this together with the disturbed state of Europe caused him to remain profitlessly in Vienna until the following July when he finally decided to make his way to Paris. Soon after his arrival in what was then the centre of European culture and a focal point of the romantic movement Chopin realized that he had found the exact milieu in which his genius could flourish. The circles to which his talents and distinction admitted him quickly acknowledged that they had found the artist whom the moment called for, and after a brief period of uncertainty Chopin settled down to the main business of his life—teaching and composing. His high income from these sources set him free from the strain of concert giving to which he had an innate repugnance. Nevertheless his reputation as a pianist did not suffer from this quasi-retirement and a legend grew around his name even during his lifetime, thanks to the rapturous accounts of the few who heard him privately and to the steady flow of new compositions that began with the publication of his early mazurkas in 1832 and continued without interruption until 1847.

Chopin's youthful love affairs with Constantia Gladkowska in Warsaw (1830) and Maria Wodzinska in Dresden (1835–36) came to nothing, although he actually became engaged to the latter. In 1836 he met for the first time Aurore Dudevant, better known as George Sand (*q.v.*), and their liaison began in the summer of 1838. In the autumn of that year the pair made their celebrated excursion to Majorca during which Chopin completed his Preludes, Opus 28, but in most other respects the trip was disastrous, and the privations that Chopin endured brought on the slow decline in his health which ended with his death from tuberculosis ten years later. However the period following the return from Majorca was the happiest and most productive of his life, and the long summers spent at Nohant, George Sand's country estate, bore fruit in a succession of masterpieces. Family dissensions caused by the marriage of George Sand's daughter Solange brought the liaison to an end in 1847 and thereafter Chopin seems to have given up his struggle with ill-health. The revolution of Feb. 1848 produced a temporary dissolution of the society upon which he depended for his living and he sought escape in a visit to England and Scotland during the summer of 1848. His reception was enthusiastic but he did not have the strength to profit by it. His last public appearance on a concert platform was made at the Guildhall, London, on Nov. 16, 1848, when, in a final patriotic gesture, he played for the benefit of Polish refugees. He returned to Paris on Nov. 23 and died at 12, Place Vendôme on Oct. 17, 1849. He was buried at the cemetery of Père Lachaise.

Evaluation as Pianist.—As a pianist Chopin was unique in acquiring a reputation of the highest order on the basis of an extreme minimum of public appearances—few more than 30 in the course of his lifetime. His original and uninhibited approach to the keyboard allowed him to exploit all the resources of the modern piano. He was inexhaustible in discovering colourful new passage work and technical figures; he understood as no one before him, and few since, the true nature of the piano as an expressive instrument, and he had the secret of writing music whose very existence is bound up with the instrument for which it was conceived and which cannot be imagined apart from it. His innovations in fingering, his use of the pedals and general treatment of the keyboard are a milestone in the history of the piano, and his works set a standard that is recognized as unsurpassable.

Evaluation as Composer.—Chopin as a composer has acquired increased stature after a period (the later years of the 19th century) during which his work was judged by academic standards that were in fact inapplicable to its forward-looking character. It is now seen that his harmonic and formal procedures often anticipate Wagner, Richard Strauss and even the Impressionists. Music like the finale of the "Funeral March" Sonata (Sonata in B flat minor, Opus 35) or the second Prelude is well in advance of its time in its abandonment of the classical diatonic system used contemporaneously by Mendelssohn and others. Chopin's sonatas are remarkable for the boldness with which he threw overboard the accepted rules of his time and wrote first movements whose form is dictated by the nature of their musical material rather than by adherence to a standardized scheme. He had the rare gift of a very personal melody, expressive of heartfelt emotion but never merely sentimental; and his music is penetrated by a poetical feeling whose appeal has been almost universal. Although "romantic" in its essence, Chopin's music has none of the expected trappings of romanticism—there is a classic purity and discretion in everything he wrote, and not a sign of romantic exhibitionism. He found within himself and in the tragic story of Poland the chief sources of his inspiration. The theme of Poland's glories and sufferings was constantly before him and in his polonaises and numerous mazurkas he transmuted the primitive rhythms and melodies of his youth into enduring art forms. From the great Italian singers of the age he learned the art of "singing" on the piano and his nocturnes reveal the perfection of his cantabile style and delicate charm of his ornamentation, while his ballades and scherzos have a dramatic turbulence and passion such as to dispel the notion that Chopin was merely a drawing-room composer. His total output was small and practically limited to solo pianoforte, yet within its limited framework its range is seen to be vast, comprehending every variety of intensely experienced emotion.

Works.—Chopin's works are available in many collected editions, the best of which are the Polish National editions published in Warsaw from 1949 onward and based on original manuscripts. His work consists of 2 piano concertos; 21 nocturnes; 27 studies; nearly 60 mazurkas, of which 42 were published by Chopin himself; 21 waltzes; 4 scherzos; 4 ballades; 26 preludes; 4 impromptus; 16 polonaises; 3 piano sonatas; and many individual pieces such as Barcarolle Opus 60, Fantasia Opus 49, Berceuse Opus 57 and 19 Polish songs.

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CHORALE (Ger. *Choral*), a metrical hymn tune associated in common English usage with the Lutheran Church in Germany. In the unreformed church, the word had been used to distinguish, in the liturgical plainsong, that which was to be sung by many voices in unison from that which was to be sung by one voice. The term *cantus choralis* was used in this sense; and in German Catholic circles before the Reformation the choral plainsong was known as *cantus concentus*, as distinguished from the (solo) *cantus accentus*. As late as 1872, H. Mendel's *Musiklexicon* devoted the whole of its article on "Chorale" to a study of plainsong. But in 20th-century speech the word always carries the Reformed sense. Martin Luther himself composed, or caused to be composed, many hymn tunes that were known at once as "chorales" (*Chorale*) because they were designed for congregational singing. That they were called "chorales" does not imply that they were designed for singing in harmony; unison singing was the rule of the Reformed churches, both in Germany and in other countries. It was only gradually, however, that the melody shifted from the tenor to the treble line and that the organ was established as the harmonic base for congregational singing.

The earliest large collection of such melodies was the *Encheiridion* (1524), edited by Luther and J. Walther (1496–1570). From that time the technique of chorale writing expanded, and many collections were published. Luther himself is credited with the composition of several, including *Ein' feste Burg* and *Vom Himmel hoch*, of which he certainly wrote the words and almost certainly wrote or adapted the music.

Landmarks in the history of chorale development are the names of Michael Weisse (*c.* 1484–1534), N. Herman (*c.* 1485–1561), N. Selnecker (1528–92), P. Nicolai (1556–1608), composer of the celebrated *Wachet Auf*, M. Vulpius (*c.* 1560–1616), J. Schein (1586–1630) and, greatest of all, J. Crüger (1598–1662). Crüger edited the first editions of *Praxis pietatis melica*, a collection of tunes first published in 1644 and continuing in successive editions.

More complex chorales come from J. Eccard (1553–1611), M. Praetorius (1571–1621) and H. Schütz (1585–1672). Eccard's chorales are virtually brief motets; Praetorius was one of the first systematic arrangers in polyphonic style of tunes from earlier sources (*Musae Zionae*, 1609); Schütz's contributions are in his *Psalmen Davids* (1628), in many of which is foreshadowed the more sophisticated and lyrical style adopted by the later pietist composers. For these, and for later German hymnody, *see* HYMN.

In the passions and cantatas of J. S. Bach, the chorale appears as a richly harmonized hymn tune in which the audience is expected to join with the choir. Bach's "chorales" (some of which are sung as English hymn tunes) are strictly chorale arrangements. It was Bach's practice to take a well-known hymn tune, remove (as the convention of his day required) its irregular rhythm and adorn it with elaborate harmony. Bach's own compositions in this field were devotional songs; it is fair to say that he never composed a "chorale." But in later works that imitate the passions of Bach, a congregational hymn is not infrequently inserted, and sometimes this is, by analogy, known as a chorale.

The chorale-prelude is a musical form most closely associated with organ music, in which a chorale is made the basis of a (usually) short piece that decorates or varies the chorale. The organist in Lutheran churches traditionally introduced congregational hymns not by playing a phrase over but by extemporizing briefly on the tune; hence "prelude." These extemporizations become chorale-preludes; the form was invented well before Bach's time, and since his death most organ composers have attempted it; and even when the *cantus firmus* is not a German tune, the piece is often still called chorale-prelude. The most eminent exponents of the form for organ were (before Bach) D. Buxtehude and (after him) S. Karg-Elert and C. H. H. Parry.

See E. Routley, *The Music of Christian Hymnody* (1957); J. Zahn, *Die Melodie der deutschen evangelischen Kirchenlieder* (1889–93); C. S. Terry, *Bach's Chorals*, 3 vol. (1915–21). (E. R. Ro.)

CHORDATE is the common name given to one of the major groups, or phyla, into which the animal kingdom is subdivided. The chordate phylum (Chordata) is dominated by the vertebrate subphylum, but contains in addition three other subphyla, the members of which share some basic chordate characteristics in common with the vertebrates: (1) an elongate rod, or notochord, which stiffens the body; (2) a single, hollow nerve cord located on the dorsal (back) side; (3) an enlarged chamber, or pharynx, the sides of which are perforated by gill slits, just posterior to the mouth; (4) blood contained within vessels and propelled by a heart located on the ventral (belly) side; (5) a tail extending beyond the anus. Although these features are not present in all adult chordates, they appear at some stage in the life cycle of every chordate. The possession of these common characteristics indicates that all members of the chordate group are descended from a common ancestor. (*See* also VERTEBRATE.)

The three nonvertebrate subphyla (often called protochordates) are small marine forms. The cephalochordates, of which *Amphioxus* (*q.v.*) is best known, are small fishlike animals which as adults display all the general features of the phylum. The urochordates, or tunicates (*q.v.*), are almost devoid of chordate features in the sessile, adult state; but they produce a free-swimming larva having a dorsal hollow nerve cord, notochord, and other chordate features. The wormlike hemichordates never have a well-developed notochord but only a tiny rod in the head region; their affinity to the other chordates is doubted by some authorities.

See J. Z. Young, *The Life of Vertebrates* (1952). (F. MG.)

CHOREA (ST. VITUS' DANCE; SYDENHAM'S CHOREA) is a convulsive neurological disease usually associated with rheumatic fever. It is sometimes called chorea minor, infectious chorea, or rheumatic chorea to distinguish it from other choreiform diseases (*see* below).

Chorea is characterized by irregular, involuntary, and purposeless movements of muscle groups. These movements are most obvious in the extremities and face, but are present in the trunk and may involve muscles of speech and swallowing. The name St. Vitus' dance derives from the hysterical dancing mania of the late Middle Ages: persons in the grip of the mania attended the chapels of St. Vitus, who was believed to have curative powers.

Chorea is chiefly a disease of childhood, occurring most frequently between the ages of 5 and 15 years. It is more common in girls than in boys. It may occur in young adults and is an infrequent complication of pregnancy, when it is especially severe. Since more than 70% of cases of chorea are clinically associated with rheumatic fever, it may be considered a peculiar manifestation of that disease; it is estimated that 50% of children who have had rheumatic fever also develop chorea. Patients with chorea who have evidence of systemic infection as indicated by fever, increase of white blood cells, or increase of the sedimentation rate of red blood cells, have rheumatic heart disease as frequently as do those who have rheumatic fever. However, if these indications of systemic infection are absent, heart disease is uncommon. Because of the slow development of signs of rheumatic heart disease and the absence of evidence of acute infection, chorea of this type has been considered nonrheumatic and psychogenic in origin. This differentiation is difficult to substantiate since the clinical manifestations are identical.

While emotional crises and anxiety may appear to be intimately related to the onset of chorea, they are a manifestation of the disease and do not precipitate it. Facial grimaces, tics, and habit spasms are frequently confused with chorea, but these repetitive movements are quite different from the uncoordinated, purposeless movements of the disease. These movements, which are typical and recognizable, are usually preceded by or appear with evidence of irritability and emotional instability, chiefly episodes of crying initiated by trivial incidents.

Symptoms of chorea range in severity from mild to completely incapacitating. Inability to hold objects or to write properly and difficulty in walking are frequent. Vague identification of deterioration in ability to perform customary tasks is soon replaced by recognition of gross twitching of muscle groups, most easily observed in the extremities. The movements are more marked on one side but are present on both.

While there is debate concerning the pathological changes in the central nervous system, there is considerable evidence that both the emotional manifestations and the typical movements are related to changes in the cerebral cortex.

Attacks of chorea tend to be self-limited although the duration is several weeks. Recurrence is frequent. Recovery is hastened by rest in bed in a pleasant, sympathetic environment; patients improve quickly in hospitals or convalescent homes. Sedation with phenobarbital is helpful, and administration of tranquilizers may give striking though partial relief in severe cases when the patient is helpless.

HUNTINGTON'S CHOREA is a relatively rare, and invariably fatal, hereditary disease. The proximate cause is degeneration of brain tissue, perhaps due to inherited defects of metabolism. In most cases the symptoms first appear in middle life. They include mental disorder that begins as restlessness, moodiness, and lassitude, and becomes progressively delusional; and choreiform muscular spasms that are absent only during sleep and eventually become totally incapacitating.

SENILE CHOREA is a progressive disease caused by vascular lesions. Onset usually occurs late in life. The muscular symptoms somewhat resemble those of Sydenham's chorea, and there may be more or less severe disturbance of personality. (D. E. C.)

CHOREOGRAPHY. (1) The art of creating and arranging dances for theatrical performance, as for a ballet, opera or musical comedy. (2) The complete sequence of dance patterns in a theatrical production. (3) Choreography originally signified the notation of dances in script (as devised by Raoul Ager Feuillet in 1699); the phrase "dance notation" has generally superseded this usage.

Although dance patterns often appear to the spectator to be the result of spontaneous improvisation, any ballet or formal dance composition is planned as carefully as a complicated orchestral score. A choreographer decides the number of dancers to be used in each section of his projected work; he is responsible for the floor pattern, or movement of the dancers around the stage, as well as for the sequence of steps executed by each individual dancer. If he is staging a dramatic ballet, he must devise a method of expressing his theme or story through pantomime or dance movement. If it is a pure dance work, he must invent new patterns of movement or arrange existing ones with such skill and ingenuity that they alone will hold the attention of an audience.

The statement of the theme of a ballet, its development, climax and denouement are all planned by the choreographer and translated by him into terms of movement. He not only selects or invents the dance steps and patterns to be used but teaches them to the dancers. The choreography of a work is learned by the performers through direct imitation and not, as is the case with music, through the reading of a score.

The creation of a ballet usually begins with the writing of a libretto. This can be based on an existing literary work, as was customary in the 18th and 19th centuries, but in the 20th century it has been most frequently the original work of the choreographer. If a new musical score is commissioned, the choreographer collaborates closely with the composer, often going so far as to indicate not only the character and style of the music required but the actual rhythmic patterns and the number of measures needed in each. The great ballets of Petr Tchaikovsky, for example, were composed in intimate collaboration with the ballet master Marius Petipa, who outlined the dances of *The Sleeping Beauty* and *The Nutcracker* in meticulous detail before Tchaikovsky set them to music.

If the choreographer works from an existing score, the rhythms and general atmosphere of the work are predetermined by the composer. This is the case in such ballets as *Scheherazade,* staged by Michel Fokine to music by Nicolai Rimski-Korsakov, *Pillar of Fire,* choreographed by Antony Tudor to music by Arnold Schönberg, and *Symphony in C,* arranged by George Balanchine to music by Georges Bizet. For *Scheherazade* and *Pillar of Fire,* the choreographers superimposed new plots, entirely unrelated to the original intentions of the composers, on musical works which they found appropriate in style and feeling. In *Symphony in C* an abstract symphonic work was chosen to accompany a plotless ballet in which dance steps reflected the changing moods of the music.

Choreographers are almost invariably skilled, experienced professional dancers, for no others are fully qualified to understand the capabilities and limitations of the human body in dance movement. The successful practice of choreography demands not only an expert practical knowledge of dancing, preferably in several different techniques (such as ballet, modern dance, folk and ethnic forms and tap dancing), but a basic knowledge of music and an active imagination. Because taste and style are reflected in the choreographer's choice of movements, poses and patterns, as well as in his use of costume and scenery, his work gains in authority if he is also thoroughly grounded in painting, sculpture, poetry and the other arts.

Choreography in its most elementary form is seen in the circles and straight lines of simple folk dances. Geometric forms such as straight and diagonal lines, squares, rectangles, circles, semicircles and spirals continue to be found in the most advanced manifestations of the art. The geometrical element was predominant in the court ballets of the 17th century, where design was formal and symmetrical. As drama entered the ballet through the work of Franz Hilverding, Gasparo Angiolini and the distinguished theoretician Jean Georges Noverre, greater freedom of movement and pattern were introduced, and choreographers explored new ways of making dancing expressive. During the 19th century Filippo Taglioni, Jean Coralli, Jules Perrot and Arthur Saint-León became adept at suggesting place and period through the incorporation of folk dance materials in ballet, while the increased use of dancing on the points of the toes lent a suggestion of flight and an atmosphere of mystery to conventional ballet steps. Choreographers of the later 19th century often exploited tours de force such as spinning turns and tricks of balance, calling attention to the acrobatic accomplishments of their dancers, with a corresponding neglect of poetry and elegance. Fokine, in the early years of the 20th century, returned to dramatic ballet in such important works as *Petrouchka, Scheherazade* and *The Firebird.*

The emergence of modern dance as an independent dance form, in Germany and the United States, between 1915 and 1935, brought with it a strong impetus toward experimentation and a challenge which stirred choreographers in all dance forms to more inventive, imaginative and original work. Dancing in opera, musical comedy, films and television all underwent fundamental changes and were vastly enriched by new and broader concepts of dance design. Isadora Duncan, Ruth St. Denis, Ted Shawn, Mary Wigman, Martha Graham and Doris Humphrey were among the pioneers of modern dance choreography; their work was extended and carried into the field of popular entertainment by Agnes de Mille, Jerome Robbins and Michael Kidd.

In ballet choreography, Balanchine and Frederick Ashton perhaps went furthest in extending and developing classic dance design, while Tudor and Robbins discovered new means of expressing subtleties of emotion through the dance.

Choreography, throughout its history, has suffered from the fact that no universally satisfactory system of dance notation has been devised, so that the discoveries of one period must be passed on from one dancer to another through direct example and imitation. Many things have been lost in this process. After 1950, dances by Petipa and complete choreographic works by Balanchine, Hanya Holm and a few others were recorded in the most successful system of dance writing, Labanotation (*see* DANCE NOTATION).

Perhaps because so few written examples are available, and study of them is complicated by the fact that very few individuals are adequately prepared to read those scores that have been notated, there has been little systematic teaching of choreography. Dance composition, the teaching of which was pioneered by Louis Horst, was included in the curriculum of the Neighborhood Playhouse, New York city, in 1928, and was later introduced at Bennington college, Bennington, Vt., Connecticut college, New London, the Juilliard School of Music, the High School of Performing Arts, New York city, and other schools and universities.

Nevertheless, professional theatre choreographers continue to learn chiefly through observation and practical experience. Such experience is usually difficult to obtain, for a choreographer is not able to practice his art in solitude, like a writer, composer, painter or sculptor. He must experiment with living dancers. Under the conditions prevalent in the modern commercial theatre, mistakes are prohibitively expensive, and consequently managers tend to engage proved choreographers who are known to be competent craftsmen. Experimentation was carried on, nevertheless, by such co-operative groups as Choreographers' Workshop, active in New York city from 1946 to 1954, and Ballet Workshop, active in London after 1951. *See* also BALLET. (LN. ME.)

CHORIAMBIC VERSE. The choriamb is a metron of the form –⏑⏑– used in Greek and Latin verse. Unmixed sequences of choriambic metra are sometimes found in Greek lyric (*e.g.*, Sophocles, *Oedipus Tyrannus*, 483–486, and antistrophe), but the choriamb most commonly appears as a constituent of aeolochoriambic verses (*see* PROSODY, CLASSICAL). Thus the verse called "lesser asclepiad" is composed of aeolic base (⏓⏓), choriamb and –⏑⏑–⏑–; *e.g.*,

– – – ⏑ ⏑ – – ⏑ ⏑ – ⏑ –
Maecenas atavis edite regibus (Horace, *Odes* I, i).

The greater asclepiad contains two choriambs; *e.g.*,

– – – ⏑ ⏑ – – ⏑ ⏑ – – ⏑ ⏑ – ⏑ –
aetas: carpe diem, quam minimum credula postero.

Horace (*Odes* I, xi, xviii; IV, x) and Catullus (xxx) use sequences of greater asclepiads unmixed. In his lyric stanzas Horace often combines lesser asclepiads with glyconics and pherecrateans (*see* GLYCONIC) in such patterns as three lesser asclepiads and glyconic (*e.g.*, *Odes* I, vi, xv) or two lesser asclepiads, pherecratean, glyconic (*e.g.*, *Odes* I, v, xiv, xxi, xxiii). In Horace the aeolic base usually takes the form – –, as in the lines quoted above.

Choriambic verses have occasionally been composed in English in imitation of classical poetry; *e.g.*,

/ ⏑ / ⏑ ⏑ / / ⏑ ⏑ / / ⏑
Here the flame that was ash, shrine that was void, lost in
⏑ / ⏑ /
the haunted wood (Rupert Brooke). (L. P. E. P.)

CHORICIUS OF GAZA (fl. first half of the 6th century A.D.), Greek sophist and rhetorician whose orations were accepted as models by medieval writers. A pupil of Procopius of Gaza (d. *c.* 538), he wrote his master's funeral oration and continued his work. A number of his orations have survived, including panegyrics and wedding and funeral speeches. Some of his speeches on historical personages are valuable sources of information.

The *Ekphrasis eikonos* or description of a cycle of paintings in Gaza, formerly attributed to him, is now considered to belong to Procopius of Gaza.

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CHORLEY, a municipal borough (1881) in the Chorley parliamentary division of Lancashire, Eng., 22 mi. N.W. of Manchester by road, on the Leeds and Liverpool canal. Pop. (1961) 31,262. The town is on the fall line between a westward projection of the Pennines and the north Lancashire plain. The church of St. Lawrence is mainly Perpendicular and contains fine woodwork. The beautiful Elizabethan mansion of Astley hall, with its park, was presented to Chorley as a World War I memorial, and the corporation bought Duxbury park estate (541 ac.) in 1932. Duxbury hall is associated with Myles Standish (*q.v.*), the early New England colonist. Since 1779 cotton has been the chief industry and machinery for the mills has been made there since 1866. A foundry, laundry and cleaning works, the making of rubber, cosmetics, footwear and rope, employ most of the inhabitants. There is a large reservoir owned by Liverpool corporation waterworks.

CHOROTEGA, the most powerful Indian tribe of northwest Costa Rica at the time of the Spanish conquest, and a linguistic family which includes besides the Chorotega proper, Chiapaneco, spoken by a small group in Chiapas, Mex., and the two extinct languages Choluteca, located on the Gulf of Fonseca in Honduras, and Mangue, centred on the Pacific coast of Nicaragua. The Chorotegan family is affiliated with the larger Oto-Manguean stock of Mexico and Central America. According to early Spanish chroniclers, the Chorotega claimed to have migrated from a homeland in Chiapas many generations prior to the Conquest, driving the aboriginal inhabitants out of their new territory. The Chorotega were maize farmers, had markets and a quasi-democratic social structure in which chiefs were elected, and carried on frequent warfare with neighbouring peoples. They wore padded cotton armour and fought with bow and arrow and a wooden sword set with small flint knives, a typically Mexican weapon. Religious festivals featured the South American custom of the ritual drinking bout; however, Mexican traits such as human sacrifice and self-mutilation of the ears, tongue and genitals were also present. A pantheon of gods was worshiped in specially constructed temples. Chorotegan culture and language disappeared during the colonial period.

For the Chorotegan languages, *see* INDIAN, LATIN-AMERICAN. (M. D.-Co.)

CHOROTÍ (CHOROTES), a South American Indian tribe belonging to the Matacoan linguistic family (*see* MATACO). About 3,000 in number, they live in the region of the upper Pilcomayo river in the Gran Chaco (near the juncture of the frontiers of Bolivia, Paraguay and Argentina), where they subsist by means of agriculture and fishing, supplemented by wild-food gathering and hunting.

The bow is the aboriginal weapon, and in former times the Chorotí wore thick shirts of string "mail" in battle to ward off arrows. Woolen wrap-around skirts with ornamented borders constitute the typical dress for both sexes. Nets, netted bags and simple pottery are made.

Chorotí society basically consists of land-owning bands of 50–200 persons. Monogamy is the characteristic form of marriage, with girls selecting their future husbands.

See Alfred Métraux, "Ethnography of the Chaco," Bureau of American Ethnology *Bulletin 143*, vol. 1, pp. 197–370 (1946). (M. J. H.)

CHORUS, a term used in music and drama to designate those who perform in a group as opposed to those who perform singly (*see* DRAMA: *Greek Drama;* CHOIR). In England some Elizabethan dramatists wrote the chorus part for a single player who introduced and commented on the action of the play.

In music the word has several applications: to the organized body of singers in opera, oratorio, cantata and church music; to compositions sung by such bodies; to the refrain of a song, sung by a group of singers, between verses for solo voice; and, as a medieval Latin term, to the crwth (*q.v.*) or to the bagpipe.

CHORZOW, a town in southwest Poland in the Katowice *wojewodztwo* (province), is on the Cracow-Wroclaw railway line. Pop. (1960) 146,700.

Chorzow was at one time the country seat of the bishops of Wroclaw near Bytom, and as such shared the political fate of the Bytom principality (*see* BYTOM). It became Polish by the division of Upper Silesia in 1921. Classified as a town in 1934, it was formed of several industrial settlements, the largest being Königshütte, later renamed Krolewska Huta, which became a town in 1869. In 1919 half the population of Krolewska Huta was German speaking, but by 1939 the number of Germans had been reduced to 15%. A new attempt to Germanize the town took place during World War II, but after the war Chorzow became purely Polish. Chorzow is an important centre of heavy industry and mining. One of the first coal mines in the Upper Silesian basin was started in 1790 at Swietochlowice, a little to the southwest. The iron foundry known as the Königshütte began operation in 1802, thereby laying the foundations for the future town of that name. During World War I a second coal mine was started at Chorzow. The town has several coal mines, two foundries and a steel works, much enlarged after 1947, a streetcar and steel factory, a nitrogen and other chemical products factory, a zinc foundry and electrical industry. (K. M. Wi.)

CHOSEN: *see* KOREA.

CHOSROES: *see* KHOSRAU.

CHOTA NAGPUR, a plateau in eastern India, approximately conterminous with Chota Nagpur division of Bihar state; a considerable portion of India's heavy industry is located there. The division, occupying the hilly southern part of Bihar, consists of Palamau, Hazaribagh, Dhanbad, Ranchi and Singhbhum districts (*qq.v.*), with a total area of 25,293 sq.mi. and pop. (1961) 8,931,286. The Chota Nagpur uplands lie between the basins of the Ganges, Son and Mahanadi rivers, at an altitude of 1,000–2,000 ft. It is a comparatively cool, forest-clad, much dissected and overdrained region. The plateau, which is mainly formed of crystalline rocks, is traversed in the centre by the faulted sedimentary coal-bearing trough of the Damodar basin. There are a number of beautiful waterfalls, particularly in Ranchi district. Chota Nagpur has one chief crop, unirrigated rice; subsidiary crops are maize, oilseeds, pulses and potatoes. The principal forest products are timber, particularly sal; lac (of which Chota Nagpur is the world's leading producer); tussah silk; and mahua flowers, which are used as food and as a source of country liquor.

Chota Nagpur contains the Jharia, Giridih, Bokaro, Karanpura and Daltonganj coal fields and produces about half the coal of India. The mica belt, occurring mainly in Hazaribagh district, is one of the main sources of mica in the world. Other important mineral products of the region are iron, copper, manganese, chromite, china clay, limestone, apatite, kyanite, fire clay and bauxite. Notable manufactures are iron and steel, aluminum, railway engines and coaches, fertilizer, copper and cement. Industrialization expanded upon completion of four dams (Tilayia, Konar, Maithon and Panchet) and a huge thermal plant at Bokaro as part of the Damodar valley project (*see* DAMODAR). The plateau is connected by road and rail with Calcutta to the east, Patna to the north, and with cities in the south and west via Cuttack and Bilaspur. (E. AH.)

CHOUANS, the name given to the bands of peasants, mainly smugglers and dealers in contraband salt, who rose in revolt in the west of France in 1793 and joined the Vendéan royalists (*see* VENDÉE, WARS OF THE). The Breton word *chouan,* meaning "screech-owl," is supposed to have been applied originally as a nickname to Jean Cottereau (1767–94), the leader of the revolt, and afterward extended to his followers. In any case, it was appropriate, for they were night birds and used the hoot of an owl as a signal. The motive for revolt was less devotion to the monarchy than resentment at interference by the new republican government with their old habits; the ruin of their contraband trade by the abolition of the *gabelle* (*q.v.*); the attacks by the Convention on the priesthood; and, above all, the enforcement of conscription. Their methods of warfare were barbarous and were met by barbarous reprisals. A vivid picture of these wild people is given by Honoré de Balzac in his novel *Les Chouans.*

CHOU EN-LAI (1898–), one of the leaders of the Chinese Communist party (C.C.P.), was born in 1898. His ancestral home was in Shao-hsing, about 200 mi. S. of Shanghai. Having been exposed to western ideas in his early youth in Chinese and Japanese schools, he took part in the 1919 student demonstrations in Peking, which gave him his first jail experience. As a student in France (1920–24) he founded the first Chinese Communist youth unit. His second arrest occurred in 1926 when he was political commissar of the Whampoa Military academy founded by the Kuomintang, and he barely escaped death in 1927 in Shanghai when the Kuomintang broke with the C.C.P. (*see* CHINA: *History: Nationalism and Communism*). As head of the C.C.P. military committee and a leading member of the political bureau in the late 1920s, he represented the C.C.P. at Comintern meetings in Moscow and had a hand in the numerous uprisings in China.

In 1931 he joined Mao Tse-tung in southern Kiangsi where they directed the defense of their soviet base against repeated Kuomintang attacks. After they were driven out by the Kuomintang, and executed the Long March in 1934–35 from Kiangsi to Yenan in north China, Chou emerged as spokesman for the embryonic Chinese Communist regime. He negotiated with the Kuomintang during and after World War II. His acquaintance with the western world and his diplomatic talent, which won many friends for the C.C.P. and impressed many visitors during this period, were again in full display at the Asian-African conference at Bandung, Indon., in April 1955. Upon the establishment of the Chinese Communist regime in 1949, Chou became premier and foreign secretary, relinquishing the latter post in 1959.

Dedicated to the party but showing no Napoleonic thirst for personal power, eloquent in defending the party's position but offering no personal interpretation of communist theories, Chou was able to survive the C.C.P. power struggle. His wife, Teng Ying-ch'ao, his comrade in revolution since their high-school days, also was an important C.C.P. leader. (KA. H.)

CHOUGH (*Coracia pyrrhocorax*), a bird of the crow family. It inhabits mountains and rocky coasts in Europe and north Africa. The combined effects of persecution by man and competition with the jackdaw (*q.v.*) have reduced its numbers and it is now rare. Recognized by its black plumage and bright red legs and red, curved beak, the chough is more slenderly built than the crows. It is less common in Great Britain and Ireland, though a breeding resident. The alpine chough (*C. graculus*), slightly smaller and with a yellow bill, is a gregarious inhabitant of inland mountains and valleys of south Europe.

CHOU-SHAN CH'ÜN-TAO (CHUSHAN, CHUSAN), an island archipelago off the north coast of Chekiang province, China. It represents the submerged terminus of the Tayü Ling, the dominant range of Chekiang. The outermost islands, which lie across the entrance to Hangchow bay, have periods of heavy fog and are swept by the beginning currents of the tidal bore that runs up the bay. The southern islands are becoming choked with silt from the Yangtze estuary, to the north, and may eventually become tied to the mainland.

Chou Shan Island, largest of the group, was during the 15th and 16th centuries an entrepôt for trade with Japan, as Hong Kong today serves China for trade with Great Britain. Great Britain failed to establish a trade centre there in the early 19th century. The Chinese Nationalists maintained a military base on Chou Shan from 1949 to 1953. P'u-t'o Island, east of Chou Shan, also is of importance in the fishing industry, but its chief interest long has been its many monasteries and temples, for it is historically famous as a Buddhist pilgrimage centre. The islands carry on agriculture and salt-making from sea water, but the prime product is fish, chiefly marketed through Ningpo on the Chekiang mainland. (J. E. SR.)

CHRESTIEN, FLORENT (1541–1596), French poet, satirist and a noted Hellenist, was born at Orléans on Jan. 26, 1541. A pupil of Henri Estienne, he was appointed at an early age as tutor to Henry of Navarre, later Henry IV, who subsequently made him his librarian. He was a contributor to the *Satire Ménippée*, the famous pasquinade written in the interest of his former royal pupil, and his works include a Latin version of *Hero and Leander* and French versions of George Buchanan's *Jephthes* and Oppian's *De venatione*. Though brought up a Calvinist, he was converted to Catholicism before his death at Vendôme in Oct. 1596.

CHRÉTIEN DE TROYES (fl. 1170), French medieval poet who was the author of the earliest surviving Arthurian romances. Knowledge about his life is very slight and most of the information available is derived from his references to himself in his works. Of these, those extant are, in probable chronological order, *Erec*, *Cligès*, *Le Chevalier à la Charette* (*Lancelot*), *Le Chevalier au lion* (*Yvain*), *Guillaume d'Angleterre* and *Le Conte del Graal* (*Perceval*), all of which, except the next to the last, deal with Arthurian legend. Since the poet refers to himself as "Chrestiiens de Troies," he was presumably a native of Troyes in Champagne. He was familiar with the writings of Ovid, may have taken holy orders and was patronized by two of the most prominent figures of his time: Marie, the daughter of Louis VII of France and Eleanor of Aquitaine, who became countess of Champagne by her marriage in 1164, and Philip of Alsace, cousin of Henry II of England, who was count of Flanders after 1168 and, as guardian of the young Philip Augustus, virtual regent of France from 1180 until 1182. For the first of these patrons he composed *Le Chevalier à la Charette;* for the second, *Le Conte del Graal*. It is not known whether Chrétien ever visited Philip's court, but the knowledge of geography displayed in *Cligès* suggests that he may have been to England. *Erec* was written after the appearance of Wace's *Roman de Brut* in 1155. *Le Chevalier à la Charette* was written after 1164 when Marie became countess of Champagne. *Le Conte del Graal* was begun before Philip went on crusade, from which he never returned, in 1190. Most probably, therefore, all the more important works of Chrétien were completed between 1160 and 1180.

The romances, which are no more than accounts of chivalrous adventures built around the framework of a love story, enjoyed great popularity. Chrétien handles the themes of courtly love and Arthurian legend with a detachment at once humorous and sympathetic and his work represents the most sophisticated product of the 12th-century courtly movement. Although his characters possess little depth and the situations with which they are faced are often extravagantly unreal, many such faults, hitherto attributed to the author, are the result of the complicated mythological ancestry of the persons and events he described. In any case, such defects would not have been regarded as serious in works which were intended merely as an intellectual pastime for courtly society, particularly when their author possessed such a brilliant narrative technique as Chrétien.

BIBLIOGRAPHY.—The best editions of *Erec, Cligès, Le Chevalier à la Charette* and *Le Chevalier au lion* are still those prepared by W. Foerster between 1884 and 1899. An English translation of these works, under the collective title *Arthurian Romances*, was reprinted in 1955. The best edition of *Le Conte del Graal* was published in 1956. For general criticism of Chrétien's work *see* R. R. Bezzola, *Le Sens de l'aventure et de l'amour* (1947); R. S. Loomis, *Arthurian Tradition and Chrétien de Troyes* (1949); W. A. Nitze, *Perceval and the Holy Grail* (1949); J. Frappier, *Le Roman breton: Chrétien de Troyes, Perceval ou le conte du Graal* (1953); S. Hofer, *Chrétien de Troyes: Leben und Werke des altfranzösischen Epikers* (1954). Many of the classic critical works on Chrétien are not easily obtainable; those given here contain bibliographies of earlier studies.

CHRISM, a mixture of olive oil and balsam used in the ritual of Eastern and Latin churches. The anointing of priests, kings and prophets in the Old Testament was interpreted by the early church as having been fulfilled in the triple role of Christ, whose name signifies "the Anointed One"—*i.e.*, by the Holy Spirit. Consequently, from at least the 2nd century, the church ritually anointed all newly baptized as a sign of their sharing in the royal priesthood of Christ (*cf.* I Pet. ii, 9). In the West the word chrism (from Gr. *chrio*, "to anoint") was retained for the oil; in the Greek church, beginning with the 4th century, the term *myron* ("perfumed oil") was substituted (appropriately, because in the complicated Greek rite of blessing the oil as many as 50 aromatic substances are added; in the west, sweet-smelling balsam has been added to the olive oil since the 6th century).

In the Latin Church, chrism is consecrated by the bishop in a special chrism mass on the morning of Maundy Thursday. The ceremonial is highly solemn, characterized by processions with the oil and requiring the assistance of 12 priests, 7 deacons and 7 subdeacons. The consecratory preface states that the sacred oil elevates those anointed with it to a sharing in the dignity of priests, kings, prophets and martyrs. In Eastern churches the consecration of the *myron* is a privilege normally reserved to patriarchs.

Chrism is used in the Latin Church for the postbaptismal anointing and for confirmation, for the consecration of bishops, churches, altars, chalices and patens, and for the blessing of bells and of baptismal water. In the rite of ordination of priests, chrism was used for the anointing of hands from the 7th to the 12th century, when the oil of catechumens came to be substituted through an unfortunate misunderstanding. Since the 6th century chrism also has been used in the ritual of coronation of kings and emperors; these, as a consequence, were no longer regarded as laymen but as belonging somehow to the ranks of the clergy, with special obligations and liturgical rights. The claim of emperors and kings to a voice in the election of bishops was often based on this fact. (G. L. D.)

CHRIST, the "Anointed One," the Greek (*Christos*) translation of the Hebrew "Messiah"; the title given in the New Testament to Jesus of Nazareth. *See* JESUS CHRIST: *The Picture of Christ in the Early Church;* MESSIAH.

CHRIST, CHURCHES OF, a group of churches, found chiefly in the United States, with a membership of approximately 2,000,000 (about 62,000 outside the U.S.) in about 18,800 local churches. They are strongest in Michigan, the Ohio valley and in the southern and southwestern sections of the U.S., including Florida and California. Each church is known locally as a Church of Christ, its members as Christians, and is autonomous in government, with elders as overseers, deacons and a minister or ministers. There is no organization beyond the local church.

The Churches of Christ claim to have originated on Pentecost in Jerusalem, A.D. 30, and to be identified with New Testament churches in origin, doctrine and practice. They believe that in the early centuries there were departures from New Testament teachings to the extent that the identity of churches as they were in New Testament times became lost. Efforts were made to restore the doctrine and practice of these churches, but it was not until the early part of the 19th century that they culminated in Great Britain and then the United States in what became known as the "restoration movement." Leaders of this movement—a number of whom were originally Presbyterians—deplored existing religious divisions, certain doctrines they considered erroneous, and the making and demands of creeds. They pleaded for the Bible alone, without creedal human additions, and for the unity of the people of God by the restoration of New Testament Christianity. Refusing affiliation with any sect, they called themselves simply "Christians." Foremost leaders were Barton W. Stone, Thomas Campbell and his son Alexander, and Walter Scott (*see* also Campbell, Alexander; Disciples of Christ).

About the middle of the 19th century controversies arose among the Christians, principally over the scriptural authorization for organized missionary societies to do the work of the church and the use of instrumental music in Christian worship. These led to an open division, with those favouring the societies and instrumental music being listed in 1906 by the federal census of religion as Disciples of Christ and those opposed as Churches of Christ. The latter hold that organized societies and instrumental music are unauthorized by the New Testament, that the New Testament church had neither and hence both are innovations.

After the division the Churches of Christ continued to grow substantially and rapidly in the United States and abroad. Though the church is opposed to organized mission societies, missionary work is nonetheless carried on in 80 foreign fields. Convinced of the importance of Christian education, members of the Churches of Christ operate 20 liberal arts colleges and many high schools in which the Bible is taught. Three of the colleges offer graduate work in religion and other fields. There is a weekly cooperative nation-wide radio and television program known as the "Herald of Truth." Members of the church also publish newspapers and operate orphanages and homes for the aged.

Sunday worship in the Churches of Christ consists of unaccompanied congregational singing, prayer, teaching, preaching, giving and the Lord's Supper. There are other worship and teaching services on appointed days during the week, with periodic special and evangelistic meetings.

The Churches of Christ have no creed in the sense of a humanly formulated statement containing official articles of faith. They believe in the manifestation of God in Christ, in the all-sufficiency of the Bible, with the primacy of the New Testament, as the revelation of the will of God and the only rule of faith and practice. They continue to advocate the restoration of New Testament Christianity. They believe that the word of God is the seed of the church (Luke viii, 11). When received it produces faith in Christ, repentance from sin, confession of faith in Christ, burial with Christ in baptism for the remission of sins, and thus leads to Christian worship, Christian living and the hope of eternal life as it did in New Testament times.

Bibliography.—W. E. Garrison and A. T. DeGroot, *The Disciples of Christ* (1948); Homer Hailey, *Attitudes and Consequences* (1945); Robert Richardson, *The Memoirs of Alexander Campbell* (1868); Earl West, *The Search for the Ancient Order*, 2 vol. (1949). (W. B. We.)

CHRISTADELPHIANS (Greek for "Brothers of Christ"), sometimes also called Thomasites, a religious body founded about 1848 by John Thomas (1805–71), who, after studying medicine in London, migrated in 1844 to Brooklyn, N.Y. There he at first joined the followers of Thomas and Alexander Campbell (*q.v.*), but afterward struck out independently, preaching largely upon the application of Hebrew prophecy and of the book of Revelation to current and future events. Both in the United States and Great Britain he gathered a number of adherents. The name Christadelphians was adopted during the Civil War when the denomination had to organize formally in order to justify its objection to military service.

The local organization, called an ecclesia, is congregational in polity, with no distinction of clergy and laity. Ruling or serving brethren are elected, who minister without compensation. Annual fraternal gatherings are held for fellowship and Bible study. The Christadelphians number around 4,000 in 115 ecclesias in the United States. They publish four magazines, chief of which are the *Faith* (Waterloo, Ia.) and the *Christadelphian* (Birmingham, Eng.).

The Bible is the only authoritative creed, and membership in the society requires a profession of faith and baptism by immersion. The group rejects orthodox views of the Trinity, and its theology is strongly millenarian, centring in the hope of a worldwide theocracy with its seat at Jerusalem and involving belief in a conditional immortality of the body.

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CHRISTCHURCH, a municipal borough of Hampshire, Eng., stands at the confluence of the Avon and Stour rivers, adjoining Bournemouth on the coast, 21 mi. S.W. of Southampton by road. Pop. (1961) 26,498. It includes the villages of Mudeford and Highcliffe. The neighbourhood was of great importance in later prehistoric times and much of the Late Bronze and Early Iron Age intercourse of Britain with the continent seems to have focused on Hengistbury head and Christchurch. In 901 it was seized by Aethelwald, but was recaptured by Edward the Elder. The town's Saxon name long survived in the form Christchurch Twynham, but in Domesday Book it appears as Thuinam when it was a borough belonging to the king. Henry I granted Christchurch (about 1100) to Richard de Redvers, who erected the castle, of which only fragments remain. The Norman Constable's house on Castle Mound has been restored. The town's first charter was granted by Baldwin of Redvers, 1st earl of Devon, about 1150; Baldwin, the 7th earl, granted to the burgesses the tolls of the fair at St. Faith about 1257. Holy Trinity fair is mentioned in 1226.

The Augustinian priory church, dedicated to the Holy Trinity, and dating from the 12th century is cruciform, lacking a central tower but having a Perpendicular tower at the west end and a Perpendicular choir. The nave and transepts are principally Norman and very fine. Early English additions appear elsewhere, and the rood screen is of ornate Decorated workmanship. The priory, dissolved in 1539, became so famous that its name, Christchurch, finally replaced the town's older name. The town was re-incorporated by royal charter in 1886.

Largely residential, Christchurch is also a seaside resort with a small harbour for sailing yachts and small craft. A regatta takes place every August; the sailing club was established in 1884. The Red house is a museum and art gallery. Besides its salmon fisheries, Christchurch has light industries, the chief of which is the building of aircraft. The Bailey bridge, invented by Sir Donald Bailey, was built there during World War II.

CHRISTCHURCH, capital city of the provincial district of Canterbury, New Zealand, lies on the east coast of South Island, to the north of Banks peninsula. The population (1961) of 151,333 (including suburbs 220,322) makes it the second largest city in New Zealand after Auckland. Situated on the alluvial Canterbury plains close by Banks peninsula, which was once a volcanic island, the city, unlike others in New Zealand, is laid out in a rectangular pattern and is sometimes known as the "Garden City" or the "City of the Plains." The small but attractive river Avon winds through Christchurch and there are beautiful parks and gardens which, with reserves and recreation grounds, account for one in every eight acres of the city. The focal point of the city is Cathedral square, which is dominated by the 240-ft. spire of the Anglican cathedral built in the Gothic style from designs by Sir Giles Gilbert Scott. There is also a Roman Catholic pro-cathedral attached to a convent of the Sacred Heart. Christchurch has always been regarded as one of New Zealand's leading centres of education. Some of its oldest and finest buildings are schools, such as Christ's college and the University of Canterbury, founded in 1873. The Robert McDougall Art gallery and the Canterbury museum, which has a fine collection of native birds (including remains of the extinct moa), a replica of an early Christchurch street and a planetarium, are situated by the Botanical gardens and Hagley park. The latter divide the residential districts in the north and west of the city from the commercial area. Other buildings include the government offices and the Princess Margaret hospital.

The main port is Lyttelton, a natural deep anchorage, 7 mi. S.E. Two roads over the Port hills and road and rail tunnels connect the port and city. The port handles more than 1,500,000 tons of goods annually, the chief exports being wool, meat, dairy products and wheat and the chief imports motor spirits (gasoline), oil, fertilizers, iron and steel. Six miles to the northwest of the city centre is Christchurch international airport. Situated on a shingle formation of more than 1,000 ac., it is one of the country's main airports, with direct services to Melbourne and Sydney in Australia and to other cities in New Zealand. A four-lane highway connects the airport with the city, which has thus become a major freight-handling centre as well as an important centre for industry connected with aviation. Christchurch also has good road and rail connections with Blenheim to the north, Dunedin and Invercargill to the south and Greymouth to the west through the Southern Alps.

With its good transport facilities, bountiful supply of water from artesian wells and unlimited quantities of inexpensive hydroelectric power, Christchurch has become the second most important industrial centre of New Zealand. Before World War II the city was chiefly dependent on the rich agricultural district surrounding it, the plains being mainly devoted to cereals and grazing. However, there were a number of important industries, including meat freezing and woolen and implement manufacturing, and after 1945 industrial expansion was phenomenal. By 1960 there were more than 2,200 factories producing such goods as clothing, carpets, wood and cork products, furniture and transport equipment. In 1960 it was estimated that the annual value of goods produced in Christchurch was more than £100,000,000, of which more than one-third represented the value added to the raw materials used. Industrial expansion has been helped by the ready availability of fully serviced land zoned for industrial purposes.

Christchurch was the last and most successful colonizing project inspired by Edward Gibbon Wakefield and his New Zealand company. It was founded by the Canterbury association, formed in 1848 largely through the efforts of John Robert Godley, which planned to establish a model Church of England settlement. The first settlers under the scheme reached Lyttelton on Dec. 16, 1850. (C. P. G.)

CHRISTIAN I (1426–1481), king of Denmark, Norway and Sweden, founder of the royal house of Oldenburg, was born on May 21, 1426, the son of Count Dietrich the Happy of Oldenburg and Hedvig of Holstein. When, in Jan. 1448, Christopher III died childless, Christian's uncle Adolf, duke of Schleswig and count of Holstein, was next in succession, but he recommended his nephew to the Danish *rigsraad*. Christian became king in the same year and in 1449 married his predecessor's widow, Queen Dorothea of Hohenzollern (1430–95).

Sweden now chose the former regent Karl Knutsson (Charles VIII) as king, while Norway hesitated. Christian's foremost political aim was to restore the northern union. At a meeting of the Danish and Swedish councils at Halmstad in 1450 he was recognized as king of Norway and heir in Sweden. Yet he supported a Swedish faction which, in 1457, deposed Charles. In March 1460, the nobles of Schleswig and Holstein chose Christian as formal successor to his uncle, though a declaration of 1448 had decided that Denmark and Schleswig should never be ruled by the same regent. Christian's Swedish plans were ruined in 1471, when the recalled Charles VIII defeated him at Brunkeberg near Stockholm. In Denmark, the nobles were restive, but this danger was met with the help of the commons in 1468, the year in which the Danish estates were first called together.

Always lacking funds, Christian could not enforce his trade laws favouring the burghers. Generous grants of privilege were the price of friendship with the Hanseatic league, whose claims to sole trading rights in Iceland entangled Denmark in a war with England (1469–74). In 1469 Christian married his daughter Margaret to James III of Scotland. As a pledge for a dowry the Norwegian Orkneys and Shetlands with the almost forgotten sovereignty over the Hebrides and Man were ceded to James—a grant never redeemed. Christian's concordat with the pope made it easier for him to deal with the Danish Church. After his visit to Rome in 1474 he obtained (1475) a papal bull for a university, which he founded in Copenhagen in 1479.

Christian combined Renaissance drive with medieval chivalry. He had courage and ambition and loved splendour and extravagance. But though he was daring and farsighted in his designs, he lacked resolve in realizing them. He died in 1481. (A. E. Cn.)

CHRISTIAN II (1481–1559), king of Denmark, Norway and Sweden, son of King Hans (John) and Christina of Saxony, was born at Nyborg castle on July 1, 1481, and succeeded his father on the Dano-Norwegian throne in 1513. In 1502 and 1506–12 he had been an able viceroy in Norway, favouring the burghers; the *rigsraad* and nobles were therefore loath to accept him. To compromise, he had to grant a charter at a Dano-Norwegian *rigsdag*, whereby the *rigsraad* was assured control of the government and the nobility acquired sole right to office under the crown, in addition to securing extensive powers in their enfeoffed estates. As the Swedish delegates present had no mandate to elect a king, the question of the union remained open and Sten Sture the younger continued as Swedish regent.

In Norway Christian had taken up two Dutch women of bourgeois origin, Dyveke as his mistress and her mother, Sigbrit Villoms (or Villomsdotther), as counselor. This association continued even after his marriage in 1515 to Elizabeth (Isabella) of Habsburg, sister of the future emperor Charles V. If the *rigsraad* disapproved of Dyveke, it also resented Sigbrit's influence. This clever woman became controller of the sound tolls and soon took charge of the financial business of the state. At first Christian tried not to breach the charter openly, though he bypassed the *rigsraad* and used the chancellery to bring in some reforms in favour of the burghers, especially the merchants, who gained sole trading rights in disregard of privileges claimed by the nobles and the Hanseatic league.

The storm broke in 1517. Christian accused Torben Oxe, governor of Copenhagen castle, of having poisoned Dyveke, and had him beheaded. Thereafter he ignored the *rigsraad* and the charter. The chancellery took on direct supervision of the provinces and for governors chose burghers loyal to the king. Christian appointed bishops at will. Hans Mikkelsen, burgomaster of Malmö, became his special counselor. The government assumed a mainly bourgeois character.

Christian stopped negotiating with the Swedes and, without the *rigsraad's* consent, resolved to fight. Both through diplomacy and help from the Swedish unionist party under Archbishop Gustav Trolle, Christian had prepared well for this war. Yet twice the Danes were beaten outside Stockholm (1517–18). Sten Sture imprisoned the archbishop, for which Pope Leo X excommunicated him. Christian now rebuilt his forces round an elite core of mercenaries and in 1520 attacked again. This time he prevailed. On Jan. 20 Sten Sture was defeated and mortally wounded at Bogesund. The victors quickly advanced to Stockholm and Uppland. On March 6, Swedish councilors assembled at Uppsala recognized Christian as king, and he in return granted an amnesty and undertook to rule according to the constitution of the former union. The nationalist party held out in Stockholm till September.

Christian was crowned king of Sweden on Nov. 4. Celebrations went on for three days, but on Nov. 8 occurred the "Stockholm blood bath," which cost the lives of about 80 Swedes—bishops, nobles and burghers. The previous day Gustav Trolle had laid dubious charges of heresy on inconvenient opponents; an ecclesiastical committee hastily pronounced them heretics, and they were turned over to the secular authorities for execution. Whether the king or the archbishop had instigated this massacre, the effect was not as intended. Rallying round Gustavus Vasa, a young noble, the Swedes in Jan. 1521 began a war of liberation. In June 1523 Gustavus Vasa was proclaimed king of Sweden. The northern union ceased to exist.

At Stockholm, in 1520, Christian had drawn up plans for a northern trading association which was to work with the south German merchant house of the Fuggers to crush the Hanseatic league and take over all Baltic trade. Meanwhile Denmark saw sweeping legal reforms, producing in 1521–22 the two new codes of the *bylov* (borough law) and *landlov* (land law). Influenced by Dutch and German institutions, these codes emphasized the power of the king and greatly altered Denmark's social structure. Class differences were limited by extension of the burghers' commercial privileges and guarantee of the peasants' freedom. The church was organized on a national basis under the supremacy of the king, and numerous humanitarian and cultural reforms were introduced.

The king's setback in Sweden, the break with the Hanseatic league, the provocative administration of the provinces, the new laws and fear of a hereditary monarchy stiffened opposition from the Danish nobles. Christian was now prepared to compromise, but too late. The Jutlanders of the *rigsraad*, having decided to depose him and appoint his uncle Frederick, duke of Schleswig-Holstein, renounced their allegiance on Jan. 20, 1523. As opposition from the nobles grew, Christian lost heart and with his counselors left Copenhagen on April 13 to seek help abroad.

Christian settled in the Netherlands. His power was broken. It was not until 1531 that, with the help of his brother-in-law the emperor Charles V, he was able to raise an army and sail to Norway, where he was once again welcomed as king. He abandoned the struggle, however, and sought to negotiate with Frederick I. In spite of a safe conduct, he was arrested at once and imprisoned at Sönderborg castle and later (1549) at Kalundborg castle, where he died on Jan. 25, 1559.

Christian's character was as changeable as his portraits are contradictory. Sometimes an energetic man of action, at others a spineless and hesitant doubter, he was usually frank and sociable but on occasion completely governed by suspicion and cruelty. But against the charge of vacillation it may be argued that he stood by his bourgeois principles. (A. E. Cx.)

CHRISTIAN III (1503–1559), king of Denmark and Norway, who established the state Lutheran Church in Denmark, was the eldest son of Frederick I of Denmark and his first wife, Anne of Brandenburg, and was born at Gottorp on Aug. 12, 1503. Early in life Christian became a convinced Lutheran. His tutor between 1518 and 1520 was Wolfgang von Utenhof from Wittenberg university, and in 1521 Christian was himself present at the diet of Worms. When, in 1523, his father was elected Danish king in succession to Christian II, Christian at once clashed with the Catholic majority in the *rigsraad*. Because of his Protestant zeal when *statholder* in Schleswig-Holstein (1526) and during his visit to Norway (1529), he was not elected heir while his father still lived. When Frederick died in 1533, the Catholic councilors preferred Christian's younger brother Hans; with the Protestant councilors' approval, the election was put off for one year. Meanwhile the burgomasters of Copenhagen and Malmö conspired with the Lutheran burgomaster of Lübeck to restore the imprisoned Christian II (*q.v.*) to the throne, and Lübeck's forces invaded Holstein. But in Aug. 1534 an assembly of Jutlandish nobles and bishops at Rye in Jutland proclaimed Christian king. In summer 1536 Copenhagen surrendered to his forces. He began consultations on a religious settlement with the Catholic bishops, but they were so obstinate that he arrested them during the night of Aug. 11–12. Next day, the lay members of the *rigsraad* swore not to oppose further changes in the church. On Oct. 30 a national assembly made over all episcopal property to the crown and established the Lutheran Church in Denmark with the king as its head, while Christian confirmed the privileges and constitutional rights of the *rigsraad* which proclaimed his son Frederick heir to the throne.

In 1537 the Danish Church was reorganized under the guidance of advisers, particularly Johann Bugenhagen from Wittenberg university. Christian himself maintained close personal contact with Wittenberg. But despite his German origins and sympathies he established good relations with the *rigsraad*, thanks mainly to the chancellor Johan Friis, and became completely reconciled with the Danish nobility. His Holstein councilors wanted him to live at Gottorp, as his father had done, but he refused and, from 1539, resided permanently in Denmark.

Christian's foreign policy rested on his alliance with the German Protestant rulers. This counterbalanced the persistent hostility of the Holy Roman emperor Charles V, who supported the claims of his nieces, the daughters of Christian II, to the Scandinavian kingdoms. In 1542 the Danish nobility voted Christian a 20th part of their property, which enabled him to clear his debt with Holstein. Thenceforth Christian and his Danish councilors took the lead in foreign policy. The conciliatory policy of Christian's German advisers was abandoned, and in 1542 war was declared against the emperor. The closing of the sound to shipping from the Habsburg Netherlands was very effective. At the diet of Speyer in May 1544 Charles V concluded peace with Denmark. From then on, Christian avoided all foreign complications, refusing to take part in the war of the League of Schmalkalden (1546) and acting as a mediator between the Albertine and Ernestine Wettin of Saxony (1554). When Christian died on Jan. 1, 1559, Denmark was rich and peaceful. His reign saw measures fitted to a country in transition, the administration had been modernized, and Denmark had become a full member of the European system. Though not perhaps a great ruler, Christian was a good one, with a strong sense of duty and genuine piety.

See K. Fabricius (ed.), *Danmarks Konger* (1944). (As. F.)

CHRISTIAN IV (1577–1648), king of Denmark and Norway, the son of Frederick II of Denmark and Sophia of Mecklenburg, was born at Frederiksborg castle on April 12, 1577, and succeeded to the throne on the death of his father (April 4, 1588); during his minority, which lasted till Aug. 17, 1596, the government was carried on by a regency of four members of the *rigsraad*, who supervised his education. Soon after his coronation in 1596 Christian won the initiative in politics. The *rigsraad*, however, succeeded in restraining his hostile policy against Sweden until Christian threatened to declare war as duke of Schleswig-Holstein (1611). The Kalmar War (1611–13) against Gustavus Adolphus of Sweden was successful, but inconclusive.

At home Christian encouraged the formation of trading companies and fostered manufactures, which, however, did not thrive. By contrast, his new silver mines at Kongsberg in Norway were a success, and Copenhagen received many fine new buildings. He founded important new towns which furthered commerce and strengthened Denmark's defenses. He employed Dutch architects and engineers and himself took part in the planning and execution of his projects. Glückstadt in Holstein and Christianshavn were among the new ports, and Christiansstad in Scania and Christianopel in Blekinge were strategically placed near the Swedish frontier. Christian followed the brilliant career of Gustavus Adolphus with envy. He had no army to match the Swedish, but spared no expense to maintain the superiority of the Danish navy and built a protecting harbour and an arsenal in Copenhagen.

By 1624 the Thirty Years' War had reached a critical phase for the Protestants: the Catholic forces were dangerously near the Baltic, and Christian agreed to intervene. He had aspirations in northern Germany and even dreamed of diverting the commerce of Hamburg to Glückstadt. He had gained the election of his second son, Frederick, as coadjutor of the secularized bishopric of Bremen in 1621 and as bishop of the adjoining Verden in 1623. Besides these German ambitions, family ties may well have led him to help the Protestants, for Elizabeth, his niece, was wife of the elector Palatine. In 1625 Christian started operations against the Catholic league, but his defeat by Tilly at Lutter-am-

Barenberge (Aug. 1626) made retreat imperative. Tilly and Wallenstein invaded and plundered Jutland, and in Jan. 1628 Christian was compelled to form an alliance with Gustavus Adolphus. After a Swedish-Danish army and fleet had compelled Wallenstein to raise the siege of Stralsund (Aug. 1628), however, Christian declined a further alliance with the Swedes and concluded a separate peace with the Holy Roman emperor at Lübeck (May 12, 1629). Unfortunately Christian would neither conciliate Sweden nor protect himself by a system of counteralliances, while his special rights in the Baltic and his privileges as king of Norway alienated him in the long run from both the United Provinces and England. Raising the sound tolls, he obstructed trade while at the same time obtaining an increased income independent of the *rigsraad*. By mediating in favour of the emperor, after the death of Gustavus Adolphus in 1632, he tried to minimize the influence of Sweden in Germany. In May 1643 the Swedes declared war on Denmark and by the end of Jan. 1644 Jutland was in their possession. Christian then showed something of his earlier drive and, since the Swedish offensive flagged, the Danes were able to save the important fortress of Malmö. At first the Swedish army could not cross from Jutland to Fünen for want of a fleet and later attempts to transport it to the Danish islands were repulsed under Christian's personal direction (July 1, 1644). Though the Danish fleet blockaded the Swedish ships in Kiel bay they escaped, and the annihilation of the Danish fleet by the combined navies of Sweden and Holland at the end of September forced Christian to come to terms. Peace was finally signed at Brömsebro in 1645. (*See* DENMARK: *History*.)

The king's last years were further embittered by the antagonism of the nobility. Throughout his reign the *rigsraad* and the nobility had opposed his warlike policies. But in the 1630s and early '40s Christian's position was strengthened by the marriages of his daughters with members of the aristocracy. However, the strain on the finances caused by the war gave the *rigsraad* and the nobility their opportunity, and finally Christian's sons-in-law also quareled with him. He died in Copenhagen on Feb. 28, 1648.

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CHRISTIAN V (1646–1699), king of Denmark and Norway, the son of Frederick III of Denmark and Sophia Amalia of Brunswick-Luneburg, was born on April 15, 1646, at Flensburg, and succeeded to the throne on Feb. 9, 1670. Christian was well liked and easily made contacts with the common people. Nevertheless he was conscious of his dignity and absolute power. He disliked the old Danish nobility and therefore opened the highest offices of state to Holstein nobles and well-placed burghers, who were admitted to the two new orders of nobility, counts and barons, set up in 1671. Peder Schumacher, a commoner, became first his leading counselor and in 1674 was made *rigskansler* (chancellor), having been created Count Peder Griffenfeld (*q.v.*) in 1673. As chancellor he reorganized the central administration and tried to conduct a peaceful foreign policy based on alliances. When he failed, the envy of his enemies led to his downfall in 1676. Thereafter Christian, though neither gifted nor well educated, tried to govern alone. The Scanian War (1675–79) impoverished Denmark and Norway without gain. More significant was the appearance of a new code of law in 1683 (*Christian V's Danske Lov*), for which he is mainly remembered. A "will." dedicated to his son and successor Frederick IV, contains his reflections on government and absolute power. He died in a hunting accident on Aug. 25, 1699.

See K. Fabricius (ed.), *Danmarks Kanger* (1944). (As. F.)

CHRISTIAN VI (1699–1746), king of Denmark and Norway, the son of Frederick IV of Denmark and Louise of Mecklenburg-Güstrow, was born on Nov. 30, 1699. He ascended the throne after his father's death on Oct. 12, 1730. Tolerably gifted, he became a diligent and conscientious ruler choosing able ministers, but he was insignificant in appearance, shy and reserved. Like his consort, Sophie Magdalene of Brandenburg-Kulmbach (1700–1770), he was imbued with German pietism. Frivolous amusements were banned at court; but the royal couple's love of splendour did find expression in costly buildings, such as Christiansborg castle (built 1733–45). In 1733 he re-established the national militia but acceded to the landowners' demand that peasants liable to conscription should remain on the estates where they were born. His foreign policy was pacific. In 1734 he formed a 15-year alliance with Sweden; from Protestant sympathies he allied himself with England (1734–42); and in 1742 a Danish-French treaty was concluded. In 1743 he unsuccessfully urged the election of his son, Crown Prince Frederick, as successor to Frederick I of Sweden. Christian interested himself in commerce, education and the care of the poor, and with sincere devoutness he encouraged a pietistic national church. He died on Aug. 6, 1746.

See H. Schultz, *Danmarks Historie*, vol. iii, new ed. (1942). (F. SK.)

CHRISTIAN VII (1749–1808), king of Denmark and Norway from 1766, was born on Jan. 29, 1749, the son of Frederick V, king of Denmark, and his first consort Louise, daughter of George II of Great Britain. He became king on his father's death on Jan. 14, 1766. Poorly educated, systematically terrorized by a brutal governor and hopelessly debauched by corrupt pages, he grew up virtually a mental incompetent. After his marriage, in Oct. 1766, with Caroline Matilda (1751–75), daughter of Frederick, prince of Wales, he abandoned himself to the worst excesses. In 1768 he undertook a European tour, visiting Holland, France, Germany and England. Shortly after his return in Jan. 1769 his mental instability became complete. He became completely subservient to Count Struensee (*q.v.*) who, after the dismissal of J. H. E. Bernstorff in 1770, controlled all affairs of state. In 1772, however, Struensee was executed for adultery with the queen. Christian, who had signed the warrant for Struensee's arrest with indifference, remained king only nominally, the government being conducted by his advisers and, from 1784, by the crown prince Frederick. The divorced queen, retaining her title, went to Celle in Hanover, where she died on May 10, 1775. Christian died on March 13, 1808.

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CHRISTIAN VIII (1786–1848), king of Denmark from 1839 to 1848 who had also been king-elect of Norway in 1814, the elder son of Frederick (d. 1805), the youngest son of King Frederick V, was born at Christiansborg castle on Sept. 18, 1786. His first marriage (June 1806), with his cousin Charlotte Frederica of Mecklenburg-Schwerin, was dissolved in 1810. In May 1813 Christian became *statholder* in Norway. In Jan. 1814 Frederick VI had been compelled to cede Norway to Sweden by the treaty of Kiel, but Christian, despite opposition from a small pro-Swedish party was elected regent of Norway on Feb. 16, 1814, by an assembly of notables. This was confirmed by the constituent assembly convened at Eidsvold in April and on May 17, Christian was elected king of Norway. On June 30 representatives of Austria, Russia, England and Prussia arrived in Christiania to compel Christian to observe the treaty of Kiel, but he rejected the ultimatum and prepared for armed resistance to the Swedish forces. The Swedish crown prince Charles John (Bernadotte) easily defeated the Norwegians and the brief war ended with the treaty of Moss on Aug. 14, 1814. Christian returned to Denmark and in 1815 married his second wife, Caroline Amelia of Augustenburg. Because the government suspected him of democratic views, he withdrew from public affairs; only in 1831 did he become a member of the council of state. On Dec. 3, 1839, Christian succeeded Frederick VI as king. He disappointed the Liberals because he opposed constitutional reform; but he reduced the national debt, reformed the prisons and authorized the opening of the restored Icelandic *althing* in 1843. Yet Christian shunned precipitate social reform.

In Schleswig-Holstein Christian's vacillating policy was unpopular with Danes and Germans alike. On July 8, 1846, he promulgated an open letter whereby the Danish law of succession was declared valid in Schleswig (*see* SCHLESWIG-HOLSTEIN QUESTION) and Lauenburg. This was a main cause of the Schleswig insurrection of March 1848. Christian died at Plön on Jan. 20, 1848.

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CHRISTIAN IX (1818–1906), king of Denmark, was a younger son of William, duke of Schleswig-Holstein-Sonderburg-Beck (duke of Glücksburg from 1825; d. 1831), and Louise of Hesse-Kassel (d. 1836), granddaughter of Frederick V of Denmark. Born at Gottorp on April 8, 1818, Christian entered the army in 1835 and served against the Schleswig insurgents of 1848. In 1842 he had married Louise of Hesse-Kassel (d. 1898), the cousin of the reigning king, Frederick VII. Frederick VII, however, and his uncle and heir-presumptive Prince Ferdinand (1792–1863) were both childless; and thus the succession to the duchies of Schleswig and Holstein as well as to Denmark was precarious (*see* Schleswig-Holstein Question). The result was that, despite the possible rights of other claimants, the representatives of the great European powers meeting in London in May 1852 signed a protocol establishing Christian as heir to the kingdom and the duchies. In March 1863 Frederick VII issued a charter (approved the following September) treating Schleswig as an integral part of his kingdom. He died, however, on Nov. 15, and Christian then became king. To ratify the constitution would be a breach of the London protocol, to withhold his consent would provoke bitter opposition in Denmark. By ratifying the constitution on Nov. 18 Christian brought Denmark into conflict with the German confederation, and the war which followed ended with the separation of the duchies from Denmark on Oct. 30, 1864. In Denmark itself a struggle between the parties of the right (supported by the *landsting*) and the left (supported by the *folketing*) occupied much of the reign. For many years Christian successfully excluded the radicals from office, but in 1901 he was forced to assent to the formation of a cabinet of the left. Christian was a simple and upright man, but had no real contact with his people. He died at Copenhagen on Jan. 29, 1906.

His daughter Alexandra married Edward VII of Great Britain and by his many connections he became something of a patriarch among the ruling houses of Europe. His second son, George, had been king of the Hellenes from 1863 and his grandson Charles became king of Norway in 1905 as Haakon VII.

See H. P. B. Barfod, *Hans Majestet Kong Christian IX*, 2 vol. (1888–1906); A. Thorsøe, *Kong Christian den Niende* (1906).

CHRISTIAN X (1870–1947), king of Denmark (1912–47) and of Iceland (1918–44), was born on Sept. 26, 1870, at Charlottenlund near Copenhagen, the eldest son of the future King Frederick VIII and Louise of Sweden-Norway. Entering the army in 1889, Christian became chief of the royal guard in 1898 and a major general in 1908. Crown prince from 1906, he became king on his father's death on May 15, 1912.

In Dec. 1914 Christian attended at Malmö the first of a series of meetings held by the Scandinavian kings during World War I. On June 5, 1915, he signed an amendment to the Danish constitution which altered the electoral laws and extended the franchise to women. On Nov. 30, 1918, he signed the federal act whereby Iceland became an independent kingdom, and "king of Iceland" was incorporated into the royal title. When the act came up for review in 1944, Iceland severed all ties with Denmark and became a republic. In July 1920 Christian received an enthusiastic reception when he visited Slesvig Nord, that part of Schleswig-Holstein ceded to Denmark by the treaty of Versailles.

During World War II Christian, who remained at the head of affairs even after the German occupation of Denmark in 1940, gained much respect by his resistance to Nazi pressure. During these years he was frequently to be seen riding in the streets of Copenhagen; the royal horseman became a national symbol. However in May 1943 he was forced to make a speech against the increasing sabotage of munitions and railways. After a rebellion against the occupation forces in August, Christian was held a virtual prisoner at Sorgenfri castle and later at the palace of Amalienborg in Copenhagen until the German surrender. On May 9, 1945, he opened the free Danish parliament. He died at Amalienborg on April 20, 1947. Christian had married Alexandra of Mecklenburg-Schwerin in 1898, and their eldest son Frederick (b. 1899) succeeded him as Frederick IX.

See J. Byskov, *Christian den X's Denmark*, 2 vol. (1947–48).

CHRISTIAN of Brunswick (1599–1626), Protestant military commander, the prototype of the ruthless, ambitious and ineffectual younger son of the German dynasties in the period of the Thirty Years' War, was born on Sept. 20, 1599, at Gröningen, the residence of the bishops of Halberstadt, his father, Duke Henry Julius (d. 1613), being the Protestant administrator of the bishopric. In 1616 Christian was elected administrator in succession to his father, but his incessant quarrels with the chapter and his unruly disposition, which earned him the nickname of "Mad Christian," made him seek his fortune in military enterprises. He fought under Maurice of Orange in the Netherlands against the Spaniards and in 1621 raised an army in aid of Frederick V of the Palatinate, former king of Bohemia. He was defeated by Tilly at Höchst in Hesse on June 20, 1622, and at Stadtlohn in Westphalia on Aug. 6, 1623, but continued guerrilla warfare in Lower Saxony and the lower Rhineland, maintained by English, Dutch and French subsidies after he had renounced his bishopric. He was included in the anti-Habsburg alliance of 1625 under the leadership of Christian IV of Denmark, but died at his brother's capital, Wolfenbüttel, on June 16, 1626, without having achieved any major success in the field.

See H. von Xylander, *Herzog Christian von Braunschweig* (1926). (S. H. S.)

CHRISTIAN, WILLIAM (1608–1663), Manx politician, famous in Manx history as Illiam Dhöne ("Brown William"), the patriot martyr of a well-known ballad, was born on April 14, 1608, a son of Ewan Christian, one of the Manx deemsters. In 1648 he was appointed receiver-general by the 7th earl of Derby, lord of the Isle of Man. In 1651 Derby crossed to England to fight for Charles II, leaving Christian to command the island militia. The countess still resided in Man, and after the earl's capture at the battle of Worcester she negotiated for his release in return for the surrender of the island to the parliamentarians. Thereupon Christian headed a revolt, but he also negotiated with the parliamentarians. Soon the island was in the power of Col. Robert Duckenfield who in Oct. 1651 had brought over a parliamentary fleet. The countess had to surrender her two fortresses, Castle Rushen and Peel castle. Christian was appointed governor of the island in 1656. Two years later, accused of misappropriating money, he fled to England, but in 1660 he was arrested in London for debt and imprisoned for 12 months. On his release, hoping to benefit under the Act of Indemnity of 1661, he returned to Man. In spite of the act, Charles, the new earl of Derby, ordered his seizure. The deemsters were induced to pass sentence upon him, and Christian was shot at Hango hill on Jan. 2, 1663. This arbitrary act angered Charles II; the deemsters were punished, and some reparation was made to Christian's family. Christian is chiefly celebrated through the ballad *Boase Illiam Dhöne*, which was translated into English by George Borrow, and through the reference to him in Sir Walter Scott's *Peveril of the Peak*.

See A. W. Moore, *History of the Isle of Man*, vol. i (1900). (S. R. Bt.)

CHRISTIAN BROTHERS: *see* Christian Brothers of Ireland; Christian Schools, Brothers of the.

CHRISTIAN BROTHERS OF IRELAND (in full, Brothers of the Christian Schools of Ireland; Fratres Scholarum Christianarum de Hibernia; F.S.C.H.), a Roman Catholic teaching congregation founded in 1802 in Waterford, Ire., by Edmund Ignatius Rice, a merchant. Rice was inspired to establish his order to serve the needs of poor Catholic boys, the English laws of the period prohibiting the establishment of Catholic schools. Between 1802 and 1820 Rice succeeded in opening a number of primary schools in the larger cities of Ireland, and in the latter year the Holy See by apostolic brief constituted his little band of workers into a religious institute; the Christian Brothers were the first Irish order of men formally approved by a charter from Rome.

There are about 3,500 brothers in 14 countries teaching 150,000 boys and young men in academic, commercial and industrial schools and colleges; the brothers also conduct orphanages and institutions for the deaf and blind. The government of the order is vested in a superior-general who is assisted by four brothers constituting a general council. Each province is governed by a brother provincial who is assisted by four brothers forming a provincial council. The brothers were established in the United States in 1906 in New York city. The home of the congregation is in Dublin. (D. T. R.)

CHRISTIAN CATHOLIC CHURCH, the name assumed by a religious organization founded at Zion City near Chicago, Ill., in 1896, by John Alexander Dowie. *See* DOWIE, JOHN ALEXANDER.

CHRISTIAN CHURCH, EARLY: *see* EARLY CHRISTIAN CHURCH.

CHRISTIAN DEMOCRATIC PARTIES. The first modern Christian political parties arose out of conflicts over church and state. They appeared in the 19th century among Protestants in the Netherlands and among Catholics in Germany, Belgium, Switzerland and the Netherlands. Their chief aim was to defend the freedom of the church and the rights of Christian parents in the schools against attacks by Liberals, Nationalists and, later, Socialists. Without this direct challenge to religious interests, parties on a specifically Christian basis would probably not have arisen. From about 1880 the accent in European politics shifted toward social reform. Socialist movements provided much of the initial drive, but in most European countries they adopted doctrines of materialism to which Christians could not subscribe. Where this happened the Christians set up their own social movements—trade unions, farmers', youth and women's movements—which soon reinforced the Christian political parties.

After World War I parties began to base their appeal less exclusively on church issues and more on the common interest of citizens in politics and social welfare. Parties founded in this period, such as the Parti Démocrate Populaire in France (1924; forerunner of the Mouvement Républicain Populaire [M.R.P.] founded in 1944) or the Partito Popolare in Italy (1919; dissolved by the Fascists in 1926; restored in 1944 as Partito Democratico Cristiano), had this new orientation from the start, and the older parties were converted to it. This evolution was completed by the end of World War II. The predominantly Catholic German party, founded in 1870 and known as Zentrum, dissolved itself "voluntarily" in 1933. The Christlich-Demokratische Union, formed in western Germany in 1946, grouped Catholics and Protestants alike.

On their revival after World War II several parties took the opportunity to revise their constitutions to fit the new aims: some also changed their names. At the same time they became more aware of problems such as European unity or aid to less-developed areas, and co-operated more with one another. Their programs, though varying in detail, start from agreed general principles. Christian Democracy is:

(1) Personalist. Policy should "lead to the fullest development of the greatest possible number of personalities" (from the program of the Parti Chrétien Social of Belgium), through both individual and collective action: personalism is not individualism.

(2) Pluralist, in two senses. First, policy should respect the existence of different "spiritual families": Catholic, Protestant, Jewish, Muslim, humanist. These can and should enjoy equal political and social rights, being free to develop in their own way so long as they respect the similar rights of others. Secondly, to offer the best chance for the growth of human personality, the social structure should be federal. The Christian Democrats support the idea of a welfare state, but understood as an educational state, which helps and trains its citizens to provide for their own needs, rather than an executive state which provides for them directly itself. Individuals and small groups are to be given all the responsibility they can take, but must also act as members of larger groups: the family as a member of the local community and, ultimately, the state as a member of an international community. The Christian Democrats support federation or confederation in Europe and Latin America.

(3) Conservative though not traditionalist. The Christian Democrats call for large changes and are not specially attached to the past. But they stress growth and continuity and oppose revolutionary change.

(4) Christian Democrats also support an open society based on competition and political and social democracy, where policy is based on a "common estimate" arrived at after full discussion. But they insist that direction and economic planning are needed to build the framework for such a society.

(5) Though agreeing that economic policy is basic, the Christian Democrats insist that it should not be stressed at the expense of political and especially cultural policy.

Many of the antagonisms that once separated Christian Democrats from Liberals and Socialists have died down. The Christian Democratic parties often co-operate with these groups, and with them resist antidemocratic forces of the right and left.

After World War II Christian Democratic parties held a majority or close to a majority in the parliaments of the German Federal Republic, Italy, the Netherlands, Belgium and Austria. They were influential in the parliaments of France, Switzerland and Luxembourg. In Latin America Christian Democratic parties, though mostly small, grew in strength after 1945. Christian Democratic political movements existed also in Poland, Hungary, Czechoslovakia and the Baltic states until the Communist dictatorship, and in Spain until Gen. Francisco Franco's victory in the civil war, and were carried on by citizens of these countries in exile. The western European parties and the eastern European exile movements were represented in the so-called Nouvelles Equipes Internationales (founded 1947; headquarters Paris). The Latin-American parties set up in 1949 a Christian Democratic Organization of America. An International Union of Young Christian Democrats was founded in 1948. A first world convention of Christian Democratic movements was held in 1956 and a second in 1958, and an Inter-Continental Committee of Christian Democracy was established.

Most Christian Democratic parties used "Christian" in their titles. A few, especially the Catholic People's party in the Netherlands, still used denominational titles. One, the French M.R.P., did not refer to Christianity in either its title or its statutes. Support came mainly from practising Catholics and Protestants. Protestant support was strongest in the Netherlands and the German Federal Republic, while the Christian Democratic party in Norway was almost entirely Protestant. In the Netherlands, Protestants voted for their own two parties, in Germany for the same party as Catholics. Party constitutions were drawn so as to open membership not only to practising Catholics and Protestants but to members of other religions and to humanists or nominal Christians. Support from sources other than practising Catholics and Protestants was small but not negligible.

Support was drawn more evenly than in other parties from different social classes, thanks partly to the religious factor and partly to the wide influence of the Christian Democratic social movements. There was generally no formal link between these movements and the political parties, but there was informal consultation and mutual aid. The parties were all independent of church authorities, but here too there was often informal co-operation. Until after World War I the division of spheres between churches and parties was not clear. In several countries this gave rise to disputes. Such disputes became rarer after 1945 but they did occur, especially in Italy and the Netherlands.

See M. P. Fogarty, *Christian Democracy in Western Europe, 1820–1953* (1957), with a full bibliography; Mario Einaudi and François Goguel-Nyegaard, *Christian Democracy in Italy and France* (1952). (M. P. F.)

CHRISTIAN FLAG. There is no one official flag of all Christian churches. By common usage, however, a so-called Christian flag came to be recognized by a number of churches. It consists of a white rectangular field with a blue rectangle in the upper corner at the mast side which contains a red Latin cross. C. C. Overton, a New York Sunday school superintendent, has been credited with designing this flag in 1897. Overton selected white to signify purity; blue, courage; and the red cross, sacrifice. Other designs incorporating the cross have been officially adopted by various churches.

CHRISTIAN INSTRUCTION, BROTHERS OF (LA MENNAIS BROTHERS; INSTITUTUM FRATRUM INSTRUCTIONIS CHRISTIANAE; F.I.C.), a Roman Catholic lay congregation of religious founded in Brittany in 1817 by J. M. R. de La Mennais (brother of H. F. R. de La Mennais) and Gabriel Deshayes. They number about 2,200 members, whose main work is teaching. They operate colleges, high schools and elementary schools in Europe, North and South America, Africa and Asia. The administrative centre of the community, originally in Ploërmel, France, was transferred in 1903 to the Island of Jersey; U.S. headquarters are in Alfred, Me. (Ro.)

CHRISTIANITY, the religion that traces its origins to Jesus of Nazareth, whom it affirms to be the chosen one (Christ) of God.

Christianity is the religion of one-third of the population of the earth. Nearly 1,000,000,000 human beings are identified in some way or other with the Christian movement, half of them in Europe and most of the rest in North and South America. Despite its representation and support in many lands, therefore, Christianity is principally a western phenomenon. Yet the influence of Christianity extends beyond the borders of Christendom. It has affected other religions, as it has been affected by them, and its ethos continues to shape the characters of individuals and nations that no longer live by its creed. Even Communism, its bitterest enemy and most formidable rival in the 20th century, has been called "a Christian heresy," which, even while it rejects the fundamental tenets of the Christian faith, rejects them in a manner and with a passion that owe much to Christian sources.

As one of the chief forces in the history of mankind, Christianity needs to be examined historically, for only thus is it possible to grasp the extent of its influence or become aware of its pervasive power. One section of this article will therefore be a brief survey of the history of Christianity. In the contemporary world, moreover, Christianity continues to form the lives of men and of entire cultures by its precepts. Hence a survey of its history must be followed by an examination of its present state—its major divisions, their relative size, their distinctive features and their peculiar doctrines and practices. That examination will constitute a second section of this article. Still Christianity is more than a force in human history or a powerful contemporary movement. It claims to be an interpretation of the world and of human life that makes sense of them in the light of divine revelation. Hazardous though such an undertaking must be in a divided Christendom and in a secularized culture, a description of this Christian claim belongs in such an article as this. The third chief part of this article will give an account of Christianity as a way of belief, as a way of worship and as a way of life; thus it will attempt to state the meaning of Christianity as this meaning is shared and debated by its various proponents.

No proponent—whether of a religion or of a political, social or aesthetic system of values—can attain complete objectivity in his portrayal of something in which he believes passionately and with conviction. But the "objectivity" of the outside observer frequently fails to grasp or to explain the power by which a religion is able to elicit loyalty and trust from its adherents. The scholarly interpretation of Christianity, if it is to be both sensitive to that power and reasonably objective in its method, must proceed from within the circle of the Christian movement and still pay serious attention to the criticisms and insights of those "outsiders" whose rejection of Christianity is based not upon trivial objections but upon an understanding of its ultimate claims. Such has been the method at work in the composition of this article.

HISTORY OF CHRISTIANITY

Christianity begins with Jesus Christ. The effects of his life, the response to his teachings and the experience of his death and resurrection were the beginnings of the Christian community; for a more detailed account of these beginnings the reader is referred to the article Jesus Christ and to the problems discussed there. When the apostle Peter is represented in the New Testament as confessing that Jesus is "the Christ, the Son of the living God," he speaks for the Christianity of all ages. And it is in response to this confession that Jesus is described as announcing the foundation of the Christian church: "You are Peter, and on this rock I will build my church, and the powers of death shall not prevail against it."

Early Christianity

Jesus was a Jew, as were all the apostles. Thus the earliest Christianity is in fact a movement within Judaism; the very acknowledgment of Jesus as "the Christ" means the confession that he is the fulfillment of the promises originally made to Abraham, Isaac and Jacob. But the Christian gospel encountered opposition within Judaism, just as Jesus had, and soon it turned toward the gentile world. Ideologically, this required Christian thought to define the gospel as both the correction and the fulfillment of Greek and Roman philosophy. This definition was the assignment of the Christian apologists of the first three centuries (*see* Apologists, Early Christian). Politically, the Christian expansion into the world of Greco-Roman paganism and its rejection of such religious practices as the worship of Caesar brought upon the early Christians the suspicion of their fellow citizens and even persecution by the Roman authorities. Nevertheless, Christian churches continued to arise in many portions of the Roman empire, attracting Romans of every social class.

The inward growth of the Christian community matched this outward growth in numbers and prestige. Christians celebrated and shared the grace and power given in Christ by participating in the rites he had instituted, especially baptism and the Eucharist. They recited the events of his life, exhorting, teaching and urging one another to prepare for his coming again, which they apparently hoped to see very soon. In this hope they set themselves consciously apart from the way of life that characterized "the world" in its terminal stages. As the company of those who were chosen by God in the last days of the world, the early Christians were bound together by ties of mutual love and concern. "See how they love one another!" is said to have been the reaction of pagans to the evidence of this mutual concern.

Neither the Christian remembrance of the acts of God in Christ nor the Christian practice of mutual love, however, took place in a vacuum. From the very outset the Christian community was a community of structure. Its remembrance and celebration followed a pattern that was indeed fluid in some of its details but was nonetheless fixed in its basic outline. Similarly, the office of the apostles, traced by the primitive church to the ordinance of the risen Christ himself, was the basis for the earliest structures of administrative and pastoral organization. And the collections of the sayings and deeds of Jesus were combined with the writings of the apostles to form a body of Christian sacred writings. From these primitive structures emerged the threefold system of apostolic authority in bishop, creed and biblical canon, with which the early church met the challenge of preserving its continuity despite the death of the apostles and the postponement of the Lord's return.

Even in these early centuries the Christian movement was plagued by heresy and torn by strife. The New Testament itself bears marks of the strife provoked by early exponents of a Christian Gnosticism (*q.v.*), who bent the gospel into conformity with their theories of sin and salvation. But the flowering of the Gnostic heresy within Christianity occurred during the 2nd century, when Basilides and Valentinus (*qq.v.*) arose to claim that true apostolic Christianity had been transmitted secretly to them and their followers rather than to the church, with its bishops and scriptures. Though differing from these Gnostics in significant ways, Marcion (*q.v.*) also purported to be the restorer of apostolic, especially Pauline, doctrine and practice. Claiming that the church had forsaken the pristine holiness of the apostles and had become too worldly, Montanism (*q.v.*) asserted that the promise of the "counselor" given in the last discourses of Jesus in St. John had been fulfilled in the life and teachings of the prophet Montanus.

The crystallization of bishop, creed and canon as the triple norm of apostolic Christianity was accentuated, if not actually hastened, by the need for a definition of orthodoxy against these heresies and schisms. As it resisted both a syncretism that would have absorbed it into a universal world-religion (Gnosticism) and a particularism that would have restricted it to the select few (Montanism), Christianity asserted that it was catholic, or universal, in its message and appeal. It was, of course, catholic in principle long before it became catholic in fact. The gospel of a Saviour who had died for the entire world; a message communicated in the Koine or common Greek that had become the universal literary language of the empire; a polity that co-ordinated local responsibility with ecumenical concern, especially through the growing prestige of the bishop in the capital city of the Roman *oikoumene;* a participation in the spirit of Greco-Roman classicism that nevertheless remained open to both the ancient oriental and the new Germanic cultures—these features characterized the Christianity of the first three centuries as "catholic"—*i.e.*, as possessing identity plus universality.

Little is recorded about the Christians of these centuries; both their number and their names remain largely unknown. Those whose names have become part of the historical record are the bishops, heretics and saints—these categories are not mutually exclusive—who attracted more than the usual attention in their own time and thus became the spokesmen to later times for the silent in the land. Thus Tertullian (*q.v.*), who died about 220, has come to epitomize the radical No spoken by the church to the world and its culture, as Clement of Alexandria (*q.v.*), who died in almost the same year, and Origen (*q.v.*), who died about 254, are the recurring symbols of the Christian conviction that Christ is "the desire of all nations" and the answer to the quest of the philosophers. In the thought of Irenaeus (*q.v.;* d. *c.* 200) the Christianity of the 2nd century produced a system that summarized many of its fundamental beliefs about the renewal and redemption accomplished in Christ. From the history of the use of these names it is clear how easily they can all become clichés, but behind the clichés is the struggle of Christianity during the first three centuries of its history to be faithful to the deposit of its faith and relevant to its world, and to be both at the same time. *See* also EARLY CHRISTIAN CHURCH.

ESTABLISHED CHRISTIANITY

How long that struggle might have continued is a matter of conjecture, for in the first decades of the 4th century Christianity received a boon that altered its history: toleration, recognition and eventually establishment, by the state. The emperor Constantine I the Great, for what appears to have been a mixture of personal and political motives, identified himself with the Christian movement (*see* CONSTANTINE). Except for a brief revival of paganism under Julian (*q.v.*), who died in 363, a Christianity of some sort, whether orthodox or heretical, was the religion of the Roman emperors thereafter, as it was of the Germanic tribes who eventually displaced the empire. So it was that after Rome had "fallen" Christianity preserved many of the values of Rome and thus provided later centuries with a link to classical culture.

Christian Dogma, Theology, Institutions.—Acceptance of Christianity by the Roman emperors helped to make possible the establishment of a general council as a means for adjudicating controversies in the areas of doctrine and discipline (*see* COUNCIL). Out of the decisions of the councils in the 4th, 5th and 6th centuries came the classical Christian dogmas of the Trinity and the Person of Christ, which have been the criterion of Christian orthodoxy ever since. (For the history of these dogmas *see* JESUS CHRIST; TRINITY.) Christianity thus acquired an intellectual formulation that befitted its new status as the dominant religious force in the Mediterranean world. It acquired theological spokesmen also, whose speculations and systematizations, based upon Scripture and dogma, created the vocabulary and set the style for a Christian culture. Most prominent among these theologians in the west was Augustine, whose *City of God* summarized the case for Christianity against a moribund paganism, and whose treatise *On the Trinity* combined fidelity to authority with philosophical reflection into a new synthesis (*see* AUGUSTINE, SAINT, of Hippo). The Greek-speaking portions of the church were more richly endowed with theological leaders than was the Christian west. Athanasius (*q.v.*) defended the full deity of Christ against the Arians. Basil, Gregory of Nyssa and Gregory of Naziansus (*qq.v.*), "the Cappadocian Fathers," refined and expanded the teachings of Athanasius into a more complete doctrine of the Trinity. (*See* also FATHERS OF THE CHURCH.) During the 5th and 6th centuries the theological parties at Antioch and Alexandria, building on the foundation of the doctrine of the Trinity, contributed to the development of the doctrine of the two natures in the person of Christ.

As Christianity in both east and west was coming to terms with the empire, monasticism (*q.v.*) arose as a way to express the continuing separation of the church from the world. The figure of Anthony the hermit, dramatically described by Athanasius, represented the Christianization of an asceticism that had been at work in Egypt even before the coming of the gospel. A second stage in the development of monasticism was the rise of the communal or cenobitic form of the monastic life and the establishment of monasteries and convents, first in the eastern section of the church through the work of Pachomius and then much later (6th century) in the western portion through the work of Benedict of Nursia. Instituted as a means of denying the world, monasticism became, through its role in the missionary enterprise and through its educational work, one of the principal means by which Christianity conquered the world. Another factor in that conquest of classical culture by the mission and expansion of Christianity was the growth in the prestige and power of the bishop of Rome. (For a detailed account of this development *see* PAPACY.) Pope Leo I the Great (d. 461) made the primacy of the Roman bishop explicit both in theory and in practice and must be counted as one of the most important figures in the history of the centralization of authority in the church (*see* LEO). The next such figure was Gregory I the Great (*see* GREGORY), pope from 590 to 604, whose work shaped the worship, the thought and the structure of the church as well as its temporal wealth and power.

Byzantine Christianity.—Still a part of the universal church but increasingly isolated from the west by differences of language, culture, politics and religion, Byzantine Christianity followed its own course in the shaping of the heritage of the primitive church. The eastern churches never became as centralized in their polity as did the church in the west, but developed the principle of the relative independence or "autocephaly" of each national church. During the centuries when western culture was striving to domesticate the German tribes, Constantinople, probably the most civilized city in Christendom, blended classical and Christian elements with a refinement that expressed itself in philosophy, the arts, statecraft, jurisprudence and scholarship. A thinker such as Michael Psellus in the 11th century, who worked in several of these fields, epitomizes this synthesis. It was from Byzantine rather than from Roman missionaries that most of the Slavic tribes received Christianity; Byzantium was also the victim of Muslim aggressions throughout the period known in the west as the middle ages. Following the pattern established by the emperors Constantine and Justinian, the relation between church and state in the Byzantine empire co-ordinated the two in such a way as often to subject the life and even the teaching of the church to the decisions of the temporal ruler—the phenomenon often termed "Caesaropapism."

All these differences between the eastern and the western parts of the church, both the religious differences and those that were largely cultural or political, came together to cause the schism between the two. It is not easy to date this schism, for the alienation between west and east erupted several times: in the 9th century through conflict over the mission to the Slavs; in the 11th century as a contest over rank and authority; in the 13th century with great vehemence in the Christian sack of Constantinople and the establishment of the Latin patriarchate there; in the 15th century after the failure of the union of Florence and after the fall of Constantinople to the Turks (*see* also BYZANTINE EMPIRE). Whatever the date, the two divisions of the church have been separated, both in spirit and in fact, for about half of Christian history, more than twice as long as Protestantism and Roman Catholicism.

Papacy and Empire.—Conflict with the east was both a cause and an effect of the distinctive development of western Christianity during the middle ages. If Popes Leo I and Gregory I may be styled the architects of the medieval papacy, Popes Gregory VII (d. 1085) and Innocent III (d. 1216) should be called its master builders. Gregory VII reformed both the church and the papacy from within, establishing the canonical and moral authority of the papal office when it was threatened by corruption and attack; Innocent III made the papal claims to universality an ecclesiastical and political fact, exercising his authority at all levels of the life of the church in the 13th century. Significantly, both these popes were obliged to defend the papacy against the Holy Roman empire and other temporal rulers. The battle between the church and the empire is a persistent theme in the history of medieval Christianity. Both the involvement of the church in feudalism and the participation of temporal rulers in the crusades can be read as variations on this theme. Preoccupied as they often are with the history of the church as an institution and with the life and thought of the leaders of the church, the documentary sources of knowledge about medieval Christianity make it difficult for the historian to descry "the religion of the common man" during this period. Both the "age of faith" depicted by Neo-Gothic romanticism and the "dark ages" depicted by secularist and Protestant polemics are a gross oversimplification of history. Faith there was during the middle ages, and intellectual darkness and superstition too; but only that historical judgment of medieval Christianity is valid that discerns how subtly faith and superstition can be blended in the piety and thought of medieval (and of modern) men.

Medieval Thought.—No product of medieval Christianity has been more influential in the centuries since the middle ages than medieval thought, particularly the philosophy and theology of scholasticism (*q.v.*), whose outstanding exponent was Thomas Aquinas (d. 1274). The theology of scholasticism was an effort to harmonize the doctrinal traditions inherited from the Fathers of the early church and to relate these traditions to the intellectual achievements of classical antiquity. Because many of the early Fathers both in the east and in the west had developed their theologies under the influence of Platonic modes of thought, the reinterpretation of these theologies by scholasticism required that the doctrinal content of the tradition be disengaged from the metaphysical assumptions of Platonism. For this purpose the recovery of Aristotle—first through the influence of Aristotelian philosophers and theologians among the Muslims, eventually, with some help from Byzantium, through translation and study of the authentic texts of Aristotle himself—seemed providential to the scholastic theologians. Because it managed to combine a fidelity to Scripture and tradition with a positive, though critical, attitude toward the "natural" mind, scholasticism is a landmark both in the history of Christianity and in the history of western culture. Very few theological systems have managed to play this dual role, which can be a symbol (depending upon one's own position) either of the Christianization of society and culture or of the betrayal of Christianity to the society and culture of the middle ages. (*See* also AVERROISM, LATIN.)

Reformation.—The latter interpretation of scholasticism and of the medieval church itself animated the Protestant Reformation (*see* REFORMATION). Protestantism differed from the various protest movements during the later middle ages by the thoroughness of its polemic against the ecclesiastical, theological and sacramental developments of western Catholicism. Initially the Protestant Reformers maintained the hope that they could accomplish the reformation of the doctrine and life of the church from within, but this proved impossible (again depending upon one's position) either because of the intransigency of the church or because of the extremism of the Protestant movements or because of the political and cultural situation. The several parties of the Reformation may be conveniently classified according to the radicalism of their protest against medieval theology, piety and polity. The Anglican Reformers, as well as Martin Luther (*q.v.*) and his movement, were, in general, the most conservative in their treatment of the Catholic tradition; John Calvin and his followers were less conservative; the Anabaptists and other groups in the left wing of the Reformation were least conservative of all (*see* CALVINISM; REFORMED CHURCHES; ANABAPTISTS). Despite their deep differences, the various Reformation movements were almost all characterized by an emphasis upon the Bible, as distinguished from the church or its tradition, as the authority in religion; by an insistence upon the sovereignty of free grace in the forgiveness of sins; by a stress upon faith alone, without works, as the precondition of acceptance with God; and by the demand that the laity assume a more significant place in both the work and the worship of the church.

The Reformation was launched as a movement within the established Christianity that had prevailed since Constantine. It envisaged neither schism within the church nor the dissolution of the Christian culture that had developed for more than a millennium. But when the Reformation was over, both the church and the culture had been radically transformed. In part this transformation was the consequence of the Reformation, in part it was the accompaniment of the Reformation. The voyages of discovery, the beginnings of a capitalistic economy, the rise of modern nationalism, the dawn of the scientific age, the culture of the Renaissance—all these factors, and others besides, helped to break up the "medieval synthesis." Among these factors, however, the Reformation was one of the most important, and certainly for the history of Christianity the most significant. For the consequences of the Reformation, not in intention but in fact, were a divided Christendom and a secularized west. Roman Catholicism, no less than Protestantism, has developed historically in the modern world as an effort to adapt historic forms to the implications of these consequences. Established Christianity, as it had been known in the west since the 4th century, ended after the Reformation, though not all at once.

MODERN CHRISTIANITY

Paradoxically, the end of "established Christianity" in the old sense resulted in the most rapid and most widespread expansion in the history of the church. The Christianization of the Americas and the evangelization of Asia, Africa and Australasia have given geographical substance to the Christian title "ecumenical." Growth in areas and in numbers, however, need not be equivalent to growth in influence. Despite its continuing strength throughout the modern period, Christianity has retreated on many fronts and has lost much of its prestige and authority.

During the formative period of modern western history, roughly from the beginning of the 16th to the middle of the 18th century, Christianity participated in many of the movements of cultural and political expansion. The explorers of the new world were followed closely by missionaries—that is, when the two were not in fact identical. Protestant and Roman Catholic clergymen were prominent in politics, letters and science. Although the rationalism of the Enlightenment (*q.v.*) alienated many people from the Christian faith, especially among the intellectuals of the 17th and 18th centuries, those who were alienated often kept a loyalty to the figure of Jesus or to the teachings of the Bible even when they broke with traditional forms of Christian doctrine and life. Citing the theological conflicts of the Reformation and the political conflicts that followed upon these as evidence of the dangers of religious intolerance, representatives of the Enlightenment gradually introduced disestablishment, toleration and religious liberty into most western countries; in this movement they were joined by various Christian individuals and groups that advocated religious freedom not out of indifference to dogmatic truth but out of a concern for the free decision of personal faith.

The state of Christian faith and life within the churches during the 17th and 18th centuries both reflected and resisted the spirit of the time. Even though the Protestant Reformation had absorbed some of the reformatory energy within Roman Catholicism, the theology and morals of the church underwent serious revision in the Catholic Counter-Reformation (*see* ROMAN CATHOLIC CHURCH: *Reform and Definition*). Fighting off the attempts by various countries to establish national Catholic churches, the papacy sought to learn from the history of the Reformation and to avoid the mistakes that had been made then. Protestantism discovered that separation from Rome did not necessarily inoculate it against many of the trends it had denounced in Roman Catholicism. The confessional orthodoxy of the 17th century both in Lutheranism and in the Reformed Churches displayed many features of medieval scholasticism, despite the attacks of the Reformers upon the latter. Partly as a compensation for the over-emphasis of orthodoxy upon doctrine at the expense of morals, Pietism (*q.v.*) summoned Protestant believers to greater seriousness of faith and purpose. Valid though its summons was, Pietism unwittingly played into the hands of its enemies, helping to make it possible for the rationalism of the Enlightenment to undermine traditional Christian belief.

In alliance with the spirit of the Enlightenment, the revolutions of the 18th, 19th and 20th century aided this process of undermining. Roman Catholicism in France, Eastern Orthodoxy in Russia and Protestantism in former European colonies in Africa were identified—by their enemies if not also by themselves—as part of the *ancien régime* and were nearly swept away with it. As the discoveries of science proceeded, they clashed with old and cherished notions about the universe and about man, many of which were passionately supported by various leaders of organized Christianity. The age of the revolutions—political, economic, technological, intellectual—was an age of crisis for Christianity. It was also an age of opportunity. The critical methods of modern scholarship, despite their frequent attacks upon traditional Christian ideas, helped to produce editions of the chief documents of the Christian faith, the Bible and the writings of the Fathers and Reformers, and to arouse an unprecedented interest in the history of the church. The 19th century has been called the great century in the history of Christian missions, both Roman Catholic and Protestant (*see* MISSIONS). By the very force of their attacks upon Christianity the critics of the church helped to arouse within the church new apologists for the faith, who creatively reinterpreted it in relation to the new philosophy and science of the modern period. The 20th century saw additional challenges to the Christian cause in the form of Communism and of resurgent world religions. Both the relation of church and state and the missionary program of the churches thus demanded reconsideration. But the 20th century also saw renewed efforts to heal the schisms within Christendom. The ecumenical movement began within Protestantism and Anglicanism, eventually included some of the Orthodox Eastern churches, and began to engage the sympathetic attention of Roman Catholicism as well (*see* ECUMENICAL MOVEMENT).

From the history of Christianity both the critics and the adherents of the Christian movement could derive support for their ideas. To the critics of Christianity its history could prove that Christian faith was tied inseparably to world views that had been outmoded by modern discoveries and that therefore the churches were living fossils, doomed to become extinct as the full implications of science dawned upon an increasing number of believers. To the adherents of Christianity its history could prove the almost infinite adaptability of the Christian faith to a great diversity of societies, cultures and philosophies, as well as its ability to convey the grace of God to men of every social station and cultural background. Yet Christianity is not simply an important element of the history of western culture. It continues to claim the faith and the obedience of hundreds of millions. Therefore even so cursory a survey of Christianity as this article must deal also with the present state of the Christian movement.

PRESENT STATE OF CHRISTENDOM

A map of the religions of the world at the middle of the 20th century would have revealed that Christianity was the most widely disseminated faith on earth. Virtually no nation has remained unaffected by Christian missions, although in many countries Christians are only a small fraction of the total population. Most of the countries of Asia and of Africa have Christian minorities, some of these, as in India, numbering several million. Yet such a map would show the concentration of Christians in the domain of European or "western" culture. It would also give visual representation to the divisions within Christendom. Each major denomination is treated in a separate article in this encyclopaedia, where its history, tenets and practices receive a fuller exposition than this article can give them and where a bibliography on the denomination is supplied. The purpose here is to provide an overview of the principal divisions and thus to set the articles about the individual traditions into their proper context.

ROMAN CATHOLICISM

The Roman Catholics in the world probably outnumber all other Christians combined. They are organized in an intricate system that spans the life of the church from the local parish to the papacy. Under the central authority of the papacy, the church is divided into dioceses, whose bishops act in the name and by the authority of the pope but retain considerable administrative freedom within their individual jurisdictions. Similarly, the parish priest stands as the executor of papal and diocesan directives. Alongside the diocesan organization and interacting with it is a chain of orders, congregations and societies; all of them are, of course, subject to the pope, but they are not as directly responsible to the bishop as are the local parishes. It would, however, be a mistake to interpret the polity of the Roman Catholic Church in so purely an organizational a manner as this. For Roman Catholic polity rests upon a mandate that is traced to the action of Jesus Christ himself, when he invested Peter, and through Peter his successors, with the power of the keys in the church. Christ is the invisible head of his church, and by his authority the pope is the visible head.

This interpretation of the origin and authority of the church determines both the attitude of Roman Catholicism to the rest of Christendom and its relation to the social order. Believing itself to be the true church of Jesus Christ on earth, it cannot deal with other Christian traditions as equals without betraying its very identity. This does not mean, however, that anyone outside the visible fellowship of the Roman Catholic Church cannot be saved; nor does it preclude the presence of "vestiges of the church" in the other Christian bodies. During the 20th century the Roman Catholic Church has increasingly concerned itself with its "separated brethren" both in Eastern Orthodoxy and in the several Protestant churches. Thus the ecumenical movement has evoked interest not only in the Protestant groups with which it began but in Orthodoxy and Roman Catholicism as well. As the true church of Christ on earth, Roman Catholicism also believes itself responsible for the proclamation of the will of God to organized society and to the state. This role has brought the church into conflict with the state throughout church history. Yet the political activities of individual churchmen, of whom Richelieu and Mazarin are good illustrations, must not be confused with the fundamental obligation of the church, as the divinely ordained society to which the revelation of God has been entrusted, to address the meaning of that revelation and of the moral law to the nations and to work for a social and political order in which both revelation and the moral law can function.

Both in democratic and in totalitarian societies during the 20th century, the relation of the Roman Catholic Church to the state continued to engage the attention of political leaders and of prelates and theologians.

Doctrine.—The understanding that Roman Catholicism has of itself, its interpretation of the proper relation between the church and the state and its attitude to other Christian traditions are all based upon Roman Catholic doctrine. In great measure this doctrine is identical with that confessed by orthodox Christians of every label, and consists of the Bible, the dogmatic heritage of the ancient church as laid down in the historic creeds (*see* CREED) and in the decrees of the ecumenical councils, and the theological work of the great doctors of the faith in east and west. If, therefore, the presentation of the other Christian traditions in this article compares them with Roman Catholicism, this comparison has a descriptive rather than a normative function; for to a considerable degree, Protestantism and Eastern Orthodoxy have defined themselves in relation to Roman Catholicism. In addition, as the final section of this article will attempt to show, most Christians past and present do have a shared body of beliefs about God, Christ and the way of salvation.

Roman Catholic doctrine is more than this shared body of beliefs, as is the doctrine of each of the Christian groups. It is necessary here to mention only the three distinctive doctrines that have achieved definitive formulation during the 19th and 20th centuries: the infallibility of the pope, the immaculate conception and bodily assumption of the Virgin Mary (*see* INFALLIBILITY; IM-

MACULATE CONCEPTION; ASSUMPTION, FEAST OF THE). On most other major issues of Christian doctrine, Roman Catholicism and Eastern Orthodoxy are largely in agreement, while Protestantism differs from both Eastern Orthodoxy and Roman Catholicism on several of these. For example, Roman Catholic theology defines and numbers the sacraments differently from Orthodox theology; but over against Protestantism, Roman Catholic doctrine insists upon the centrality of the seven sacraments—baptism, confirmation, penance, Eucharist, extreme unction *(qq.v.)*, matrimony and holy orders—as channels of divine grace.

Liturgy.—The Roman Catholic doctrine of the sacraments is a summary, in liturgical form, of that which is affirmed by Roman Catholic liturgy. The church is not merely an organization, nor is it a school of doctrine. It is the place where God and man meet, as God approaches man through grace and man approaches God through worship. Hence the focus of Roman Catholic piety is the Eucharist, which is both a sacrament and a sacrifice. Other forms of corporate worship and of private devotion radiate from this point of central focus. The obligations of church membership are also derived from the sacramental system, either as preparations for worthy participation in it or as expressions of the obedience sustained by it. Instruction in these obligations and in the implication of the faith for the moral and intellectual life is the responsibility of Roman Catholic educational institutions all over the world, which, despite the low educational level of the church in many cultures, surpass any other system of schools in Christian history both in size and in the academic excellence of their finest products. The missions of the church and its institutions of mercy, like the schools, are largely in the hands of religious orders; orders of men are listed in the article ORDERS AND CONGREGATIONS, RELIGIOUS, and the major orders of men and women are described in individual articles; orders of nuns and sisters are discussed generally in WOMEN'S RELIGIOUS ORDERS. *See* also ROMAN CATHOLIC CHURCH.

CHURCHES OF EASTERN CHRISTENDOM

Roughly 150,000,000 Christians belong to the various Christian traditions of the east. Separated from the west, the Orthodox churches of the east have developed their own way for half of Christian history. Each national church is autonomous. The "ecumenical patriarch" of Constantinople is not the eastern pope but merely the first in honour among equals in jurisdiction. Eastern Orthodoxy interprets the primacy of Peter, and therefore that of the pope, similarly, denying the right of the pope to speak and act for the entire church by himself, without a church council and without his episcopal colleagues. Because of this polity Eastern Orthodoxy has identified itself more intimately with national cultures and with national regimes than has Roman Catholicism. Therefore the history of church-state relations in the east has been very different from the western development, because the church in the east has sometimes tended toward the extreme of becoming a mere instrument of national policy while the church in the west has sometimes tended toward the extreme of attempting to dominate the state. The history of ecumenical relations between Eastern Orthodoxy and Protestantism during the 20th century was also different from the history of Protestant-Roman Catholic relations. While keeping alive their prayer for an eventual healing of the east-west schism, the Orthodox churches have established communion with Anglicanism and with the Old Catholic Church and have participated in the conferences and organizations of the World Council of Churches *(q.v.)*.

Doctrinal authority for Eastern Orthodoxy resides in the Scriptures, the ancient creeds, the decrees of the first seven ecumenical councils and the tradition of the church. The scope and content of this tradition are not specified; hence it is not always easy to discover just what the Eastern Orthodox churches teach on a particular doctrinal question. In addition to the two issues mentioned in the discussion of Roman Catholicism above, the chief dogmatic difference between Roman Catholic and Eastern Orthodox thought is on the question of the procession of the Holy Spirit *(q.v.)* from the Father and Son, the so-called *filioque*.

But "orthodoxy," in the eastern use of the term, means primarily not a species of doctrine but a species of worship. The Feast of Orthodoxy on the first Sunday of Lent celebrates the end of the iconoclastic controversies (*see* ICONOCLASTIC CONTROVERSY) and the restoration to the churches of the icons, which are basic to Orthodox piety. In Orthodox churches (as well as in those eastern churches that have re-established communion with Rome), the most obvious points of divergence from normal western practice are: the use of the vernacular, though an archaic form of the vernacular, in the liturgy; the right of the clergy to marry before ordination, though bishops may not be married; and the administration to the laity of both species in the Eucharist at the same time by the method of intinction. The rediscovery of Eastern Orthodox liturgy and piety by western Christians is an interesting by-product of the ecumenical contacts of the 19th and 20th centuries. *See* also ORTHODOX EASTERN CHURCH.

PROTESTANTISM

Although there is a greater variety of thought and expression within both Roman Catholicism and Eastern Orthodoxy than outsiders usually recognize, both must appear monolithic when compared with Protestantism. Formulating a definition of Protestantism that would include all its varieties has long been the despair of Protestant historians and theologians, for there is greater diversity within Protestantism than there is between some forms of Protestantism and some non-Protestant Christianity. For example, an Anglican or a Lutheran high-churchman has more in common with an Orthodox theologian than he has with a Baptist theologian. Amid all this diversity, however, it is possible to define Protestantism formally as non-Roman western Christianity and to divide most of Protestantism into four major confessions or confessional families—Lutheran, Anglican, Reformed and Free Church.

Lutheranism.—The largest of these non-Roman Catholic denominations in the west is the Lutheran Church, whose membership totals approximately 70,000,000. The Lutheran churches in Germany, in the several Scandinavian countries and in the Americas are distinct from one another in polity, but almost all of them are related through various national and international councils, of which the Lutheran World federation is the most comprehensive. Doctrinally, Lutheranism sets forth its distinctive position in the Book of Concord, especially in the Augsburg Confession *(qq.v.)*. A long tradition of theological scholarship has been responsible for the development of this position into many and varied doctrinal systems. Luther, as noted above, moved conservatively in his reformation of the Roman Catholic liturgy, and the Lutheran Church, although it has altered many of his liturgical forms, has remained a liturgically traditional church. Most of the Lutheran churches of the world have participated in the ecumenical movement and are members of the World Council of Churches, but Lutheranism has not moved very often across its denominational boundaries to establish full communion with other bodies. The prominence of Lutheran societies in the history of missions during the 18th and 19th centuries gave an international character to the Lutheran Church; so did the development of strong Lutheran churches in North America, where the traditionally German and Scandinavian membership of the church was gradually replaced by a more cosmopolitan constituency. (*See* LUTHERANISM.)

Anglicanism.—The Anglican communion, with perhaps 40,000,000 members, is not only the established church of England but the Christian denomination of many believers throughout the world. Like Lutheranism, Anglicanism has striven to retain whatever it could of the Catholic tradition of liturgy and piety, but after the middle of the 19th century the Catholic revival in Anglicanism went much further in the restoration of ancient liturgical usage. Although the Catholic revival also served to rehabilitate the authority of tradition in Anglican theology generally, great variety continued to characterize the theologians of the Anglican communion. Anglicanism is set off from most other non-Roman churches in the west by its retention of and its insistence upon the apostolic succession of ordaining bishops. The Anglican claim to this apostolic succession, despite its repudiation by Pope Leo XIII in 1896, has largely determined the role of the Church of England in the discussions among the churches. Anglicanism has often taken the lead in inaugurating such discussions, but it has demanded the presence of the historic episcopate as a prerequisite to the establishment of full communion. During the 19th and 20th centuries many leaders of Anglican thought were engaged in finding new avenues of communication with industrial society and with the modern intellectual. The strength of Anglicanism in the new world and in the younger churches of Asia and Africa has confronted this communion with the problem of deciding its relation to new forms of Christian life in these new cultures. As its centuries-old reliance upon the establishment in England has been compelled to retrench, Anglicanism has discovered new ways of exerting its influence and of expressing its message. (*See* ANGLICAN COMMUNION and the articles referred to there.)

Presbyterian and Reformed Churches.—Protestant bodies that owe their origins to the reformatory work of John Calvin and his associates in various parts of Europe are often termed "Reformed," particularly in Germany, France and Switzerland. In Britain and in the United States they have usually taken their name from their distinctive polity and have been called Presbyterian. They also number about 40,000,000. They are distinguished from both Lutheranism and Anglicanism by the thoroughness of their separation from Roman Catholic patterns of liturgy, piety and even doctrine. Reformed theology has tended to emphasize the sole authority of the Bible with more rigour than has characterized the practice of Anglican or Lutheran thought, and it has looked with deeper suspicion upon the symbolic and sacramental traditions of the Catholic centuries. Perhaps because of its stress upon biblical authority, Reformed Protestantism has sometimes tended to produce a separation of churches along the lines of divergent doctrine or polity, by contrast with the inclusive or latitudinarian churchmanship of the more traditionalistic Protestant communions. This understanding of the authority of the Bible has also led Reformed Protestantism to its characteristic interpretation of the relation between church and state, sometimes labeled theocratic, according to which those charged with the proclamation of the revealed will of God in the Scriptures (*i.e.*, the ministers) are to address this will also to civil magistrates. As the church is "reformed according to the word of God," so the lives of the individuals in the church are to conform to the word of God; hence the Reformed tradition has assigned great prominence to the cultivation of moral uprightness among its members. During the 20th century most of the Reformed churches of the world took an active part in the ecumenical movement. (*See* PRESBYTERIANISM; REFORMED CHURCHES.)

Free Churches.—In the 19th century the term "free churches" was applied in Great Britain to those Protestant bodies that did not conform to the establishment, such as Congregationalists, Methodists and Baptists (and Presbyterians in England); but since that time it has come into usage among the counterparts to these churches in the United States, where each of them has grown larger than its British parent body. As the Reformed denominations go beyond both Anglicanism and Lutheranism in their independence of Catholic traditions and usages, so the free churches have tended to reject some of the Catholic remnants also in classical Presbyterian worship and theology. Baptists (*q.v.*) and Congregationalists see the local congregation of gathered believers as the most nearly adequate visible representation of Christ's people on earth. (*See* CONGREGATIONALISM.) The Baptist requirement of free personal decision as a prerequisite of membership in the congregation leads to the restriction of baptism to believers (*i.e.*, those who have made and confessed such a decision of faith) and therefore to the repudiation of infant baptism; this in turn leads to the restriction of communion at the Eucharist to those who have been properly baptized. In Methodism (*q.v.*) the free church emphasis upon personal commitment leads to a deep concern for moral perfection in the individual and for moral purity in the community. The Disciples of Christ (*q.v.*), a free church that originated in the United States, make the New Testament the sole authority of doctrine and practice in the church, requiring no creedal subscription at all; a distinctive feature of their worship is their weekly celebration of Communion. Emphasizing as they do the need for the continuing reformation of the church, the free churches have, in most cases, entered into the activities of interchurch co-operation and have provided leadership and support for the ecumenical movement. This co-operation, as well as the course of their own historical development from spontaneous movements to ecclesiastical institutions possessing many of the features that the founders of the free churches had originally found objectionable in the establishment, has made the question of their future role in Christendom a central concern of free churches on both sides of the Atlantic.

Other Churches and Movements.—In addition to these major divisions of Protestantism, there are other churches and movements not so readily classifiable; some of them are quite small, but others number millions of members. These churches and movements would include, for example, the Society of Friends (*q.v.*), known both for their cultivation of the "inward light" and for their pacifism; the Unitarian and Universalist bodies, which do not consistently identify themselves as Christian (*see* UNITARIANISM; UNIVERSALIST CHURCH); Christian Science (*q.v.*), Baha'i (*see* BAHA'I FAITH), Unity and other theosophic movements, which blend elements from the Christian tradition with practices and teachings from other religions; Pentecostal churches (*q.v.*) and churches of divine healing, which profess to return to primitive Christianity; and many independent churches and groups, most of them characterized by a free liturgy and a fundamentalist theology (*see* FUNDAMENTALISM). Separately and together, these groups illustrate how persistent has been the tendency of Christianity since its beginnings to proliferate parties, sects, heresies and movements. They illustrate also how elusive is the precise demarcation of Christendom, even for those observers whose definition of normative Christianity is quite exact.

MEANING OF CHRISTIANITY

Christian history and the variety of Christian churches and sects have given some observers the impression that Christians really have nothing in common except the name. That impression is only confirmed when well-meaning reductionists define the essence of Christianity in formulas such as "the fatherhood of God and the brotherhood of man," which mean as little or as much as one may want to make of them. A related formula, but one whose history has rendered it much more precise and more inclusive, is taken from I Cor. xiii, 13: "So faith, hope, love [charity] abide, these three." These three have traditionally formed the basis for Christian catechisms and may be used here to provide the framework for a brief statement of the meaning of Christianity as a way of belief, as a way of worship and as a way of life.

A Way of Belief.—Christian faith is both a conviction about God and a trust in the ways of God. It rests upon divine revelation as a disclosure of these ways in the history of Israel and of the church, but especially in Jesus Christ. With Judaism Christianity confesses that God is one and that he is the Creator of all. God is present and active in his creation but is neither identical with it nor captive within it. As the crown of God's creation, man has been endowed with a special mark of God's presence and activity, "the image of God," which reflects the mind of the Maker. Yet man's life does not in fact conform to the will of his Creator, but is bent away from God to the service of lesser goods. This conflict between man as he is in essence (the creature of God and therefore good) and man as he is in existence (the son of fallen Adam and therefore sinful) cannot be resolved by the moral or intellectual striving of man alone. He has been alienated from the ground of his own being, has violated the law and righteousness of God, and is subject to the power of death (*see* SIN). To become again what he was intended to be, man needs the grace of God, which can break the power of death and give man a new birth. In the incarnation of his Son, Jesus Christ, God has granted men this grace.

Christ, the eternal Son of God, was equal with God the Father—at least since the Council of Nicaea this statement has been part of the first classic confession of Christian orthodoxy, that God is one in his "essence" and three in his "persons," Father, Son and Holy Spirit (*see* TRINITY). But the eternal Son of God, who was truly God, became just as truly man by being born of the Virgin

Mary—this is the second classic confession of Christian orthodoxy. The life of Jesus Christ on earth was human life as God had intended human life to be. But more, it was part of the plan by which God wanted to restore his grace to men and to break the power of death. Therefore the teachings of Jesus described the coming of the reign of God and summoned men to cast off their old ways and to heed the will of God; and the deeds of mercy in the public ministry of Jesus were signs of God's saving care for those who turned to him in acknowledgment of their need and in expectation of his rescue. The specific means of rescue and thus the climax in the earthly life of Christ the Saviour was the cross. His death on the cross satisfied the law and righteousness of God, took away the power of death, and opened to man the possibility of living by the grace of God in the Kingdom of God. And his resurrection from death marked the end of the power of sin and death, the beginning of a newness of life.

The content of Christian faith has been defined in different ways by different theologians; but this conviction that the life, death and resurrection of Jesus Christ are the means by which God has brought about the salvation of the world would be identified by most Christians in most centuries as the absolutely irreducible minimum of Christian belief.

The communication of this salvation and its eventual consummation are the subjects of the Christian confession about the person and work of the Holy Spirit (*q.v.*). The Third in the divine Trinity, the Holy Spirit proceeds eternally from God—whether from both the Father and the Son or only from the Father was a point at issue between the eastern and the western parts of the church. To the Holy Spirit is assigned the inspiration of the men who revealed the will of God from the beginning, for "he spake by the prophets." The continuing life of the church is similarly said to be a special activity of the Holy Spirit, which preserves its unity, creates its holiness, assures its catholicity and guarantees its bond with apostolic Christianity. Sustaining this life in the church and communicating the grace of God to the believer are the means of grace, the sacraments (variously defined and numbered) and the word of the gospel (variously identified). Imperfect though it continues to be, the life of grace is the way toward the perfection that is the content of the life eternal. The consummation of the plan of divine salvation is to come with the end of human history, the appearance of Jesus Christ as the judge of all mankind and the resurrection of the dead. This consummation is both an article of Christian belief and an object of Christian hope.

Every sentence of this summary of Christian belief would probably call forth a challenge from one or another theology; so would its many omissions. Yet following as it does the outline of the most nearly universal Christian confession, the Nicene Creed, it seeks to meet the threefold standard of orthodoxy and catholicity formulated by Vincent of Lérins in the 5th century: "that which has been believed everywhere, always, and by everyone."

A Way of Worship.—The knowledge of God and the service of God are the twin themes of Christianity. The service of God consists of both hope and charity (*q.v.*). In many Christian writers, therefore, the exposition of the meaning of hope has been based upon the Lord's Prayer. The prayer that the name of God, as the Father in heaven, may be hallowed embraces all Christian worship and all the Christian hope. By its corporate worship the church confesses the unholiness of men in the presence of divine holiness, and prays: "Lord, have mercy upon us." In the *Sanctus* of the Mass or in the Protestant hymn "Holy, Holy, Holy," Christian worship is directed not toward man and his achievements, nor even toward man and his need, but toward the glory of the "name" of God; *i.e.*, toward God as he has revealed himself in Christ. Private prayer and devotion may frequently rise from a deep and personal sense of need, but Christianity as a way of worship shifts this focus from man to God and considers man's need in the light of God's grace. Hope is therefore the content of Christian worship, for hope is directed toward the future as God's future and is the anticipation of deeds of God yet to come.

The biblical term for those deeds yet to come is "the Kingdom of God." Christian worship celebrates the reign of God over the world as founded in the creation and as re-established in the coming of Christ, and it looks for the further disclosure of the reign of God in the events of history and in the consummation of history. The accents of past, present and future all appear in the hope and worship of the church. Recognizing the contrast between the world as it is in essence (where the will of God is always obeyed) and the world as it is in existence (where the will of God is often defied), the church prays that "on earth," in the world of men and nations, the will of God may be carried out as perfectly as it is "in heaven," in the world of angels and perfected saints. Only when it has thus prayed for the sanctification of the name of God, the coming of the reign of God and the accomplishment of the will of God, does the petition of the church go on to request the necessities of daily life.

This does not mean, as heretics from within Christianity and opponents from outside it have charged, that Christianity looks upon the body and its needs as unimportant or even sinful; for God is the Creator of the body, who redeemed it together with the soul and who promises to raise it from the dead. But it does mean that God is God, without whose grace man cannot live though he have all he needs of daily bread. Penitence for sin, request for deliverance and adoration of God for his glory recur as the motifs of Christian worship. Each motif is both a petition toward God and an imperative toward man. Therefore the prayer for forgiveness is made contingent upon the readiness to forgive others; the request for deliverance from evil does not sound without the reminder of the reality of temptation; the adoration of the glory of God, together with the opening petition that the name of God be hallowed, encloses every human plea for aid within a doxology that acknowledges the sovereignty of God over all. When Christianity assumes the postures of expectation and worship, it voices this hope, whose ultimate source and final object is the Father, Son and Holy Spirit confessed and described by Christian faith—not only a Deity and a Creator, but a Father and a Saviour who is also a Brother as well as a Master, eternal Love as well as eternal Truth.

A Way of Life.—As a way of life, Christianity is defined as a life of charity or love, love toward God and love toward men. Here the priority of man's relation to God, which is fundamental to the Christian way of belief and to the Christian way of worship, asserts itself once more. The commandment, "You shall love the Lord your God with all your heart, and with all your soul, and with all your mind" is the first and greatest commandment. Upon it is based the second: "You shall love your neighbor as yourself." For where the commandment of love toward God is properly understood, there the commandment to love other men, as well as all other commandments, will proceed from it as corollaries.

The commandment of love toward God has been the subject of extensive theological discussion (*see* CHARITY). For if love is a desire to possess the object—as, for example, sexual love, *eros*, is—is it not idolatrous to "love" God in the sense of wishing to subject him to one's own will and desire and to use him as a means toward a lesser end? But if, as some theologians argue, love as *agape* is to be defined exclusively as the recognition of another's need and the desire to answer that need, it may be equally idolatrous for man to suppose that God stands in need of his creatures and of their love. The Augustinian way out of this dilemma is the one followed by many Christian interpreters of the meaning of love. The love of God for man is the recognition of man's need, the vision of man's potentiality and the desire to answer the need and to make the potential a reality through the gift of Christ. But the love of man for God necessarily partakes of the nature of love as a desire to be united with its object, for the soul of man yearns for union with God "as a hart longs for flowing streams." Yet it is necessary to classify all of man's loves on the basis of their objects. A soul is healthy if it loves each of these objects according to the particular nature of the object, desiring things as things (and no more), persons as persons (and no less) and God as God (and both things and persons in God). So the soul ascends through desire and yearning to a love for God that elevates him above all temporal objects.

The avoidance of idols, reverence for the "name" of God, and the observance of the sabbath as a day of worship and rest are practical expressions of man's love for God. The practical expressions of one's love for the neighbour vary according to one's own situation and according to the neighbour's need, but the Decalogue enumerates the principal relationships in which man's love for his fellow men articulates itself. Chronologically and logically first among these relationships are the home and the family, where love takes the form of mutual respect between parents and children. Yet the respect for human life itself is perhaps even more elemental; the commandment "You shall not kill" puts the authority of God around the body and life of another and makes violence against another human being a sin against God.

A violation of the bond of marriage is also interpreted as a desecration of the relation between man and God, not merely as a breach of human morality. Love for another human being implies a due regard for his earthly possessions and for his reputation.

In precise ethical terms most of these requirements of the Ten Commandments are comprehended not so much in love as in justice, for they are a way of rendering to each his due. The charity spoken of in Christian ethics is never less than justice, which is the indispensable condition for wholesome relations in human society. But love transcends justice, goes the second mile and has regard for the total person. Justice without love may become legalistic, love without justice may become sentimental. Hence the Christian ethic of charity takes justice seriously, not only as the least that God demands but often as the most that man can achieve under the conditions of human existence. Justice is an instrument of love and sometimes its most satisfactory expression. Yet the Christian gospel declares that God has gone beyond justice to love, granting grace and forgiveness in Christ not because men have deserved it but out of his mercy. Man's responding love for God and for fellow man also goes beyond justice. Thus it opens one to the possibility of a service to others that does not demand its due, but "bears all things, believes all things, hopes all things, endures all things." Faith, hope and charity: faith is the acknowledgment of God's love for man in Christ; hope is the expectation of further love from God; charity is love in action. Because it comprehends the other two in this way and because it is said to abide even when both faith and hope have attained their goals, "the greatest of these is charity." In it is also the meaning of Christianity.

See also references under "Christianity" in the Index volume.

Bibliography.—Throughout this encyclopaedia there are hundreds of articles on the institutions, eras, personalities, issues and ideas of Christianity. Most of the articles contain specific bibliographies. In the present article only a few very general works can be cited, from which the reader can proceed to a study of detailed topics. *The Oxford Dictionary of the Christian Church,* ed. by F. L. Cross (1957), is the most useful one-volume work of reference on Christianity and things Christian. Both *The Catholic Encyclopedia* (1907 *et seq.*) and *Die Religion in Geschichte und Gegenwart* (3rd ed.; 1957 *et seq.*) are multivolume encyclopaedias, in which the reader may obtain information about many issues in Christianity, as well as extensive bibliographies.

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(J. J. Pn.)

CHRISTIAN SCHOOLS, BROTHERS OF THE (Institutum Fratrum Scholarum Christianarum; F.S.C.), often simply Christian Brothers, the first religious congregation of male nonclerics in the Roman Catholic Church to devote itself exclusively to schools and solely to learning and teaching. Members, numbering more than 17,000, are found on all continents. The congregation was formally founded at Reims by St. Jean Baptiste de La Salle (*q.v.*) in 1684 for the education of boys, especially of poor families. Benedict XIII raised the congregation to the status of a papal institute in 1725. Historically the brothers have engaged in popular education through varied types of schools depending upon the requirements of localities and times. Besides teaching in elementary, secondary and teacher-training schools, the brothers administer and staff welfare or corrective schools, and in the United States they also conduct seven colleges. The superior general and administrative officers reside at the motherhouse in Rome. (For the Brothers of the Christian Schools of Ireland, *see* Christian Brothers of Ireland.)

See Brother A. Gabriel, *The Christian Brothers in the United States 1848–1948* (1948); Georges Rigault, *Histoire générale de l'Institut des Frères des écoles chrétiennes,* 9 vol. (1936–53).

(Au. P.)

CHRISTIAN SCIENCE, founded by Mary Baker Eddy (*q.v.*) in the latter half of the 19th century, is simultaneously, as the term is popularly used, a religious faith; an institution, organization or church; a movement; a philosophy; and a way of life. Mrs. Eddy herself seems to have thought of it as representing a recovery of certain lost emphases of primitive Christianity, notably, but not solely, the emphasis on healing. She considered that she had rediscovered Jesus' healing method, and healing has continued as the central emphasis in Christian Science. Repeated testimonies by persons that they have been healed, given in the midweek testimony meetings and in various publications and broadcast by radio and television, are the principal means of attracting new members into the movement. Once healed, many, but by no means all, become members of the organized Church of Christ, Scientist.

Christian Science is more than a healing faith, however. It has a theology as definite as that of any of the Christian churches but differing markedly from orthodox or even liberal Christian theology. While Christian Science uses the theological vocabulary of traditional Christianity, the meaning it assigns to many familiar terms—such as God, Christ, heaven, salvation, Trinity, etc.—is quite different from that ordinarily given them in the orthodox churches. (*See* "Glossary" in *Science and Health,* pp. 579–599.) The fundamental theological teachings are best to be seen in the "Christian Science Platform" (pp. 330–340) and in the chapter "Recapitulation" (pp. 465–497), which are designated as the basis of Christian Science class instruction, the most important means of perpetuating the basic teachings of the movement.

God is Principle, impersonal or, perhaps better, suprapersonal by definition, though there is a continuous alternation of emphasis on the personal and impersonal nature of God in Mrs. Eddy's own writings. In *Science and Health,* p. 465:9–10, she wrote, "God is incorporeal, divine, supreme, infinite Mind, Spirit, Soul, Principle, Life, Truth, Love." Christ is not synonymous with Jesus, though Jesus manifested the Christ in fullest measure. There is no place in Christian Science for a vicarious atonement as taught in traditional orthodoxy, yet it is through Christ Jesus, chiefly as Way-Shower, that salvation is to be won. There is no magic or forensic deliverance from sin. "The way to escape the misery of sin is to cease sinning. There is no other way" (*Science and Health,* p. 327:12–13). The ethical teachings of Jesus are accepted by Christian Science as in the general Christian tradition.

The Bible is basic to Christian Science, and Christian Scientists are encouraged to read and study it as much as or more than most other Christians are, but always in the light of Mrs. Eddy's later revelation, found chiefly in *Science and Health With Key to the Scriptures,* supplemented by her other published writings, including the *Church Manual.* In general, the method of interpretation is that employed by most so-called metaphysical groups, highly subjective and allegorical rather than literal or dependent on painstaking linguistic and critical study. (*See* "Key to the Scriptures," in *Science and Health*, pp. 501–578.)

Christian Science is part of a widespread movement with roots going back into the general intellectual movements in New England, notably Transcendentalism (*q.v.*), but influenced also in its beginnings by the teachings of Emanuel Swedenborg and by the 19th-century interest in spiritualism and mesmerism (hypnosis). Just how much Mrs. Eddy was influenced in the formulation of her healing doctrine by Phineas Parkhurst Quimby (*q.v.*), considered the father of the New Thought (*q.v.*) movement, whom she originally credited with healing her in 1862, is a moot question. Mrs. Eddy herself fixed on the year 1866 as the date of discovery of the Christ Science that she named Christian Science (*Science and Health*, p. 107). Though New Thought and Christian Science differed substantially in their final formulation, the points they have in common—metaphysical interest and general point of view, essential conceptions of God and of man, emphasis on healing and ultimately also on general well-being and prosperity (though differing greatly in the method by which these may be attained)—mark them as phases of a single movement.

Christian Science, first an idea, then a teaching and practice, expressed itself eventually in an institution, The First Church of Christ, Scientist, of Boston, which came to be known as The Mother Church, of which other Christian Science churches throughout the world are branches. It was organized and given its constitution and by-laws by Mrs. Eddy personally (these now embodied in the *Church Manual*) several years after the publication in 1875 of *Science and Health*. But she was to revise both of these many times before they reached their present form, recognized by Christian Scientists as the divinely revealed basis of the faith and organized institutional life of Christian Science.

After difficult years of opposition and struggle, the movement spread rapidly until it had become world-wide, with branches in most of the principal countries of the world.

The church is a centralized institution, under the direction of a self-perpetuating board of directors of five persons, originally four, named by Mrs. Eddy, and eventually constituted as her successors, operating according to the *Church Manual*. Under the board's direction are carried on a multitude of activities: the church's work of healing through accredited practitioners; publication and distribution of literature, including the writings of Mrs. Eddy, and periodicals such as the *Christian Science Journal*, the *Sentinel* and the influential daily *Christian Science Monitor*; lectures; promotional activities; religious education and maintenance of the purity of the church's teachings through supervision of class instruction, primary and normal, through which all those aspiring to leadership in the church ordinarily are expected to pass. The branch churches have their own boards of directors and their own constitutions and by-laws, but these must be consonant with the provisions of the *Church Manual* of The Mother Church. As a church, the Church of Christ, Scientist, has its own form of worship, uniform the world over, the chief feature being the reading by officially elected readers of passages from the Bible chosen by church authorities, followed by the reading of correlative passages from *Science and Health*. There is no sermon beyond this in any Christian Science church.

As a movement, Christian Science spreads far beyond the organized church. Some former members now withdrawn from the church, and others who have never joined it but have been attracted to the study of Christian Science, faithfully study the textbook, revere Mrs. Eddy and even, in some cases, serve as practitioners, though without official listing in the *Christian Science Journal*. Some outside the church teach classes and write books and articles on Christian Science, though without the approval of the church authorities. While there have been occasional rebellions against constituted authority, no dissident group has attained much strength or permanence. Many of the nonchurch members are concerned to present Christian Science as a true science, as effective and invariable as any other science in its results, and not as a revelation that falls within the control of an ecclesiastical institution.

As a philosophy, Christian Science is a pure idealism, theoretically monistic in its outlook but often enough practically dualistic, as indeed is much of Judaism and Christianity. It is in their denial of the reality of the phenomenal or material world, and of the reality of evil, that Christian Scientists differ from some of the other metaphysical groups and from most of western Christianity.

Christian Science is a way of life for most believers, whether in the church or outside it. It determines to a very considerable degree not only their ultimate aims, but also their day-to-day behaviour in many respects. Christian Science is relatively puritan in its sumptuary practices. It attempts through appropriate disciplines to develop in its members a serenity that is much needed in the modern age. It encourages an optimistic outlook on life favourable to the best functioning of the total organism, which is increasingly recognized by the medical profession as a psychosomatic whole, in which the mental or spiritual as well as the physical is seen as a highly determinative factor in healthful living. Finally, it leads to a dependence upon Christian Science principles of healing, many believers in this respect going far beyond the teachings of the founder herself in refusing any help at all from materia medica. Certain passages in *Science and Health* (p. 401:27–32; p. 444:7–9; p. 464:13–20) seem to warrant sufferers' seeking medical or surgical help on occasion.

Bibliography.—*Science and Health With Key to the Scriptures* and the other writings of Mrs. Eddy, with concordances. Official lives of Mrs. Eddy are Sibyl Wilbur, *Life of Mary Baker Eddy* (1908), and Lyman P. Powell, *Mary Baker Eddy* (1930). Unauthorized are Hugh A Studdert Kennedy, *Mrs. Eddy* (1947); Edwin F Dakin, *Mrs. Eddy* (1929); E. S. Bates and John V. Dittemore, *Mrs. Eddy, the Truth and the Tradition* (1932). Later histories of the movement: Norman Beasley, *The Continuing Spirit* (1956); Robert Peel, *Christian Science: Its Encounter With American Culture* (1958); Clifford P. Smith, *Historical Sketches From the Life of Mary Baker Eddy and From the History of Christian Science* (1941); Henry W. Steiger, *Christian Science and Philosophy* (1948); Charles S. Braden, *Christian Science Today* (1958), with extensive bibliography. (C. S. B.)

CHRISTIAN SOCIALISM is a term that has been used to denote a wide variety of social doctrines and movements that have attempted to give a basic, structural application to the social principles of Christianity. In the 19th century the term socialism in this context was employed in a loose sense, denoting, in opposition to laissez-faire individualism, a Christian demand for some form of political or economic action in the interest of all the people. Christian socialists usually did not demand the common ownership and control of the means of production and exchange. Roman Catholic Christian socialism, for example, promoted certain reforms to improve social relations, but its ultimate aim, in accord with papal encyclicals, was the establishment of a neofeudal corporative system, an order quite different from what is usually called socialism. In the 20th century, Christian social and industrial reform movements have been more and more referred to as the Christian social, the Protestant social or the Catholic social movement. The term Christian socialism tends to be reserved for those movements which attempt to combine the fundamental aims of socialism with the religious and ethical convictions of Christianity. It is this sort of Christian socialism that is mainly dealt with here.

Christian Socialism in England.—Although anticipations of Christian socialism are to be found in early Christian "communism of love" and in the radical sects of the middle ages, of the "left wing" of the Reformation and of the 17th century (*e.g.*, the Diggers in England), the term Christian socialism was first appropriated by the broad churchmen J. F. D. Maurice, Charles Kingsley (the novelist), J. M. Ludlow and others, who entered on public propaganda immediately after the collapse of the Chartist uprising of 1848. Their general purpose was to vindicate for "the Kingdom of Christ" its "true authority over the realms of industry and trade," and "for socialism its true character as the great Christian revolution of the 19th century." Four years after Karl Marx characterized religion as "opiate for the people," Kingsley (probably unaware of Marx's phrase) asserted that the Bible had been wrongly used as "an opium-dose for keeping beasts of burden patient while they were being overloaded" and as a "mere book to keep the poor in order" (in *Politics for the*

People, 1848). Greatly stirred by the sufferings of the poor, the group vigorously criticized socially conservative Christianity and laissez-faire industrialism, extolling "the Bible principles" of self-sacrifice and co-operation as against self-interest and competition.

Reviving the co-operative movement, they favoured copartnership and profit sharing in industry; they organized the Council for Promoting Working Men's Associations, which gave rise to or encouraged producers' and consumers' co-operatives; they aided in securing the enactment in 1852 of the Industrial and Provident Partnerships bill, the Magna Carta of the modern co-operative movement; and they instituted workers' education by founding the Working Men's college in London (1854). The movement as such continued for only a decade.

In 1877 Stewart Headlam founded the (Anglo-Catholic) Guild of St. Matthew, which espoused a composite of doctrines drawn from Maurice, from Tractarianism and from Fabian socialism. Somewhat similar if less definitely socialistic ideas gained influence after the turn of the century through the support of certain high churchmen who founded the Christian Social union (1889).

Subsequent to Headlam's effort numerous Christian socialist organizations were formed, both in the established church and among the free churches. Prominent among these were the interdenominational Christian Socialist league, originating in the early 1880s, the labour churches (organized in 1891) and the (Anglican) Church Socialist league (founded in 1906), which emanated from the industrial north of England and brought the churches closer to labour and socialist movements. Following internal dissension the Church Socialist league was succeeded in 1923 by the League of the Kingdom of God, which called for a generically Catholic Christian sociology looking toward the establishment of a neomedieval social system. The (official Anglican) Industrial Christian fellowship, founded in 1919, was of a mediating character.

The later (predominantly Free Church) Socialist Christian league and the (Anglo-Catholic) Order of the Church Militant made explicit demand for the communal control of the means of life and regarded socialism as the economic expression of Christianity. The Malvern declaration of 1941, drawn up by Anglicans under the leadership of Archbishop William Temple, was considered to be left wing in character, but it was criticized for its "vagueness" by the Council of Clergy and Ministers for Common Ownership (founded in 1942). More sympathetic to Marxist philosophy was the (Free Church) Christian Left, which, under the leadership of John Macmurray, flourished in the 1930s and which viewed it to be "the religious mission of the working class to achieve Socialism."

Christian Socialism on the Continent.—The precursors of this movement on the continent are dealt with in Socialism. Roman Catholic Christian socialism (now called the Catholic social movement) was the first of its kind on the continent, but it was not socialistic except in the sense of a clerical socialism.

In France the Protestant Association for the Practical Study of Social Questions (founded in 1888) was mainly concerned with the need for social reform. T. Fallot, one of its principal founders, opposed bourgeois, individualistic Protestantism and strove for a Protestant socialism that would achieve liberty through co-operation and through resisting an "artificial and deadly" equalitarian socialism.

Until World War I, Protestant left-wing views were for the most part mildly social-reformist in character. In the 20th century Protestant socialists found their most effective mediums of expression in the periodical *Le Christianisme Social* (founded in 1877), edited by Élie Gounelle, and in the Fédération du Christianisme Social. In this group one of the most influential Christian socialists of the second quarter of the century was André Philip, an economist, a prolific writer on Christianity and socialism and a leader in labour and government circles.

Outstanding among German Protestant Christian socialists in the 19th century were Rudolf Todt, Adolf Stöcker (who deviated into anti-Semitism), Friedrich Naumann and J. C. Blumhardt. The state socialists Todt and Stöcker (anti-Marxist and in the throne and altar tradition) were, like the Catholic groups, opposed by the Social Democrats. Naumann took a more democratic attitude toward the worker and also believed it desirable for churchmen to co-operate with a revisionist social democracy. A still more favourable attitude toward social democracy was adopted by Blumhardt, who held that the Kingdom of God can be hindered by the churches and can be advanced by seemingly anti-Christian secular movements; indeed, he joined the Social Democratic party.

In the early part of the 20th century Hermann Kutter, "the Zürich Savonarola," held that the Social Democrats were revolutionary because God is; God's Kingdom must go forward in a revolutionary way despite, and even because of, the sluggishness of the churches. Leonhard Ragaz of Zürich, who looked forward to a socialist society organized in freedom and love, was the connecting link with post-World War I movements in Switzerland and Germany. Christian socialism now assumed a great variety of forms. Some Christian socialists (1) held that socialism is the logical consequence of Christianity; (2) others made socialism into a religion; (3) others tried to bring about understanding and interpenetration between the churches and the organized socialist proletariat; and (4) still others tried to uncover the roots of both Christianity and Marxist socialism toward the end of understanding more critically the affinities and the needed correctives. Representative of the third type was the League of Religious Socialists of south Germany, which included both Protestants and Catholics in its membership. Philosophically and theologically the most important and fruitful was the (Berlin) Kairos circle, which belonged to the fourth type mentioned and which for the decade preceding the Nazi revolution was under the leadership of the theologian Paul Tillich and the economist Eduard Heimann. After 1933 Tillich and Heimann went to the U.S., where this type of religious socialism exercised an influence. Tillich's writings appeared in translation in countries of the orient as well as of the occident. After World War II Protestant socialists in Germany came together in the Gemeinschaft für Christentum und Sozialismus, Bund der Religiösen Sozialisten, which in the 1950s began the publication of the magazine *Christ und Sozialist*.

Movements similar to the above-mentioned types have appeared also in other European countries; they were especially successful in the Scandinavian countries. Of intellectual significance in the 1930s and 1940s was the religious-socialist "personalist" philosophy of the one-time Marxist, theosophical Russian Orthodox writer Nikolai Berdyaev, whose antecedents appear in the writings of 19th-century Russian lay theologians such as Fëdor Dostoievski and Leo Tolstoi. In the 1950s certain French Roman Catholics, including the "worker-priests," promoted a sympathetic interpretation of Marxism. Typical of a vigorous and discriminating concern for Marx's social analysis was the influential volume *La Pensée de Karl Marx* (1956) by the French Jesuit Jean Yves Calvez.

Developments in America.—As the result of the absence of an archaic period in the history of the U.S., neofeudal and patriarchal forms of Christian socialism have played a small role; Puritan activism, the Enlightenment and radical democratic tendencies have been more in evidence. Although ethical rationalism and deism exercised considerable influence in 18th-century religion and politics, although semiutopian Fourierist communities were established in the 1840s and 1850s and although progressive social concerns during this period found strong advocates in the Unitarians W. E. Channing, Joseph Tuckerman and Theodore Parker, a social Christianity was not widely expounded until after the Civil War.

Social Christianity's outstanding leaders down to the 1930s were R. H. Newton (an Episcopalian), Washington Gladden, Josiah Strong, G. D. Herron (Congregationalists), Shailer Mathews (a Baptist), Bishop Francis J. McConnell (a Methodist) and F. G. Peabody and J. H. Holmes (Unitarians). Of these men only Herron and Holmes were socialists.

As early as 1849 Henry James, Sr., had argued the identity of the aims of Christianity and socialism. Largely under the leadership of W. D. P. Bliss, an Episcopalian who had been a member of the Knights of Labor, the Society of Christian Socialists was organized in 1889. Vigorously criticizing economic individualism and its ruinous progeny of plutocracy, industrial crises and wage slavery, the society attempted to show that "the aim of socialism is embraced in the aim of Christianity."

In the first quarter of the 20th century numerous Christian socialist or quasi-socialist groups were formed, as, for example, the nondenominational Christian Socialist fellowship (1906), the (pacifist) Fellowship of Reconciliation (started in England in 1914 and extended to the U.S. in 1915), the (Episcopalian) Christian Socialist league (1911–19), followed by the Church League for Industrial Democracy.

This period was the heyday of the Social Gospel movement, which, in the spirit of evolutionism and evangelical humanitarianism, interpreted the Kingdom of God as requiring social as well as individual salvation. Its most influential exponent was Walter Rauschenbusch (a Baptist), who demanded "a new order that would rest on the Christian principles of equal rights and democratic distribution of economic power." He distinguished sharply between the ultimate presuppositions of Christian socialism and those of secular socialism. Influences from this movement extended to Japan (*e.g.,* through T. Kagawa), China, South America and India.

Following World War I Marxist doctrine and also radically democratic doctrine began to play a larger role. Harry F. Ward (a Methodist) and his disciples were moving toward a Christian Marxism which showed a marked sympathy with Russian communism. In the 1930s and 1940s a neo-Marxist and theologically neo-orthodox Christian socialism gained wide attention under the leadership of Reinhold Niebuhr (an Evangelical); attacking the "utopian naturalism" of Marxism and the overoptimism of the "liberal" Social Gospel, the nondenominational Fellowship of Socialist Christians, founded in 1932, undertook a "Christian espousal of socialism" as the logical next step in a technical society; and the group published a magazine, *Christianity and Society.*

The National Religion and Labor foundation (1932 *et seq.*), the Fellowship of Southern Churchmen (1934 *et seq.*) and the (Canadian) Fellowship for a Christian Social Order (1934 *et seq.*) advocated similar economic policies, as did the United Christian Council for Democracy (1936 *et seq.*) which provided a means of common action for the left-wing organizations of six liberal Protestant denominations.

Beginning in 1939 *The Protestant Digest,* later named *The Protestant,* a journal edited by Kenneth Leslie (a Baptist), served as a medium of expression for Christian, Jewish and secular left-wing and neo-Marxist viewpoints. The Highlander Folk school (Monteagle, Tenn., 1932 *et seq.*) espoused a Christian socialist gospel, co-operatives, unionism and adult education among rural and industrial workers. In most of these groups the promotion of social planning or of the welfare state tended to replace gradualist socialism as the remedy proposed for the ills of capitalism.

Although it has not been markedly successful in attracting the alienated working classes to the churches, Christian socialism has done much to stimulate churchmen to give a radical social application to Christian ethics in an industrial society.

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CHRISTINA, queens of Spain: *see* Maria Cristina.

CHRISTINA (1626–1689), queen of Sweden from 1644 to 1654, daughter of Gustavus II Adolphus and Maria Eleonora of Brandenburg, was born in Stockholm on Dec. 8, 1626. After her father died in battle Christina, the only heir, became queen-elect at the age of six. By his orders she was educated as a prince, with the learned Johannes Matthiae as her tutor, while five regents headed by the chancellor Axel Oxenstierna (*q.v.*) governed the country. Her brilliance and strong will were evident even in her childhood. Oxenstierna himself instructed her in politics and first admitted her to council meetings when she was 14.

When Christina attained majority and became queen in 1644, she opposed Oxenstierna and there was constant friction between them thereafter, particularly concerning the war in Germany, later known as the Thirty Years' War. In spite of his opposition, she was a prime mover, with the aid of Adler Salvius, one of Sweden's delegates at the peace congress, in gaining the peace of Westphalia and ending the war. An assiduous politician, Christina kept the bitter class rivalries that broke out after the war from lapsing into civil war, but was unable to solve the desperate financial problems caused by the long years of fighting. In the end, she had to recall Oxenstierna. Her passion was culture and learning. She rose at five in the morning to read, and she invited eminent foreign writers, musicians and scholars to her court. One of them was Descartes, who taught her philosophy and who died in Stockholm (1650). For her wit and learning all Europe called her the Minerva of the North; but she was extravagant, too free in giving away crown lands and intent on a luxurious court in a country that could not support it and did not want it. Her reign was nevertheless beneficent: it saw the first Swedish newspaper (1645) and the first country-wide school ordinance; science and literature were encouraged, and new privileges were given to the towns; trade, manufactures and mining also made great strides.

Christina's abdication after ten years of rule shocked and confused the Christian world. She pleaded that she was ill and that the burden of ruling was too heavy for a woman. The real reasons were her aversion to marriage and her secret conversion to Roman Catholicism, which was forbidden in Sweden. As her successor she chose her cousin, Charles X Gustavus, who was crowned on June 6, 1654, the day of her abdication. Christina left Sweden immediately.

At the end of Dec. 1655 Pope Alexander VII received Christina in splendour at Rome. However, he was soon disillusioned with his famous convert, who opposed public displays of piety. Although she was far from beautiful (short and pock-marked, with a humped right shoulder), Christina by her manners and personality created a sensation in Rome. Missing the activity of ruling, she entered into negotiations with the French chief minister, Cardinal Mazarin, and with the duke of Modena to seize Naples (then under the Spanish crown), intending to become queen of Naples and to leave the throne to a French prince at her death. This scheme collapsed in 1657 during a visit by Christina to France. When staying at Fontainebleau, she ordered the summary execution of her equerry, the marchese Gian Riccardo Monaldeschi, alleging that he had betrayed her plans to the Holy See. Her refusal to give reasons for this action, beyond insisting on her royal authority, shocked the French court, nor did the pope welcome her return to Rome.

In spite of this scandal Christina lived to become one of the most influential figures of her time, the friend of four popes and a magnificent patroness of the arts. Always extravagant, she had financial difficulties most of her life: the revenues due from Sweden came slowly or not at all. She visited Sweden in 1660 and in 1667. On the second journey, while staying in Hamburg, she had Pope Clement IX's support in an attempt to gain another crown, that of her second-cousin John Casimir, who had abdicated the throne of Poland; but her failure seemed to please her since she could return to her beloved Rome. There she had formed a strong friendship with Decio Cardinal Azzolino, a clever, charming, prudent man, leader of the group of cardinals called the *squadrone volante* and active in church politics. It was generally believed in Rome that he was her lover, a view sustained by her letters which were decoded in the 20th century. With him, she, too, became active in church politics, insisting for years on the pursuance of the Christian war against the Turks. Pope Innocent

XI. who pushed this war to its victorious conclusion, stopped her pension at her own urgent request, in order to add it to the war treasury. In 1681, having secured a trustworthy administrator for her lands in Sweden, Christina at last became financially secure.

Christina's extraordinary taste in the arts has influenced European culture since her time. Her palace, the Riario, now the Corsini, on the Lungara, contained the greatest collection of Venetian paintings ever assembled as well as other notable paintings, sculpture and medallions. There forgathered men of letters and musicians. The Arcadia academy, which she founded for philosophy and literature, still exists in Rome. It was at her instigation that the first public opera house in Rome was opened, the Tordinona, and it was she who recognized the genius of and sponsored Alessandro Scarlatti, who became her choirmaster, and Arcangelo Corelli, who directed her orchestra. Bernini, her friend, considered her his saviour when she commissioned Baldinucci to write his biography while he was being discredited in 1680. Her enormous collection of books and manuscripts is now in the Vatican library. She was renowned, too, for her militant protection of personal freedoms, for her charities and as protectress of the Jews in Rome.

Christina died in the Riario palace on April 19, 1689. She made Cardinal Azzolino her heir, but he followed her in death two months later. Her tomb is in St. Peter's in Rome. A selection of Christina's letters and an edition of *pensées* by her were both published in 1907.

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CHRISTINE de Pisan (1364–*c.* 1430), French writer of Italian descent, who wrote many poems—of uneven quality—in the courtly love tradition, was born in Venice in 1364. Her father, who was from a small town near Bologna, entered the service of the French king, Charles V, and his family followed him to Paris in 1368. After spending a pleasant yet studious childhood at the French court, Christine at 15 married Étienne du Castel, who became a secretary in the royal household. When the king died in 1380, her father lost his office; he died some time later. Her husband died in 1389. Finding she had to support herself and her three young children, Christine turned to a literary career. She wrote her first *ballades* in memory of her husband, and, as these poems met with success, she persevered. Her collections of *ballades, rondeaux, lais* and *complaintes*, in which she expresses her feelings with grace and sincerity, were followed by numerous works unfortunately marred by an excessive display of learning and too much allegory. Her patrons included Louis d'Orléans, the duc de Berry, Philip the Bold, and Queen Isabella of Bavaria; and, in England, the earl of Salisbury.

Among her works in verse, mention should be made of her *Débat des deux amans*, the *Dit des trois jugemens amoureux*, the *Dit de la pastoure*, the *Dit de Poissy* and the *Épistre d'Othéa à Hector*, all on the themes of courtly love. The *Épistre du dieu d'amours* (1399) and the *Dit de la Rose* (1401) defend women against the satire of Jean de Meun in the *Roman de la Rose*. The *Chemin de long estude* (1402), over 6,000 lines, is a work of greater range. The *Mutacion de fortune* (1403), the longest of her rhymed works (24,000 lines), begins with an interesting autobiography.

Having become famous, Christine was asked by Philip, duke of Burgundy, the regent, to write the life of the deceased king. She did so in her *Livre des fais et bonnes moeurs du sage roy Charles V* (1404; critical ed. by S. Solente, 2 vol., 1936–40). Other prose works followed: the *Cité des dames* (1405), in which Christine gathers from all over the world women whose heroism and virtue have made them famous; the *Livre des trois vertus* (1406), a collection of moral lessons for the instruction of women in the various spheres of society; and the *Avision Christine* (1405; critical ed. by M. L. Towner, 1932) in which she told the story of her life, as a reply to her detractors, in a strange allegorical manner.

Grieving over the evils of France—the civil war between the Armagnac and Burgundian factions, the madness of the king, the rebellion of the Cabochiens and the English occupation—Christine dedicated her *Lamentation* (1410) to the queen, and in the *Livre de la paix* (1413) she urged harmony between the men of her country. After the defeat at Agincourt and the death of the duc de Berry, to comfort whose daughter she composed a short treatise entitled *Épistre de prison de vie humaine*, she retired in 1418 to a convent, probably at Passy (now part of Paris), where she wrote a *Méditation sur la passion*. In 1426 the death of her elder son Jean du Castel came as a new blow to her. In 1429 she made herself heard for the last time in a joyful lyrical outburst inspired by Joan of Arc's early victories. She must have died soon after, but nothing is known of the actual circumstances of her death.

BIBLIOGRAPHY.—Her many works have not yet been published in their entirety. Modern editions include *Oeuvres poétiques*, ed. by M. Roy, 3 vol. (1886–96; incomplete); *Le Chemin de Long estude*, ed. by R. Püschel (1881; 2nd ed., 1887); *Épistre de prison de vie humaine*, ed. by S. Solente in *Bibliothèque de l'École des Chartes*, vol. lxxxv (1924); *Dittié sur Jeanne d'Arc* in J. E. J. Quicherat, *Procès de Jeanne d'Arc* (1841–49), vol. v. Critical studies: *see* M. Laigle, *Le "Livre des trois vertus" de Christine de Pisan* (1913); P. G. Campbell, *L'Épitre d'Othéa à Hector. Étude sur les sources de Christine de Pisan* (1924); M.-J. Pinet, *Christine de Pisan, étude biographique et littéraire* (1927). (L.-F. F.; X.)

CHRISTMAS, on Dec. 25, the Feast of the Nativity of Our Lord, commemorating the birth of Jesus Christ, is the most popular commemoration of the church year. Its observance as the birthday of the Saviour is attended with secular customs often drawn from pagan sources; indeed, both Christmas and Epiphany, which falls 12 days later on Jan. 6, are transformed pagan celebrations of the winter solstice, and so closely linked that their origins cannot be discussed separately.

Christmas on Dec. 25 is first known to have been celebrated in Rome in the second quarter of the 4th century, when it commemorated the birth of Christ; there was as yet no Epiphany. In the eastern part of the empire a festival on Jan. 6 commemorated the manifestation (Gr. *epiphaneia*) of God in both the birth and the baptism of Jesus (in Jerusalem, however, only the birth was remembered), and there was as yet no Christmas. In the course of the 4th century the celebration on Dec. 25 was adopted in the east (except in Jerusalem), and became the day when the birth was commemorated, Jan. 6 retaining its connection with the baptism. In the west the process worked out differently: Epiphany became a kind of doublet of Christmas, commemorating the visit of the Magi to the infant Christ, the baptism being relegated to a mere mention in the octave (the eighth day after the feast).

December 25 in Rome.—This was the date of a pagan festival in Rome, chosen in A.D. 274 by the emperor Aurelian as the birthday of the unconquered sun (*natalis solis invicti*), which at the winter solstice begins again to show an increase of light. At some point before A.D. 336 the church at Rome established the commemoration of the birthday of Christ, the sun of righteousness, on this same date. The evidence is contained in the chronography of A.D. 354 (an almanac for the use of Christians), which includes a Christian martyrology beginning with an entry for Dec. 25: "Christ born in Bethlehem of Judaea" (*natus Christus in Betleem Iudaea*). It can be shown, however, from another part of this chronography that Christmas was celebrated in Rome at least as early as 336, and that it stood at the beginning of the church year.

January 6 in Egypt.—Clement of Alexandria (*c.* A.D. 200) reports that Gnostics in Egypt celebrated the day of Christ's baptism on Jan. 10, though others said Jan. 6 was the correct date. In either case the date was thought to be the anniversary of the actual event. Clement does not give the name of this festival. The earliest reference to Jan. 6 as a festival of the church in Egypt, as opposed to a commemoration by Gnostics, comes from nearly two centuries later. Between 380 and 400 John Cassian made two visits to Egypt, where he noted that Epiphany was kept as the festival of both the birth and the baptism of Christ.

Introduction of Christmas in the Eastern Empire.—The first evidence for the celebration of Christmas as a separate festival in the east comes from the capital, Constantinople. In 380 Gregory of Nazianzus delivered his 38th oration on the festival of the Theophany, when Christ appeared to men and was born in the flesh. His 39th oration (381), on Epiphany, called the festival of lights, commemorated the baptism of Christ, the true light. He speaks of Christmas as recently past and reminds his audience that at Christmas they followed the star, worshiped with the Magi, were bathed in light with the shepherds, glorified God with the angels, took Christ in their arms with Simeon and confessed him with Anna. Now, however, at Epiphany, there is another event and another mystery, the baptism.

If in Constantinople, as in contemporary Egypt, Epiphany up until Gregory's two sermons had been celebrated as a unitive festival of the nativity and the baptism, then the careful way he distinguishes the events accompanying the nativity (Christmas) from the baptism (Epiphany) is most naturally explained. Christmas and Epiphany, it seems, had not been long distinct, and the introduction of the former as the celebration of the nativity of the incarnate Son may well have been connected with the struggle against the Arians, who denied Christ's divinity.

Christmas began to be celebrated at about the same time in Antioch as in Constantinople. In his Pentecost sermon in 386 St. John Chrysostom refers to three great festivals, Epiphany, Pascha and Pentecost, and gives the ground for celebrating each of them. At Epiphany he says, "God 'appeared upon earth and lived among men' (Bar. iii, 37); since God the only-begotten Child of God was with us." It seems therefore that there was no Christmas, and Epiphany (as in nearby Jerusalem) may have meant the nativity, for there is no mention of the baptism. Later in the same year the situation seems to have changed, for in his sermon on the martyr Philogonius delivered on Dec. 20 Chrysostom looks forward to Christmas as the birthday of Christ and the festival from which all the others come. This sermon also refers to the visit of the Magi as commemorated at Christmas. Five days later, in his Christmas sermon, Chrysostom says that this day has been known among the Antiochenes for less than ten years, though it has been known longer in the west. It is clear that there was some opposition to the new date, as there was also to the name of the festival. In his sermon preached on Epiphany in 387 Chrysostom explains that the name Epiphany (manifestation) ought not to be applied to Christmas, as some held, but to the festival on Jan. 6, for Christ only became manifest to all at his baptism. It appears that the opposition to Christmas at Antioch was not lasting, for the so-called Apostolic Constitutions, which reflect conditions there at the end of the 4th century, speak of the Nativity on Dec. 25 and the Epiphany on Jan. 6.

The introduction of Christmas to other parts of the east can be passed over more quickly. Gregory of Nyssa (d. *c.* 396), preaching on the Epiphany as the festival of the baptism, says that the Nativity had been observed a few days previously. The separation of the nativity and the baptism into two different days in Egypt is first known in 432. No doubt the Council of Ephesus in 431, with its insistence on the eternal divinity of the child born of Mary, had given an impetus to this celebration. In Jerusalem opposition to Christmas lasted long; it was not until the 6th century that the Nativity was finally detached from Jan. 6 and celebrated on Dec. 25. In the Armenian church Christmas is still not kept, the Nativity being observed on Jan. 6.

Religious Practices.—In the Eastern Church Christmas commemorates the birth of Christ, together with the visit of the shepherds, who were told the good news by an angel on the same day (*cf.* Luke ii, 11), and the adoration of the Magi, about the time of whose arrival no precise indication is given in the Bible (*see* Matt. ii, 1 ff.). In the Western Church the birth and the shepherds only are remembered, for the adoration of the Magi is attached to Epiphany. This usage goes back to 5th-century Rome but the evidence concerning it is obscure and scanty. In the Roman Catholic Church three Masses are said on Christmas day, the first being at midnight and the second at dawn. (X.)

Traditional Customs.—The traditional customs connected with Christmas have been derived from several sources as a result of the coincidence of the feast of the Nativity of Christ and the pagan agricultural and solar observances at midwinter. In the Roman world the Saturnalia (Dec. 17–24) was a time of merrymaking and exchange of presents (*see* SATURN). But, though Christmas festivities were indirectly influenced by these customs, the fact that Christmas was celebrated on the birthday of the unconquered sun gave the season a solar background, connected with the kalends of January (Jan. 1, the Roman New Year) when houses were decorated with greenery and lights, and presents were given to children and the poor. To these solstitial observances were added the Germano-Celtic yule rites when the Teutonic tribes penetrated into Gaul, Britain and central Europe. Yuletide brought its own tradition of feasting and mortuary customs, to combine with Roman solstitial and transitional New Year rites. Special food and good fellowship, the Yule log and Yule cakes, greenery and fir trees, wassailing, gifts and greetings, all commemorated different aspects of this festive season. Fires and lights, symbols of warmth and lasting life, have always been associated with the winter festival, both pagan and Christian. Evergreens, as symbols of survival, have a long association with Christmas festivities, probably dating from the 8th century when St. Boniface completed the Christianization of Germany and dedicated the fir tree to the Holy Child to replace the sacred oak of Odin.

In the United States traditional Christmas customs were at first suppressed (as in England under the Commonwealth), because of the Puritan objection to them as pagan in origin, but since the middle of the 19th century the celebrations have become increasingly popular and commercialized. Christmas is traditionally regarded as the festival of the family and of children under the name of whose patron, St. Nicholas (*q.v.*), presents are given.

See ADVENT; EPIPHANY; CHURCH YEAR; *see* also references under "Christmas" in the Index. (E. O. J.)

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CHRISTMAS CARD: *see* GREETING CARD.

CHRISTMAS MØLLER, GUIDO LEO JOHN (1894–1948), Danish statesman and foreign minister in 1945, was born on April 3, 1894. In 1920 he became a Conservative member of the *folketing*. Energetic and determined, he soon became a leading member of his party and from 1932 was its chairman. Under him Conservative policy became more active and independent and the party cooperated with the Social Democratic-Radical government in an attempt to modify the suffrage laws and the structure of Parliament. When the measure was rejected in a referendum in 1939, Christmas Møller resigned as party chairman. After the German occupation of Denmark in April 1940, he entered the coalition government and, in July, became minister of commerce. A bold critic of the Germans, he was forced to withdraw from the government in October 1940 and from the *folketing* in January 1941. He soon became a leader of the Danish resistance and helped to found an underground newspaper. In May 1942 he fled to London where, as chairman of the Danish Council, he tried to explain and justify developments in Denmark to the Allies, while actively backing the resistance movement. In May 1945 he became foreign minister in the first postwar government. He again became chairman of the Conservative Party, but his insistence that Denmark's frontier with Germany remain unchanged brought him into conflict with the party majority, and he resigned in October 1947. He failed to secure reelection as an independent in 1947. He died on April 13, 1948. (F. SK.)

CHRISTOPHE, HENRY (1767–1820), king of northern Haiti, was born a slave in the British West Indies and was a lieutenant of Toussaint l'Ouverture (*q.v.*) in the war for Haitian independence. When the French attempted to reconquer the colony Christophe surrendered in 1802, but later joined Jean Jacques Dessalines in ousting them and commanded the army under that ruler. After Dessalines' death, Christophe established a separate state in north Haiti, ruling as King Henry I after 1811. He promoted agriculture and trade by forcing the peasants to work under military rule, and built the famous citadel. After suffering a stroke in 1820, he shot himself on Oct. 8, 1820, and his kingdom became part of the Haitian republic. *See* HAITI: *History*.

(D. G. Mo.)

CHRISTOPHER, SAINT (? 3rd century), patron of wayfarers, was martyred, according to tradition, under the emperor Decius *c.* A.D. 250. He is the hero of many later legends, which represent him as a giant who, after being converted, devoted his life to carrying travelers across a river. One day a small child asked to be taken across; but in the middle of the river the child became so heavy that Christopher staggered under the burden. "Had I borne the whole world on my back," he said, "it could not have weighed heavier than you." "Marvel not," was the reply, "for you have borne upon your back the world and Him who created it." Hence Christopher is generally represented in art carrying the Christ Child on his back. He is one of the 14 auxiliary saints, or holy helpers. His feast day is July 25 in the western church and May 9 in the Orthodox Church.

See C. Johnson, *St. Christopher* (1938). (H. C. G.)

CHRISTOPHER (CHRISTOPHORUS) (d. 904), antipope. This cardinal's name appears in many lists of the popes, but he is now regarded as having been an antipope. In 903 he drove Leo V from the papal chair, but in 904 was driven out in turn by the supporters of Bishop Sergius, who became Pope Sergius III. It is said that both Christopher and his victim Leo were strangled in prison. (D. Ar.)

CHRISTOPHER OF BAVARIA (1416–1448), king of Denmark, Norway and Sweden, was born in Feb. 1416, the son of John, count of the Upper Palatinate, and Catherine of Pomerania. In Oct. 1439 the Danish *rigsraad* invited him to take the crown as successor to the deposed Eric of Pomerania, his maternal uncle. On April 9, 1440, he was proclaimed king of Denmark. The country soon settled into a period of peace, marred only by the Jutland peasant rising of 1441, which was quelled. In the same year Sweden accepted Christopher as king, and in 1442 Norway followed, thus confirming the Northern union and restoring peace throughout Scandinavia. In 1443 he was crowned in Ribe as Denmark's *archirex*. When he died, without issue, in Jan. 1448, the union once more fell apart. (A. E. Cn.)

CHRISTUS, PETRUS (*c.* 1420–1472/73), Flemish painter, the closest of Jan van Eyck's followers, was born at Baerle in Brabant, in 1444 acquiring citizenship rights at Bruges, where he worked until his death. Following the example of Jan van Eyck, he added a date and signature, usually in the form "PETRUS XPI," to some of his pictures. These include "Edward Grymeston," 1446 (earl of Verulam's collection); "A Carthusian," 1446 (New York); "St. Eligius," 1449 (New York); "Virgin and Child," 1449 (Lugano); altar wings with "Annunciation," "Nativity" and "Last Judgment," 1452 (Berlin); and the "Virgin With SS. Jerome and Francis," probably 1457 (Frankfurt).

Among other pictures ascribed to him are two versions of the "Nativity" (Washington, D.C.; New York), three versions of the "Lamentation Over the Dead Christ" (Brussels; New York; Paris), the "Virgin With a Carthusian" (Berlin) and two portraits (Berlin; London).

Although his work is most like Jan van Eyck's, some of his motifs and compositions show that Christus was no stranger to the different tradition exemplified by Robert Campin and Rogier van der Weyden. These borrowings from more powerful spirits tend to overshadow and confuse his personal development. Compared with Van Eyck's all-seeing eye or with Rogier's emotional force his pictures seem empty, conventional and phlegmatic. Nevertheless, they remain admirable for their careful construction and jewellike execution.

The Frankfurt "Virgin With Saints" is the earliest Netherlandish picture with a single vanishing point.

See E. Panofsky, *Early Netherlandish Painting* (1954). (D. Kg.)

CHROMATICISM, a musical term signifying the use of notes extraneous to the mode or scale in which a piece is written and introduced to intensify melodic design or harmonic texture. The term derives from the Greek, *chroma* ("colour"), the chromatic tetrachord in Greek music consisting of four notes, A, F♯, F, E, marked by two semitone intervals. Possibly under the influence of oriental melodies, the intervals of the Greek tetrachords were modified or coloured by fractions of a tone, such inflections being known as the *chroai*.

In medieval music chromaticism was associated with the theory of *musica ficta* which provided for the introduction of notes foreign to the modes. In the 16th and 17th centuries chromaticism was widely used to illustrate or underline literary associations, notably in the English and Italian madrigals. An early English example is John Danyel's "Chromatic tunes most like my passions sound" (1606). With the establishment of the major and minor scales of tonality chromaticism was integrated into contrapuntal technique. Chromatic themes were used as subjects for fugues. At the same period chromatic harmony was used in cantatas, oratorios and operas for dramatic or pictorial purposes, notably to convey disintegration in "The Representation of Chaos" in Haydn's *Creation*. The expressive resources of chromaticism were progressively explored by Mozart, Beethoven and the romantic composers.

At the end of the 19th century a much wider use was made of chromaticism and this was soon to present a dilemma. From the technical viewpoint chromatic features in classical or romantic harmony had been mainly used for the purpose of modulation to another key. In the works of César Franck and Alexander Scriabin chromaticism and modulation were almost constant. In the works of Wagner chromatic inflections were increased to a point which frequently obscured or undermined the sense of tonality. As a result, the function of chromaticism as a means of intensifying expression was correspondingly reduced. Later composers either rejected the tonal scale in favour of a chromatic scale in which none of the 12 notes in the octave is allowed to predominate, or established harmonic systems based on personal conceptions of chromaticism. (E. Lr.)

CHROMATOGRAPHY is a term that describes a number of physical methods used in chemistry and biology to separate and identify mixtures of chemical compounds. Although the term implies that colour (Greek *chroma*) is a necessary part of the detection procedure, no such limitation exists in fact; the methods can be applied to coloured and uncoloured compounds alike.

The principle behind all variants lies in the repeated subjection of a mixture of chemical compounds to extraction by liquid or adsorption on a solid surface. The mixture is moved physically past a stationary phase, which may be either a solid or a liquid immobilized in the pores of a solid. The various components of the mixture migrate from the moving phase into the stationary phase and back again into the moving phase. This process is repeated many times during the course of travel. If differences in solubility or adsorption exist between the components of the mixture, the more strongly adsorbed or more soluble compounds will gradually lag behind the less strongly adsorbed or less soluble ones. In sufficient time a complete separation can thus be brought about. (For the physical and chemical principles underlying these processes *see* ADSORPTION and SOLUTIONS.)

The moving phase may be a mixture of gases, a mixture of liquids or a liquid containing dissolved solids. The table summarizes several possible combinations and the common names by which techniques are known.

Two basically different physical separating principles are involved; *i.e.*, separation due to differences in solubility in two immiscible phases (partition chromatography), and separations

Name	Mixture	Stationary phase	Moving phase
Gas chromatography	Gas or vapour	Liquid (held by solid)	Gas
Partition chromatography .	Liquids or dissolved solids	Liquid (held by solid)	Liquid
Paper chromatography	Liquids or dissolved solids	Liquid (held by solid)	Liquid
Adsorption chromatography .	Gas or vapour	Solid	Gas
Adsorption chromatography .	Liquids or dissolved solids	Solid	Liquid
Ion exchange chromatography .	Ions in solution	Solid	Liquid

due to differences in adsorption on a solid surface (adsorption and ion exchange chromatography). The former method, although historically more recent, has found wider use, particularly in biochemical research where the separation of small amounts of complex mixtures is difficult. However, for convenience, the adsorption methods will be discussed first.

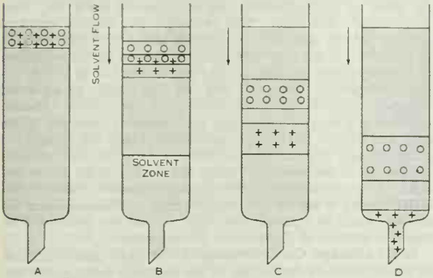

FIG. 1.—SEPARATION BY ELUTION CHROMATOGRAPHY

Stages in the separation of two components: (A) mixture applied to the top of a packed column; (B) partial separation of the mixture after application of solvent. Note that solvent front is ahead of either component; (C) complete separation. At this point components could be separated by sectioning the column; (D) the faster moving component leaving the column together with the solvent

The invention of adsorption chromatography is attributed to the Russian botanist M. S. Tswett, whose earliest publication on the separation of leaf pigments appeared in 1903. Prior to Tswett's work, petroleum chemists were aware of the separation possibilities of solid adsorbents. Tswett, however, provided the clearest insight into the elementary processes occurring on adsorption columns. Although his publications remained unrecognized and unapplied for nearly 30 years, a rapid growth began in 1931, when R. Kuhn and co-workers demonstrated the efficacy of the method in the separation of vitamin A fractions. The method has been applied to a wide variety of classes of compounds, including the chlorophylls, blood pigments, dyestuffs, fats, sugars, amino acids, hormones, alkaloids, vitamins, and enzymes. Without chromatographic separations the resolutions of complex mixtures would not only be difficult but would also require time-consuming manipulations and large sample sizes. Major advances in the understanding of the chemical steps in photosynthesis, protein structure and metabolic pathways can be attributed to the availability of chromatographic techniques.

Elution Chromatography.—The technique of adsorption chromatography is quite simple, the apparatus consisting of a tube filled with a solid adsorbent through which a mixture is allowed to flow. The sample is introduced at the top of the column. In the method known as elution chromatography, the sample is swept through the column by a solvent that is continuously introduced at the top and that flows through the tube by gravity or is aided in its flow by pressure on the top or suction at the bottom of the column. As shown in fig. 1, the mixture is gradually separated into its components, which move as bands (or zones) down the column. Adsorbent and solvent have to be chosen so that the components of the mixture will establish a suitable distribution ratio between the amount remaining in the solvent and the amount adsorbed on the surface. If adsorption on the solid is low, the separation effect for a given column length will be low. On the other hand, if the solid adsorbs very strongly, the rate of progress of the substance through the column will be slow and the separations will require a long time.

Choice of Adsorbents.—Since the method can be applied to so many different classes of compounds, it is difficult to generalize about suitable adsorbents or solvents. Under no circumstances, however, must the adsorbent be soluble in the solvent, nor must it react with or decompose the substances that it is intended to separate. Furthermore, for ease in locating the position of the zones it is desirable for the adsorbent to be colourless. This requirement is not as stringent as the first two since it is frequently more convenient to collect the separated samples after complete elution at the bottom of the column rather than to identify the bands while they are still adsorbed on the solid. Another important requirement for a successful adsorbent material is availability in reproducible form so that similar results can be obtained with different charges of the same substance. The absence of strict reproducibility is to some extent responsible for the eclipse of adsorption methods by partition techniques.

Commonly used adsorbents include such inorganic compounds as alumina, magnesia, fuller's earth, lime and calcium carbonate and, in the organic field, sucrose, starch and charcoal. Adsorbents cannot easily be classified according to their strength of adsorption without specifying the particular solvent and material that is being adsorbed. Well-dried aluminas and activated carbons, however, show strong adsorption characteristics under most conditions whereas the organic solids are generally weak in their adsorption behaviour. Since the nature of the solid has such pronounced effects on the separation of mixtures, it is clearly desirable to have adequate quantitative information concerning its activity. The surface structure of a given adsorbent and not merely its chemical nature plays a major role. The fine distinction made by structural effects can be shown by silica gel, whose adsorptive powers toward a particular dye can be increased more than tenfold by preparing the gel in the presence of the dye. In a manner not fully understood, the surface of the gel is adjusted to the shape of the dye in whose presence it was prepared, with the result that the gel shows markedly smaller attractions toward dyes that differ even only slightly in molecular structure. In view of this sensitivity, reproducible results can be obtained only by the strictest maintenance of uniformity and stringent control during the manufacture of the adsorbent.

Several physical measurements can be used to determine the characteristics of various batches of the same adsorbent. The heat of wetting of a particular liquid on a known amount of adsorbent is a useful measurement although it may fail if the solid is composed of a mixture of particles having widely different surface structures. A more direct determination consists of the measurement of the rates of movement of bands of known compounds along the column. Column packings can then be specified by the packing density of the solid in the column (which is a function of the method by which the column was prepared, as well as the particle size and shape of the solid), by the rate of flow of the developing solvent through the column and by the ratio of flow velocity of the substance being adsorbed to the flow velocity of the solvent. This latter term (commonly designated R_f), when specified for particular systems of solvent and adsorbent, is useful in indicating the relative ease of separation of two substances. If R_f values of two compounds differ by less than 10%, resolution is likely to be unsatisfactory.

Choice of Solvents.—The solvent has the multiple function of introducing the mixture onto the column, of resolving the mixture into components and removing the components from the column. The solvent plays its role by competing with the materials to be separated for the various adsorption sites on the solid. Solvents differ widely in their adsorption behaviour on solid surfaces. The choice of solvent will depend on the nature of the substances to be separated and on the adsorbing surfaces. For the more frequently used hydrophilic adsorbents, such as the aluminas, the sequence of increasing eluting power is: petroleum ether, benzene, chloroform, diethyl ether, ethyl acetate, acetone, ethyl alcohol, methyl alcohol, water and pyridine. Thus pyridine, as the strongest solvent, can be used for the resolution of substances that are held with great tenacity on the solid adsorbent. Although this sequence is generally maintained in measuring the eluting power toward a single substance, it is frequently observed that in the presence of several substances or in case of mixed solvents inversions in the above order are found. This can be applied usefully as proof of the purity of a substance that can be considered established if no further resolution into components takes place on a variety of adsorbents and from a number of solvents.

After separation, the zones can be located in a variety of manners. When the tube is transparent and the components coloured, the bands can be seen readily. Frequently, colourless substances will fluoresce under ultraviolet light. A less satisfactory procedure is to remove the entire packing from the column and treat it with a thin line of a substance that forms a coloured reaction product with the adsorbed substances. Sugars, for example, can be located with permanganate solution. If the chromatographic process is continued until the bands of the various fractions appear in the effluent, identification can be made by any one of a number of physical measurements; *e.g.*, determination of refractive index or thermal conductivity. (*See* ADSORPTION: *Applications of Adsorption.*)

Partition Chromatography.—The technique of partition chromatography has assumed greater importance than has adsorption chromatography for two reasons: it can readily be adapted to the separation of very small amounts of mixtures (paper chromatography), and it also deals with a simpler principle of separation. Partition chromatography depends on the fact that dissolved substances are in continual transport between a moving carrier phase and a stationary liquid phase. Under near-equilibrium conditions the distribution of a dissolved substance between these two phases depends upon its relative solubilities therein. The ratios of the concentrations of substances in the two phases are very often independent of the absolute concentration, in contrast with the ratios encountered in adsorption chromatography. This fact is of great importance in preventing unwanted spreading out (tailing) of the adsorption bands.

The technique utilizes a porous solid to immobilize the stationary liquid phase. The carrier can be either a liquid or a gas. The only requirements are that the substances to be separated be soluble in both phases and that the phases themselves show no appreciable miscibility. If the stationary liquid is held by a granular solid, such as silica gel, the apparatus and manipulations are very similar to adsorption chromatography.

If the moving phase is a gas, a wide variety of classes of compounds such as hydrocarbons, organic solvents, etc., can be separated as vapours. In gas chromatography the stationary liquid phase should be kept at sufficiently low temperature so that it remains in the column indefinitely. Glycerol, silicone fluids, dinonyl phthalate and other high-boiling liquids can be used as the stationary liquid phase. The separated gases are detected by measurement of either thermal conductivity or gas density. The method gives quantitative results and can detect quantities as small as 0.1% by volume.

Paper Chromatography.—A remarkable modification of partition chromatography has become a most powerful and widely used analytical tool, viz., the use of sheets of paper as the means of stabilizing a stationary water or other liquid phase. Paper will absorb enough water from a humid atmosphere so that no additional moistening is required. Apart from its simplicity of operation, paper chromatography is admirably suited to micromanipulations. This is of particular importance in biochemical work where the sample quantities are frequently small.

The method consists of applying the mixture as a spot in one corner of the paper. Developing solution is then allowed to flow down the paper by capillary action, thereby resolving into a number of individual spots. To prevent solvent evaporation during development, the paper is held in a glass jar and surrounded by an atmosphere saturated with the solvent. If the solvent flowing in one direction is not able to separate all the components satisfactorily, the paper may be turned through 90° and further development carried out with another solvent or solvent mixture (fig. 2). As many as 16 components can be separated using the "two-dimensional" technique. This procedure has become standard practice for the separation of complex amino acid mixtures and of peptides. It has also been widely employed in the separation of carbohydrates, steroids, purines and a long list of simple organic compounds. Inorganic ions can also readily be separated on paper. Solvents are chosen for the particular problem. Phenol, collidine and butanol-acetic acid are commonly used for amino acids and sugars. If the spots are colourless they can be detected either through reagents sprayed onto the paper to form coloured compounds of the substance, or by observation under fluorescent light. A very sensitive detection technique consists of using radioactive tracers in making the chromatogram and then exposing the chromatogram to a photographic film, so that the radiation indicates the position of the spots by self-exposure.

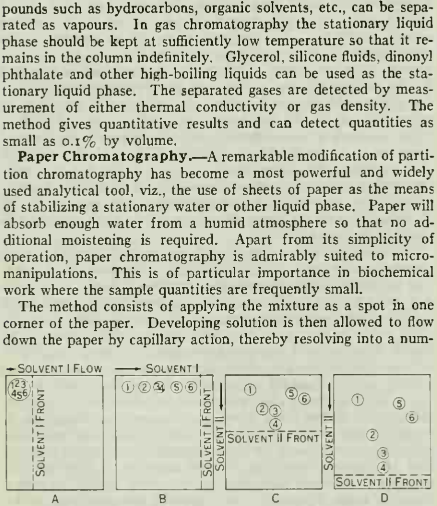

FIG. 2.—"TWO-DIMENSIONAL" PAPER CHROMATOGRAPHY

Steps in the separation of a six component mixture: (A) solvent I beginning to separate components initially mixed together; (B) partial separation achieved but components 3 and 4 not separate; (C) further separation achieved by use of solvent II and chromatographing at right angles to previous flow; (D) separation of all components. Spot positions can be located by means of colour reagents

Ion Exchange Chromatography.—A more specialized case of chromatography makes use of ion exchange resins as the immobile solid phase and can be used to separate ionized compounds. Instead of adsorption, the substances displace inorganic ions from the solid and are in turn displaced by a developer containing ions that are even more strongly held by the solid. Ion exchange materials are available as two major types in which either an anion or cation is exchangeable. A remarkable application of this method is the separation of compounds of the rare earth group on cation exchange columns.

For a detailed discussion of ion exchange chromatography *see* ION EXCHANGE: *Applications.*

Gas Chromatography.—This is a variation of partition chromatography in which a moving gas stream carries a mixture through a column of a stationary liquid or solid phase, on which resolution into components takes place.

Gas chromatography is widely used for assaying mixtures, for the preparation of pure compounds, and for the determination of physical constants such as heats of solution and vaporization, vapour pressure and activity coefficients. In view of its simplicity, sensitivity and high resolving power, gas chromatography has become one of the most important analytical tools in chemistry.

Technique.—The gaseous components of the sample move through the column at rates which are influenced by the degree of interaction of each constituent with the stationary nonvolatile phase. The substances having the greater interaction with the stationary phase are retarded in their passage and, consequently, separate from those with smaller attraction. An inert gas acts as the carrier for the sample, and flows through the instrument continuously.

The basic components of a gas chromatograph apparatus are shown in fig. 3. The carrier gas enters the instrument through control valves which determine the flow rate. If the detector is a differential device, *i.e.*, one which responds to a change of a particular physical constant between the carrier gas without and with a sample component, the carrier gas first flows through the reference side of the detector and then to the sample port, where the sample is introduced. The combined sample and carrier gas traverse the column, where the sample is resolved into components. As each component leaves the column with the carrier it passes through the detector again for comparison with the reference value and then goes either to a fraction collection or is discharged into the atmosphere.

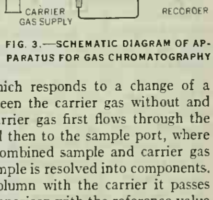

FIG. 3.—SCHEMATIC DIAGRAM OF APPARATUS FOR GAS CHROMATOGRAPHY

Carrier Gases.—The most frequently used carrier gases are helium, nitrogen, hydrogen and argon. They must not react with either the sample, the stationary phase or the detector. Helium is preferred for most analytical procedures where changes in thermal conductivity are measured. Flame ionization detectors use hydrogen which, on mixing with air, produces a flame in which components of the sample are ionized for subsequent detection. Argon is used in beta-ray detection systems because of the long half-life and energy content of its metastable atoms, which ionize selected constituents for subsequent detection.

Sample Introduction.—Samples may be introduced into the carrier either as a liquid or as a gas. Liquid samples, usually in the order of 0.01 cu.cm. or less, are rapidly injected into a chamber which is maintained at a temperature that ensures quick and complete vaporization of the sample. Common methods of introduction are by microsyringes through a self-sealing rubber septum, or by means of calibrated capillary tubes. For the latter, part of the carrier-gas stream is diverted quickly to the capillary, forcing the liquid sample into the heated chamber.

Gas mixtures are introduced by trapping a sample in a bypass line of known volume. By rapid switching of valves the carrier gas pushes the sample out of the trap into the main carrier stream. Microsyringes have also been used successfully.

Columns.—Columns can be made of glass or metal of convenient length and diameter. The column packing may consist of a variety of liquids, held stationary on supporting solids such as diatomaceous earth, alumina, glass beads or fluorocarbons. Nearly any unreactive, nonvolatile liquid may be used as the stationary phase. As a general rule its boiling point should be 150°–200° C. above the column temperature, to minimize its gradual vaporization.

The stationary liquids are divided into two groups, depending on whether or not they show selectivity for particular functional groups. Separation on nonselective columns (silicone oils and greases, squalene, Apiezon grease) is due mainly to differences in vapour pressure or diffusion rates of the components. In selective columns a preferred interaction of components with the stationary liquid phase (esters, polyglycols, alcohols, acids, amines), based on complementarity of chemical structures, plays the major role.

A third group of column materials includes so-called molecular sieves—solid absorbents whose structure permits diffusion of gases of small molecular size into pores of carefully controlled dimensions while rejecting gases whose molecules are too large. Such materials are particularly useful for the separation of gases of low molecular weight, such as methane, ethane and other hydrocarbons (fig. 4).

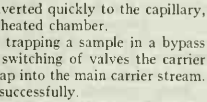

FIG. 4.—CHROMATOGRAPHIC SEPARATION OF HYDROCARBONS ON MOLECULAR SIEVE 3A AND ALUMINA COLUMN

In addition to the packed columns, capillary columns in which the stationary liquid phase covers the capillary wall are in use with internal diameters of less than 0.01 in. (0.25 mm.) and several hundred feet long. Such columns are very efficient separation devices but have the disadvantage of relative slowness and small capacity.

Detectors.—The function of the detectors is to sense and measure the small amounts of components in the carrier-gas stream as they leave the column. An ideal instrument would be sensitive and versatile in detecting a wide variety of compounds and would also be stable and nonreactive. Such universality does not exist; therefore detectors must be chosen and optimized for the particular components under investigation. The physical characteristics that are measured can usually be interpreted in terms of concentration in the initial sample if proper calibrations are performed and standardized procedures are followed. The chemical nature of the substance giving rise to a signal can only rarely be identified directly; the help of other diagnostic methods is required.

Thermal conductivity detectors depend on the cooling effect of a gas flowing over a heated element. When the thermal conductivity of a sample component and of the carrier gas differ, a differential signal will be obtained when the thermal conductivity of the pure carrier gas is compared with carrier gas that contains a sample component.

In the beta-ray argon detector, radiation from strontium-90 or krypton-85 is used to produce metastable atoms in the argon carrier. These atoms, in turn, transfer their energy to components that ionize rather readily. The resulting ions can be detected with great sensitivity.

Flame ionization detectors measure the electric conductivity in a flame which is produced by the carrier gas (hydrogen) as it burns in air after leaving the column. Pure hydrogen flames conduct very little current. However, many compounds, when added to the hydrogen flame, give rise to thermally induced ionization which results in a strong signal.

Applications.—The most common use of gas chromatography is as an analytical tool to separate and detect components in mixtures. It may be used in conjunction with infrared or ultraviolet spectroscopy, which identifies the separated components specifically. Gas chromatography is particularly suitable for those mixtures in which the chemical identities of the components are known but not their relative amounts. In that case, substances can readily be detected and identified on the basis of their time of arrival at the detector and the magnitude of the detection signal.

Another use is in the preparation of very pure compounds in large amounts. Production rates are limited only by the size of the column and by their number. The desired fraction is collected as it leaves the column and separated from the carrier gas.

Gas chromatography is used to monitor industrial processes automatically. Gas streams are analyzed periodically and manual or automatic responses are made to counteract undesirable variations.

Many routine analyses are performed rapidly in medical and other fields. By the use of only 0.1 cc. of blood it is possible to determine the percentage of dissolved oxygen, nitrogen, carbon dioxide and carbon monoxide. Gas chromatography is also useful in the analysis of air pollution, alcohol in blood, essential oils and food products.

Related Techniques.—In view of the great need in analytical chemistry to separate and identify components in complex mixtures, the search for methods based on the chromatographic principle has been intense. The following techniques have found increasing use in special cases:

Gel Filtration.—The conventional stationary liquid or solid adsorbents in the chromatography column are replaced by small polymer beads, usually made up of cross-linked macromolecules of sugars. Depending on the degree of polymerization the beads allow small molecules to diffuse into their interior while large molecules cannot enter the gel pores. The method is especially useful in separating proteins, peptides and amino acids from each other and from low-molecular-weight impurities.

Thin-layer Chromatography.—The principle of paper chromatography has been extended by the use of finely ground materials such as silica gel, alumina, ion exchange resins, etc., which are placed as a thin film between two glass plates. The unknown material is deposited as a spot near one corner of the assembly and its components eluted with a suitable solvent. The technique is most useful in situations where only small quantities of mixture are available.

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CHROME STEEL: *see* IRON AND STEEL INDUSTRY; STAINLESS STEEL.

CHROMITE, a member of the spinel group of minerals, is an oxide of chromium and ferrous iron. It is the chief commercial source of chromium and its compounds. The earliest worked deposits of chromite were those in the serpentine of the Bare hills near Baltimore, Md. The principal producing areas of chromite are, in the order of their importance, Southern Rhodesia in the Federation of Rhodesia and Nyasaland, U.S.S.R., Turkey, Republic of South Africa, Republic of the Philippines, Yugoslavia, India, Greece and New Caledonia. Chrome ore is used in manufacturing special steels and alloys, as a metallurgical refractory and in manufacturing chemicals used in dyeing, tanning and pigments.

Chromite crystallizes in regular octahedra (*see* SPINEL), but is usually found as grains or as granular to compact masses. In its iron-black colour with submetallic lustre and absence of cleavage it resembles magnetite (magnetic iron ore) in appearance, but differs from this in being only slightly, if at all, magnetic and in the brown colour of its powder. The hardness is 5.5; specific gravity, 4.5. The theoretical formula $FeCr_2O_4$ corresponds with chromic oxide (Cr_2O_3) 68%, and ferrous oxide 32%; the ferrous oxide is, however, usually partly replaced by magnesia and the chromic oxide by alumina and ferric oxide, so that there may be a gradual passage to picotite or chrome spinel. Much of the material mined as ore does not contain more than 40% to 50% of chromic oxide. (W. F. FG.)

CHROMIUM. The element chromium was first isolated in 1797 by L. N. Vauquelin from the mineral crocoite which was discovered in 1765 in Russia by P. S. Pallas. It is from the Greek *chromos,* meaning colour, due to the varied colour of its compounds. The green colour of emerald, serpentine and chrome mica, and the red colour of the ruby, are due to chromium.

Although chromium is widely dispersed in natural deposits, it is never found in the uncombined state. Chromite, $FeO.Cr_2O_3$, is the only important ore of chromium, and the major producing areas are Southern Rhodesia in the Federation of Rhodesia and Nyasaland, the U.S.S.R., Republic of South Africa, Turkey and the Philippines; the principal U.S. mine is in Montana. The chemical composition of chrome ore varies between 42% and 56% chromic oxide, Cr_2O_3, and 10% to 26% FeO. Most of the ores mined are of a sufficiently high grade to be marketed without beneficiation.

Chromite was first used to make chromium chemicals about 1800 to 1816, and was first employed as a refractory in 1879. Although a patent was granted on a chromium steel in 1865, it was not until much later—1904 to 1913—that chromium became important metallurgically in steelmaking. The chief uses of chromite are metallurgical, refractory and chemical.

USES

Metallurgical.—The metallurgical use is derived from the addition of chromium to iron, nickel and other metals to increase their strength, and corrosion and oxidation resistance. It is added to steel in the form of ferrochromium, containing about 70% chromium as a high- or low-carbon grade alloy.

High-carbon ferrochromium (4% to 6% carbon) is used in producing steels in which chromium and carbon must be present. The chromite used for ferrochromium production contains a minimum of 48% chromic oxide and a usual ratio of chromium to iron of about three to one, although a considerable amount of alloy with ratios different than three to one is used in the steel industry. Coke is employed as the reducing agent. The charge is fed into the top of an open-top, submerged arc furnace, and the molten metal collects at the bottom of the furnace and is cast into chill molds. After cooling, it is broken up into lumps and is graded.

For steels in which carbon is detrimental, low-carbon ferrochromium is produced. A silicon reduction of chromite is used. This is a two-step process. In the first stage, a high-silicon ferrochromium substantially carbon-free is produced in a submerged arc furnace. This product is then treated in open-arc-type furnaces with a synthetic slag containing chromic oxide. The alloy produced has a carbon content in the range 0.03% to 0.15%.

A ferrochromium of very low carbon content (0.01% carbon) is made by heating high-carbon ferrochrome with ground quartzite in a high vacuum with the removal of carbon as carbon monoxide.

For making alloys of the chromium-nickel, heat-resisting type, chromium copper and other nonferrous alloys, a chromium metal low in iron is desired. Metal of this grade may be produced by thermal or electrolytic methods. In the thermal processes, chromic oxide is reduced with aluminum or silicon. Although both reactions are exothermic, not enough heat is generated in the silicon reduction to complete the reaction, and this reaction is carried out in an electric arc furnace. Other thermal methods, such as the reduction of chromic chloride by hydrogen or magnesium, produce a high-grade metal, but these methods have not been exploited.

A very high grade of metal may be made by wet electrolysis of chromic acid and sulfate or chrome alum. The metal is contaminated with oxygen and hydrogen. The oxygen can be removed by heating the metal in hydrogen at a high temperature, and hydrogen may be eliminated by heating the metal at 400° C. Oxygen can also be eliminated by heating the metal with carbon in a vacuum. Fusion electrolysis of chromic chloride in a potassium chloride-sodium chloride electrolyte has produced chromium metal, but this process is not used commercially. Metal produced by the dissociation of chromium iodide at a low temperature in a vacuum with the subsequent deposition of the liberated chromium on a filament heated to a high temperature is the purest form of chromium that has been made.

Pure chromium metal may be arc-cast by consumable or nonconsumable electrode techniques or formed by powder metallurgy methods. The ingots so produced possess a certain degree of workability and may be hot-forged and sheath-rolled to a degree.

Steels containing chromium in amounts up to about 3% have improved physical properties and are more susceptible to heat-treatment than plain carbon steels. In conjunction with other elements such as molybdenum, nickel, manganese and vanadium, the steels of this type are used for springs, roller and ball bearings, dies, rails and high-strength structures. Steels containing 5% to 6% chromium have increased resistance to oxidation and corrosion and are used in the oil industry in the form of tubes. Another group of steels, known as stainless irons or steels because of their superior resistance to oxidation and atmospheric corrosion, contain 10% to 18% chromium. The susceptibility to heat-treatment and corrosion resistance of this group depends on the carbon content. The low-carbon varieties (0.10% carbon or lower) cannot be hardened by heat-treatment if the chromium content is over about 13%. Their corrosion resistance is good, and the higher chromium steels may be used as automobile trim and in handling nitric acid. Steels with about 13% chromium and 0.3% carbon are heat-treatable and are used for cutlery. High-carbon (1% to 2%) steels of this type are used when hardness and abrasion resistance are of importance; for example, special tool and die steels. Chromium contents of 25% to 30% impart excellent oxidation-resisting properties to steels, and they are used for furnace parts, burner nozzles, heat exchangers, kiln linings, etc. (*see* also STAINLESS STEEL).

Other alloying elements, such as nickel and manganese, can be added with chromium to steels to form the austenitic types of which the 18% chromium-8% nickel variety is probably the best known. These stainless steels are resistant to oxidation and corrosion and retain their strength at high temperatures much better than the plain chromium steels. They are used where resistance to creep at high temperatures is required. They sometimes contain additions of molybdenum, tungsten, columbium or titanium to add strength and corrosion resistance to the alloy or to stabilize the carbides present.

There are a great number of other alloys containing chromium, such as the Stellites, electrical resistance materials and turbine alloys. Chromium is also added to cast iron (*q.v.*) to increase its tensile strength and wear and heat resistance.

Refractory.—Next in importance to the metallurgical application of chromium is the use of chromite as a refractory. A typical analysis of a chromite suitable for refractory purposes would be 38% to 48% Cr_2O_3, 12% to 24% Al_2O_3, 14% to 24% Fe_2O_3, 14% to 18% MgO, and under 10% SiO_2. The usefulness of chromite as a refractory is based on its high melting point, moderate thermal expansion, stability of crystalline form at elevated temperatures and its neutral chemical behaviour.

The melting point frequently given for chromite is the value 2,180° C. These refractories are among the heaviest produced, and the specific gravity varies between 4 and 4.6. Their thermal stability is one of the most valuable properties, as there are no polymorphous forms to cause sudden volume changes on heating.

Chromite exhibits some shrinkage on heating which is caused by the silicates present. Cuban ore at 1,500° C. shows a linear shrinkage of 1.5%.

Chrome refractories are available in the form of molded brick and shapes, plastic mixtures consisting of moistened aggregates which are rammed in place, castables composed of dry aggregates and a binder which after mixing with water can be poured like concrete, and mortars and cements for laying brickwork. Crushed raw ore is also sold for patching or filling holes.

Bricks comprised of 100% chrome ore have been largely replaced by bricks composed of mixtures of chrome ore and magnesia for greater refractoriness, volume stability and resistance to spalling. One of the refractories used in the fused-cast condition is composed of 80% alumina and 20% chromite. This product is the most corrosion-resistant refractory commercially available and is very resistant to a variety of fluxes, slags and glasses.

Chemical.—The third application of chromite is for the production of chrome chemicals. For this purpose, the ore should contain a minimum of 45% Cr_2O_3, and the iron content may be higher than for the other applications. The production of sodium dichromate is usually the first step in making chemicals. This reagent is produced by heating the ore with soda ash and then leaching out soluble chromate which is converted to the dichromate by treatment with sulfuric acid.

One of the chief uses of chromium chemicals is for the production of pigments. Chrome oxide green, which is nearly pure Cr_2O_3, is the most stable green pigment known. It is used for colouring roofing granules, cements and plasters. It is also employed as a fine powder for polishing purposes. Chromium yellow varies greatly in the shades available and is essentially lead chromate. This pigment makes an excellent paint for both wood and metal. Zinc yellow, a basic zinc chromate, is used as a corrosion-inhibiting primer on aircraft parts fabricated from aluminum or magnesium. Molybdate orange is a combination of lead chromate with molybdenum salts. Chromium green is a mixture of lead chromate with iron blue. This pigment has excellent covering and hiding power and is widely used in paints. Pigments account for about one-third of the primary production of chromium chemicals.

The textile industry accounts for about 10% of the primary production of these chemicals. They are used as mordants, in textile-printing compounds and in aftertreatments. Both trivalent and hexavalent compounds (see *Compounds,* below) are employed, and such reagents as basic chromic acetate, basic chromic chloride, chromic fluorides, bisulfites, lactates, bromates, oxalates and thiocyanates are employed.

About 25% of the chromium chemicals produced go into chrome tanning. Practically all types of leather tanned use chrome reagents in the form of basic chromic sulfates which, in turn, are produced from the dichromate.

The insolubilizing action of chromium chemicals is used for hardening photographic films and in photoengraving.

Over one-fourth of the primary chromium chemicals are used in metal surface treatments and corrosion control. Such applications are: chromium plating; chromizing; anodizing aluminum; treatment of zinc and magnesium; dips for iron, steel, brass and tin; inhibitors for brines and recirculating water systems; and for a large number of combinations in the oil and gas industries.

These chemicals also find important use for organic oxidations such as the production of synthetic dyes, saccharin, benzoic acid, anthraquinone, camphor, synthetic fibres, bleaching and the purification of chemicals. Other chemical uses are: application as an analytical reagent; for inorganic and electrochemical oxidations; in electric dry cells, slushing compounds, phosphate coatings and catalysts; and in the manufacture of sponge rubber.

PHYSICAL AND CHEMICAL PROPERTIES

Chromium is one of the transition elements appearing in the sixth group of the periodic table. Its chemical symbol is Cr; its atomic number is 24; and it has an atomic weight of 52.01. Natural isotopes of the following mass numbers and relative abundance occur: Cr^{50}(4.49%), Cr^{52}(83.78%), Cr^{53}(9.43%) and Cr^{54}(2.30%). Radioactive isotopes of masses 49, 51 and 55 have been reported.

Chromium is body-centred cubic in structure with a lattice constant at 20° C. of $a_0 = 2.8787$ kx units. A transition to a face-centred structure at 1,830° C. has been reported. The distribution of the 24 electrons in the various energy levels is $1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^6$, $3d^5$ and $4s^1$. The density of chromium is 7.19 g./cm.^{3} at 20° C.

The melting and boiling points of the metal are $1{,}903 \pm 10$ and 2,480° C., respectively. The linear coefficient of expansion is 6.2×10^{-6} per degrees centigrade. The specific heat is found to be 0.1 cal./g./° C. at 25° C. The values for the entropy are 5.68 cal./degree/mole for solid chromium and 44.64 for gaseous chromium. The latent heat of fusion is 80.75 cal./g., and the latent heat of vaporization is 1,470 cal./g. at the boiling point.

Referred to copper, the volume electrical conductivity equals 12.2% for high-purity chromium, a specific resistance of about 13 microhm-cm. at 20° C. being obtained. The metal does not exhibit superconductivity down to 0.082° K.

Chromium is paramagnetic and the average of two reported mass-susceptibility values is 3.29×10^{-6} c.g.s. unit.

Chromium is steel-gray in colour and when electroplated reflects white light 77%. Its refractive index varies between 1.64 and 3.38 with wave lengths between 2,570 and 6,080 Å. Total emissivity at 100° C. in a nonoxidizing atmosphere is 0.08.

The Brinell hardness of as-cast metal varies between 110 and 170, and that of electrodeposited metal between 500 and 1,250, depending upon the hydrogen content. Annealed electrodeposited metal gives a value between 70 and 90. At a Knoop hardness of 200, a tensile strength of 70,000 pounds per square inch (p.s.i.), and a Young's modulus of 36,000,000 p.s.i. have been reported for annealed electrolytic chromium. Other elastic properties are: compressibility, 0.42×10^{-5} p.s.i.; modulus of compression, 23.5×10^6 p.s.i.; modulus of shear, 10.4×10^6 p.s.i.; and Poisson's ratio, 0.31. The static and sliding coefficients of friction at room temperature of steel against chromium-plated steel are 0.17 and 0.16, respectively.

Chromium may be joined by brazing, using a low-melting-point silver alloy, a potassium fluoborate flux and a reducing flame.

Compounds.—Three series of compounds are formed by chromium: (1) chromous compounds, CrX_2; containing divalent chromium; (2) chromic compounds, CrX_3; containing trivalent chromium; and (3) hexavalent chromium compounds such as chromates and dichromates. Univalent and pentavalent chromium compounds have also been reported.

Chemical Reactions.—Chromium reacts with the anhydrous halogens, hydrogen chloride and hydrogen fluoride, at temperatures about 600° C. Aqueous HF, HCl, HBr and HI slowly dissolve chromium. Dilute sulfuric acid slowly dissolves chromium with the evolution of hydrogen while the metal liberates SO_2 in boiling concentrated acid. At room temperature, fuming nitric acid and aqua regia have no effect on chromium. Many oxidizing agents such as chlorine or bromine water, concentrated nitric, phosphoric, chloric and perchloric acids cause passivity in chromium due to the formation of a thin oxide layer on the metal surface under certain conditions. In the passive state, chromium is not attacked by dilute mineral acids. Chromium is only slightly attacked by acetic acid and not at all by formic, citric or tartaric acids.

Wet or dry air has little effect on chromium at ordinary temperatures. Superficial oxidation takes place in both oxygen and air at elevated temperatures and the metal burns in oxygen at 2,000° C. Water vapour oxidizes chromium at a bright-red heat, but the metal shows no reaction with sea water or aerated rain water at ordinary temperatures.

Alkali hydroxide attacks chromium at a red heat, but it is unaffected by fused alkali carbonates. Chromium reacts with sulfur vapour (700° C.), hydrogen sulfide (red heat) and sulfur dioxide (red heat). Phosphorus attacks the metal at 800° C. Carbon monoxide oxidizes the metal at or above 1,000° C. Molten chromium dissolves up to 4% nitrogen by weight. Ammonia reacts with chromium at 850° C. to form a nitride, and hot nitric oxide forms both nitride and oxide with chromium. Chromium also forms a hydride, and it reacts at high temperature with carbon, silicon or boron. Calcium vapour has very little effect on the metal at a red heat, and under oxidizing conditions chromium attacks porcelain at 1,600° C.

For equilibrium diagrams of chromium with other metals *see* references cited in *Bibliography*.

Toxicology.—Pure metallic chromium, as well as chromite and the trivalent compounds, do not produce any serious damage to the body tissues, and the toxic action of chromium is confined to the hexavalent compounds. These latter compounds exert an extremely irritative, corrosive and in some cases toxic action on the human body. Under certain conditions, these hexavalent compounds cause denaturation and precipitation of tissue proteins. In industrial exposure, they affect chiefly the skin and respiratory tract. The skin reactions cause chrome ulcers and dermatitis. Inhalation of chromate dust or chromic oxide mist causes perforation of the nasal septum, cancer of the respiratory tract and chronic irritation or congestion. The maximum allowable concentration of dusts and mists in the air measured as CrO_3 is 0.1 mg./m.^{3} of air for daily eight-hour exposures.

Analysis.—Chromium can be detected in compounds by the formation of a green borax bead, by the yellow colour of chromates formed on fusion with potassium nitrate, and by the red-violet colour produced by the reaction of dichromates with diphenyl carbazide. In standard qualitative analysis procedure, the chromium is precipitated along with aluminum as the hydroxide as it is not precipitated by hydrogen sulfide in acid solution. Chromium is usually determined quantitatively by oxidation to dichromate followed by titration with a ferrous iron solution of known strength.

See also references under "Chromium" in the Index volume.

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(F. E. B.)

CHROMOSOME. So called because of their affinity for certain dyes, the chromosomes are minute bodies seen in the dividing cells of which the bodies of animals and plants are composed. The word was first used by Wilhelm von Waldeyer-Hartz (1888). Their characteristic configurations and remarkable behaviour in cell division, in the process of development and in the union and formation of the reproductive elements, have been the subject of a large body of research since their discovery in 1873 by Anton Schneider, Walter Flemming, Otto Bütschli and others. The progress achieved during the three decades that followed their discovery made it possible, when Mendel's law of segregation was rediscovered in the opening years of the 20th century, to identify the structural mechanism predicted by him. From that time on intensive study of the behaviour of the chromosomes in relation to breeding experiments resulted in the building up of one of the most spectacular generalizations of modern biology—the chromosome-gene theory, an exposition of which is given in the article CYTOLOGY.

See HEREDITY; GENE; *see* also references under "Chromosome" in the Index volume. (L. T. H.)

CHROMOSPHERE. The solar chromosphere (literally, the colour sphere of the sun) is the attenuated envelope some thousands of kilometres thick that lies immediately above the bright surface or photosphere of the sun. Above the chromosphere lies the hot extensive corona that extends outward for hundreds of thousands of kilometres. (*See* SUN.)

Although the chromosphere can be observed outside of solar eclipses with the slit of a spectrograph placed on the limb of the sun or with the Lyot coronagraph, the best views are obtained at the time of solar eclipses when the chromosphere appears as a bright red crescent just after the white bright photosphere has been occulted. The red colour is due to the Hα line of hydrogen, the most abundant gas in the solar atmosphere. The radiations of ionized calcium (H and K lines) are yet stronger, but they fall in a spectral region where the sensitivity of the eye is very low.

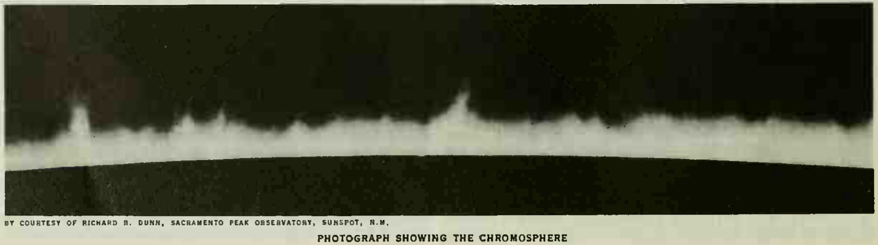
Photographs obtained under conditions of best viewing indicate that the chromosphere has a nonuniform structure. It consists of many individual filaments or spicules. The gas between the spicules is believed to have a different temperature and density from the gas in the spicules. A nonhomogeneous chromosphere, consisting of alternate hot and cold columns, seems necessary to explain certain of the spectroscopic anomalies exhibited by the chromosphere.

The spectrum of the chromosphere shows the same lines as the dark-line photospheric spectrum, but the intensities are different. The lines of hydrogen are relatively more prominent, and there also appear lines of helium which are missing from the dark-line solar spectrum. Some of the differences can be explained by the effects of the lower chromospheric density, but others cannot be interpreted in terms of any model in which the temperature and density depend only on the height.

Structure of Chromosphere Deduced From Radio Data

Height (in kilometres)	$N_e \times 10^{10}$	T_e°K.
2,000	8.20	6,900°
2,500	4.80	7,000
3,000	3.04	7,180
3,500	2.02	7,310
4,500	0.876	7,700
5,500	0.607	11,000
6,500	0.357	30,200
7,500	0.209	66,000
8,500	0.131	145,000
9,500	0.095	327,000
10,500	0.0765	630,000
11,500	0.0660	757,000

Numerous chromospheric models have been proposed by various writers but none has been successful in explaining all of the observations. One of the most powerful techniques for the study of the outer solar envelopes is provided by radio astronomy. Much of the time the radio-frequency solar radiation consists of both a nonthermal noise component and a thermal component which is produced simply by the high temperature of the sun. Near sunspot minimum there are times when the nonthermal noise virtually disappears and the thermal noise alone can be observed. The maximum depths in the chromosphere or corona from which radio-frequency emission of a given frequency can escape depend on the frequency: the higher the frequency, the deeper the layer. The intensity of the radiation will depend on the temperature of the emitting layers. By making use of these principles and by using some of the optical data as a guide, it is possible to obtain the run of density and temperature and height. The temperatures and



BY COURTESY OF RICHARD B. DUNN, SACRAMENTO PEAK OBSERVATORY, SUNSPOT, N.M.

PHOTOGRAPH SHOWING THE CHROMOSPHERE

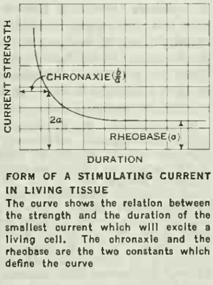
densities thus obtained are of course mean values averaged over any "hot" and "cool" columns that may exist. Observations from spectrographs flown in artificial satellites offered further means of obtaining data on the structure of the chromosphere.

The table gives the structure of the chromosphere deduced with the aid of the radio data and shows the steep decline in the electron density N_e (electrons per cubic centimetre) and the sharp temperature rise between 4,500 and 6,500 km. At the very lowest level the optical spectroscopic data indicate a temperature of about 4,000° K. in the cool regions. Above 12,000 km. the chromosphere merges into the corona, which has a temperature of 1,000,000°.

See G. P. Kuiper (ed.), *The Sun* (1953); L. H. Aller, *Atmospheres of Sun and Stars*, ch. 9 (1953). (L. H. A.)

CHRONAXIE (CHRONAXIA), a term introduced by Louis Lapicque in 1909 to define the character of the stimulus that is required to excite various types of living tissue, particularly muscle and nerve. The most convenient form of stimulus is an electric current, since this can be made to excite (*i.e.*, to cause the tissue to display its characteristic activity) without doing any damage. It is found that a current must fulfill three conditions if it is to excite: (1) it must flow for more than a certain minimal duration; (2) the final strength must exceed a certain value; and (3) the rate of increase of the current from zero must exceed a definite velocity. The need for a minimal duration is shown by the fact that a current alternating at 1,000,000 cycles a second is powerless to excite any tissue in the body, and the surgical technique of diathermy is based on this.

The curve relating minimal duration and minimal strength has the form shown in the figure, and as a first approximation it obeys the formula of Weiss, $i = a + \frac{b}{t}$, where i is the current, t its duration and a and b are constants. Lapicque showed that curves of the same form are obtained from the most diverse tissues, ranging from the human nerve, where the minimal duration is less than .0001 sec., to the cells of a plant where it may be longer than 1 sec. Thus, the character of the stimulus for a given tissue can be defined at once if the constants a and b for that tissue are known. The constant a (the rheobase) is given by the minimal current strength at long durations. The other constant b is the more important, for it determines the slope of the curve and it can be fixed by measuring the chronaxie, which is equal to $\frac{b}{a}$ and is the least duration required when the current strength is $2a$. The true form of the curve differs somewhat from that given by Weiss's equation, and it has been used as a basis from which to deduce the mechanism of excitation. In Lapicque's hands the measurement of the chronaxie also was used to investigate the passage of the state of excitation from one tissue to another (*e.g.*, from nerve to muscle). (E. D. A.)



FORM OF A STIMULATING CURRENT IN LIVING TISSUE

The curve shows the relation between the strength and the duration of the smallest current which will excite a living cell. The chronaxie and the rheobase are the two constants which define the curve

CHRONICLE. Chronicles, records of noteworthy events both natural and cultural, arranged in chronological order, represent a more detailed and sophisticated form of annals (*q.v.*). Insofar as they are bare statements of fact, given without comment and compiled without inductive purpose, chronicles differ essentially from history (Gr. *historia,* "inquiry"), which is understood as being concerned not only to describe but also to interpret the actions of men. Nevertheless few chronicles are entirely free of tendentiousness; from the earliest times their compilers began to select data in order to exalt a reigning house or a religion, or to provide moral *exempla*.

Antiquity.—Chronicles were compiled by the inventors of writing. Many ancient Chinese principalities had their "spring and autumn annals"; those of the state of Lu (722–481 B.C.) have survived, probably because they were edited by Confucius. The Semites made calendars, regnal lists and genealogies and often included in them records of phenomenal events. In translating the Scriptures St. Jerome gave the name *Chronicon* to the Hebrew book entitled "Events of the Times"; but the Yahwist sections of the Pentateuch, the books of Joshua and Samuel and the first two chapters of Kings provide earlier and better examples of chronicle form.

In Greece the example of Hellanicus of Lesbos, who composed a chronicle of events from 683 to 404 B.C., was followed by the atthidographers, writers such as Androtion and Philochorus (4th and 3rd centuries B.C.) who chronicled the history of Attica and of Athens (*see* ATTHIS). Ephorus (*q.v.*) wrote a universal history, covering about 750 years, and the grammarian Apollodorus (fl. 2nd century B.C.) wrote a chronicle of events from the fall of Troy to his own times. In Rome from very early times the *pontifex maximus* was required to exhibit annually his whitened board (*album*) on which were listed the names of officials and the events of the past year. Chronicles compiled from these lists were thus called *Annales Maximi,* and the name annalist (*q.v.*) is usually given to all Roman historians before Sallust. Later, some grammarians followed Verrius Flaccus (*see* VERRIUS FLACCUS, MARCUS) in distinguishing chronicles (*annales*) and history (*historiae*) as accounts respectively of past or of current events: Tacitus, for instance, in his *Annals* wrote of events that occurred before his birth or in his early childhood, and in his *Histories* described his own times. This specific terminology, however, was not followed by the medieval historiographers of western Europe, whose work the word "chronicle" particularly denotes.

Early Christian.—The Christian view of history was essentially different from that of classical paganism. Greco-Roman philosophers and historians usually viewed human history as a cyclic departure from and return to some idealized golden age, set in the past or in the future. In their view, the universe of time extended indefinitely: Pliny the Elder could report that the Babylonians had recorded astrological data for 720,000 years. But early Christians, under the influence of Semitic messianic doctrines, saw the hand of God in every event and regarded time as a fixed and limited framework, of which the Creation, the Incarnation and the Last Judgment were the beginning, middle and end. St. Theophilus (*c.* 180), bishop of Antioch, whose *Apology to Autolycus* included a chronicle, set the pattern for the Christian interpretation of events. He explicitly stated his several purposes: to emphasize the culture and antiquity of the Hebrews, the rise and fall of earthly empires, the Advent as the key to typology, and the growth of the visible church.

Belief in the millennium (the return of Christ to rule on earth for 1,000 years) strongly influenced the writings of early fathers such as Hippolytus and Sextus Julius Africanus. They were thus concerned not only to demonstrate the unique position of the chosen people among the Gentiles but to calculate and predict the time of the Second Advent. The tracts of such chronologists therefore normally consisted of two parts: formulas for the computation of time, and lists of events in sacred and profane history. Their *chronica* were normally divided into six ages (*aetates*): the first two running from Adam to Noah and from Noah to Abraham; then the three ages mentioned in St. Matthew's Gospel (i, 17), namely from Abraham to David, from David to the Babylonian captivity and from the captivity to the Incarnation; and finally the last age, from the Incarnation to the Second Advent. These ages were variously calculated, but no version assumed a period longer than 6,000 years between the creation of the world and the coming of Christ. Each thereby created its mundane era. These eras were eventually displaced in western Europe by the "Christian era," calculated by Dionysius Exiguus in 525, which numbered the sixth age alone. The practice of associating with chronicles formulas for calculating time was followed as late as the 8th century; the shorter and the longer chronicles of Bede (703 and 725) each form part of a textbook on the theory and practice of chronology or *computus*.

While Christians formed a persecuted or barely tolerated religious minority, they naturally found millennarian doctrine attractive. But during the 4th century, after the conversion of the emperor Constantine, Christianity became not only an accepted but a favoured and protected religion; and the prognostic calculations of Christian writers were employed to predict the Last Judgment. St. Augustine in *The City of God* wrote of the Roman empire as a vehicle divinely ordained for the birth and propagation of Christianity; but he also set it in context with the other great empires of antiquity. From the 4th century, Christian chroniclers tended to include in their records various Gentile events, according to their individual taste and the sources available to them. The real prototype of western chronicles is that of the historian Eusebius of Caesarea, who improved and expanded the work of Africanus, creating a concordance by inscribing in parallel columns events which occurred among the several ancient peoples. St. Jerome adapted it in Latin and extended the record to the year 378. Writers such as Idatius of Galicia and Prosper of Aquitaine extended Jerome's chronicle to the years 468 and 455 respectively, but they noted only events in western Europe, primarily those in their own regions.

Medieval.—After the chaos and destruction of the Merovingian period, men came to appreciate that the monastic chronicles could provide valuable evidence of social position, property rights and franchises. The Carolingian compilers after 750, still self-effacing and often anonymous, became increasingly prolix and often quite worldly in their choice of items to record. Maintenance of such records became a duty of virtually every community, religious and secular, though the Christian aims and methods of the earlier chroniclers were in the main continued. Until the 12th century all compilers, with the two notable exceptions of Nithard and Aethelweard, were clerks (*clerici*), usually monks and often schoolmasters. Some chronicles of the medieval period are clearly annalistic in form, being either jottings made on Easter tables or collections of items copied from such tables or from regnal or consular lists. The more famous chronicles are less severely chronological. As medieval historiography became less consciously religious, compilers injected some personality and style into their records, aping the scholastic classics, and they often discussed causes and topics without strict adherence to chronology. Their scribes described such works indiscriminately as *chronica* or *historiae*. In the main, however, chronicles continued to provide succinct dry records of indisputable events and phenomena such as legations, councils, coronations, deaths, earthquakes, eclipses and wars, securely set in a framework of time.

The Judaeo-Christian doctrines of chosen people and of divinely ordered classes, such as Levites and Scribes, provided the incentive for chronicling the activities of national, religious and local groups. The *Liber pontificalis* is a record of the see of Rome, arranged according to the reigns of popes; and almost every western diocese came to have its bishops' book. Cassiodorus and Jordanes composed histories of the Goths, Isidore of Seville of the Visigoths, Vandals and Suebi, Gregory of Tours of the Franks and Paulus Diaconus of the Lombards. In these works pure chronology often was sacrificed to larger, usually moral, purposes; the races which they described were each regarded as designed by God for a particular mission. Nevertheless, Gregory, for example, began his *History* from the time of Adam, including an epitome of Jerome's chronicle. Bede's *Ecclesiastical History of the English Nation* (731), despite the title and its marked contrast with his more scholastic chronicles, is similarly grounded; and it first introduced into historiography the Christian era of Dionysius. Otto of Freising in his chronicle to 1146 developed St. Augustine's theme of *The City of God*. Works like the *Liber historiae Francorum* (727) by an unknown monk of St. Denis are more purely chronographic. The so-called *Annals of Lorsch* (Frankish annals up to the year 829), composed by clerks of the royal chapel, show the rising interest of secular rulers in exalting their achievements and confirming their claims. These tendencies are even more evident in the *Annales Bertiniani*, composed by the prelates Prudentius of Troyes and Hincmar of Reims in the time of Charles II the Bald (d. 877). Newly converted peoples such as the Saxons, Poles, Hungarians and Scandinavians used historical writing to establish their place among nations. The Normans produced an unusually large number of chronicles, starting from those of Dudo of St. Quentin (*c.* 1000) in northern France and of Amatus of Monte Cassino (*c.* 1050) in southern Italy. Chronicles of pilgrimages were made from the 4th century onward, and the crusaders' chronicles were composed in a variety of forms not only by participants but by those who remained at home. The first vernacular chronicles were Anglo-Saxon, begun in the reign of Alfred the Great in England, and one version (MS. "E") was extended to 1154. Robert Wace chronicled the acts of the Norman dukes in 16,547 rhymed tetrameters of *romans*. Geoffrey of Monmouth purposely and deftly mingled the chronicler's and epic writer's styles in his *Historia Britonum*, thereby launching the Arthurian tradition.

Modern.—Although some historians of the later middle ages, such as Geoffroy de Villehardouin, Giovanni Villani and Jean Froissart, all of whom wrote in the vernacular, remained essentially chroniclers, the growing tendency to adopt an epic or discursive style paved the way for the revival of classical canons of form and criticism at the time of the Renaissance and Reformation. Yet the chronicle type of historical writing, based now on more exacting standards of scholarship, was continued by church historians such as Caesar Baronius, whose *Annales Ecclesiastici* (1588–1607) covered church history up to the year 1198. Moreover, from the 17th century onward, scholars began to publish great collections of the manuscript records and chronicles relating to their countries' past: for instance in France Dom Martin Bouquet brought out the first eight volumes of *Rerum Gallicarum et Francicarum scriptores* (1738–), and in Italy Ludovico Muratori was responsible for the series *Rerum italicarum scriptores* (1723–51). Also, the Romantics at the end of the 18th century overcame the neoclassical distaste for chronicles, and even in fiction such titles as Sir Walter Scott's *Chronicles of the Canongate* (1827) and Prosper Mérimée's *Chronique du règne de Charles IX* (1829) became acceptable. Finally, in the 19th century, governments were willing to subsidize the editing and publication of national records. Germany began the magnificent series *Monumenta Germaniae historica* (1826–), and Great Britain gave to a wide range of scholars the opportunity to investigate the country's past by bringing out the "Rolls Series" (*Chronicles and Memorials of Great Britain and Ireland*, 1858–96). By the combined study of these chronicles and of important record sources modern historians have some chance of formulating a realistic portrait of medieval times.

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CHRONICLES, BOOKS OF THE (in the Douai version of the Bible, Paralipomenon), two narrative books of the Old Testament written in Hebrew prose, except for one inserted canto from the Psalms (I Chron. xvi, 8–36). The name "Chronicles" derives from Jerome (*c.* A.D. 400), who explained the Hebrew title "Events of the Days" as "*Chronicon* of the whole sacred history." "Events of the Days" is an imitation of the titles of certain historical books referred to in the books of Kings; *e.g.*, "The rest of the acts of Ahab . . . , are they not written in the events of the days of the Kings of Israel?" (I Kings xxii, 39) and "acts of Jehoshaphat . . . written in the events of the days of the kings of Judah?" (I Kings xxii, 45). Similar references are found also in Chronicles itself. The imprecision of "Events of the Days" without any further qualification is due partly to the extent of the subject matter, for Chronicles begins with Adam and goes beyond the last king of Judah. Moreover, the real aim of the author is to present a history of the Jerusalem "church."

Originally Chronicles and Ezra formed a single book, to which the book of Nehemiah was added later, parts of Ezra being dovetailed into the records of Nehemiah. Oddly enough, the order suggested by the sense (I Chron., II Chron., Ezra, Neh.) is not followed in the Hebrew text, where Ezra and Nehemiah come first, followed by Chronicles at the very end of the Old Testament. The reason why Ezra and Nehemiah were placed first is probably that in building up the canon they were regarded as more important in that they contained fresh information. That Chronicles were thus "left aside" may account for the choice of *Paraleipomena* ("Omissions") as the Greek title of the books, but the usual and perhaps correct explanation is that Chronicles contains stories, speeches and observations that were omitted from the parallel account in the books of Kings. On this view "Omissions" really means "Appendices" (*i.e.*, to the books of Kings). In the Septuagint, Chronicles comes next after the books of Kings and is followed by Ezra and Nehemiah, which is the order usually preserved in Christian translations of the Old Testament. The division into I and II Chronicles, which is unnecessary to the sense, also goes back to the Septuagint. In the middle ages it was even found in Jewish Bibles.

Contents.—Chronicles can be divided into four parts:

1. An extensive genealogy from Adam to Saul; *i.e.*, covering the story of Judah before the monarchy (I Chron. i–ix).

2. The fall of Saul and the rise and rule of David, together with instructions about worship and the building of the Temple (I Chron. x–xxix).

3. The reign of Solomon (II Chron. i–ix).

4. The story of Judah and Jerusalem from the division of the kingdom to the destruction of Jerusalem and the exile in Babylon (II Chron. x–xxxvi); in order to end on a positive note the first three verses of Ezra, which look forward to the return to Jerusalem, are inserted as a conclusion to Chronicles.

Relationship to Samuel and Kings.—Even from a translation of the Hebrew text it is easy to see that the chronicler (as the author of Chronicles is usually called) is closely dependent on I Sam.–II Kings for all but the first nine chapters of his work. Sometimes he even repeats the actual words of his model, though slight textual variations suggest that the Hebrew copy he had before him differed a little from that of the canon and corresponded to that which lies behind the Septuagint. A fragment of II Sam. found in the caves at Qumran shows such a text, which is closely related to that of the chronicler.

It was not only the books of Samuel and Kings, however, that the chronicler was able to consult. Writing no earlier than 350 B.C. (*see* below) he had at his disposal the books of the Old Testament from Genesis to II Kings, which were by then already included in one corpus; *i.e.*, he had the final version of the "priestly document" (Gen. to Num., plus the death of Moses in Deut. xxxiv) and the "deuteronomistic history" from Deuteronomy to II Kings (*see* PENTATEUCH). From the first of these two he took information about the sanctuary and the sacrificial and priestly office, from the second his most important historical material (the story of David and his successors) together with the judgments on religious offenses.

The leading theme of Chronicles, derived also from this second source and shared by the prophet Ezekiel, is that a person receives his deserts. Thus, if a king's reign is long and successful, this is the reward of God for a life led in obedience to his will. Conversely, a king suffers misfortune only if he has sinned. Thus the illnesses of Asa and Jehoram are punishments from God (II Chron. xvi; xxi), and Uzziah is afflicted with leprosy for a sin that is not recorded in the earlier tradition (II Kings xv, 3–5). The story of Manasseh provides a particularly good example of the chronicler's moralistic rewriting of history: the fact that Manasseh had a long reign in spite of his grave sins, which were punished by deportation to Babylon, is explained by his later repentance and the reform of his ways after he had been allowed to return (II Chron. xxxiii). Though the chronicler may have heard an oral tradition of Manasseh's tribute to Esarhaddon (and though perhaps Manasseh also was summoned to the king at Damascus), most of the story is his own free invention (*cf.* II Kings xxi, 1–17). The unfortunate end of the devout Josiah, who died in the battle of Megiddo, is accounted for by his failure to obey a command of God that had come to him from his enemy (II Chron. xxxv, 20–24; *cf.* II Kings xxiii, 29).

In the story of David and Solomon, whose portraits allowed of no shadow, the chronicler's solution was to leave out the stories found in the original (II Sam.–I Kings xi) that did not fit into his picture. David is, of course, king of all Israel; in the war with the Ammonites the murder of Uriah for the sake of Bathsheba is suppressed. No rising, not even Absalom's, against the rule of David is mentioned, and when sovereignty passes to David's son Solomon there are none of the disorders reported in I Kings i ff. The chronicler's omission of impeccably neutral information about Solomon (his judgments, division of territory, wisdom, poetry) probably is due to a desire to pass immediately from the divine confirmation of the kingship (II Chron. i) to Solomon's own great work, the building of the Temple. The description of the Temple differs in various points from that of I Kings vi ff., probably because the chronicler had in mind the newly rebuilt Temple of 515 B.C. The embarrassing fact that Solomon had to cede a piece of Israelite land to the king of Tyre in return for deliveries of cedar, etc., is completely transformed: the land becomes a gift from Hiram (Huram) to Solomon (II Chron. viii, 2). There is of course no mention of Solomon's foreign wives or his idolatry, which in the chronicler's source was the immediate reason for the end of the greater kingdom.

Although in several places the chronicler gives fantastic figures for Jewish as well as for enemy troops, it is the help of God, who marvelously intervenes, that is decisive in all Judah's victories. If the message of the prophets is attended to and the king's address to his people is filled with trust in God, then singers may lead the army, for the victory is with God: the enemy will be defeated or will destroy himself. Levites and singers are mentioned on various occasions (*e.g.*, the office of the Levites in connection with the ark), and it is not improbable that the chronicler was associated with these groups. It is a pointer in the same direction that he reports extensively on religious reforms and feasts (*e.g.*, II Chron. xxx, xxxv).

Since Judah and Jerusalem determine the theme, the chronicler mentions the northern kingdom and the kings of Israel only when warlike or friendly meetings make it absolutely necessary. Among the sermonlike addresses of the prophets and kings, those addressed to "the hostile brothers" (of the northern kingdom) are especially remarkable (*e.g.*, II Chron. xxx). They are told that they should join of their own free will the one true "church" of Jerusalem. Their secession was an error and their repentance will also contribute to the salvation of those deported from the northern kingdom. Thus Chronicles is an *apologia* for orthodox Judaism.

Other Sources.—The books of Samuel and Kings do not provide all the information that appears in Chronicles, so the existence of other sources has been suspected. The chronicler does in fact refer to certain documents, about which, as they have not survived, only speculation is possible. Among these allusions are: "So all Israel was enrolled by genealogies; and these are written in the Book of the Kings of Israel" (I Chron. ix, 1); "The acts of Asa, from first to last, are written in the Book of the Kings of Judah and Israel" (II Chron. xvi, 11); "Accounts of his [*i.e.*, Joash's] sons, and of the many oracles against him, and of the rebuilding of the house of God are written in the Commentary [Heb. *midrash*] on the Book of the Kings" (II Chron. xxiv, 27); "The rest of the acts of Abijah, his ways and his sayings, are written in the story [*midrash*] of the prophet Iddo" (II Chron. xiii, 22); and "Now the rest of the acts of Solomon, from first to last, are they not written in the history of Nathan the prophet, and in the prophecy of Ahijah the Shilonite and in the visions of Iddo the seer concerning Jeroboam the son of Nebat?" (II Chron. ix, 29). It has been suggested that the *midrash* (paraphrased in the Targum as "copy") on the book of Kings is a title of a later history of the kings, a collective name that includes all the other sources mentioned. But in that case, why was it necessary to refer to the other sources under their separate names? A more probable theory is that the chronicler invented some of his material (perhaps the sermons) and drew some of it from oral tradition but tried to give the impression that such passages were in fact extracts from written sources in the style of Samuel and Kings.

In both the prologue and the main narrative there is material that has no didactic purpose—on wars (II Chron. xiv; xx; xxvi); on settlements (I Chron. iv); on cities of the Levites (I Chron. vi; *cf.* Josh. xxi); on fortifications, the armed forces, crown possessions and the succession (II Chron. xi–xii; xxi. 3; xxvi. 10–15; xxvii. 3 ff.). It is hard to decide how far this traditional material has undergone alteration and whether far more recent events may not have played a part in modifying it in individual cases. Much suggests reminiscences of the great period of Judah's history under Josiah (*e.g.*, the list in I Chron. xxvii. 25–31, given there as the royal possessions of David).

Date.—Although Chronicles gives a unified impression at first glance, it is clear that the original work has been added to here and there at a later period, sometimes considerably. That is true, for example, of the genealogical prologue (I Chron. i–ix) in which the genealogies of David and Saul were originally missing. It is true also of a large section of David's religious observances. This is clearly shown by the repetition of I Chron. xxiii. 2 in xxviii. 1. Among the religious ordinances various layers are recognizable; I Chron. xxiv–xxv and xxvii are particularly late, perhaps dating from the Maccabaean period. But even the narrative itself is not of a single cast, as is suggested by various repetitions (*e.g.*, II Chron. xvii. 5 and xviii. 1; the intervening material has been added later). Whether these additions were made by a later chronicler is an open question.

If it is true that Chronicles, written as an *apologia* for orthodox Judaism, presupposes the opposition of Jews and Samaritans, the earliest date would be about 400 B.C. But the date must in fact be pushed forward somewhat since in the book of Ezra the chronicler has used a chronicle written in Aramaic (Ezra iv. 6–vi. 18) where the succession of the Persian kings has been confused (Xerxes in iv. 6; Artaxerxes I in iv, 7; Darius in iv, 24; and Artaxerxes II in vii. 1). This is conceivable only at a time when precise knowledge of the period had been lost. The source containing information about the work and person of Ezra that was used in compiling Ezra vii refers, according to the modern view, to an event in 398 B.C. (seventh year of Artaxerxes II, Ezra vii. 8). The main part of Chronicles therefore cannot be placed earlier than the last 30 years of the 4th century B.C. The great crisis under the Seleucid Antiochus IV (the Maccabaean wars) would be too late a date, since the help of foreign (Persian) kings would then hardly have been so unreservedly praised. The approximate date must be about 300 B.C. and for the final additions perhaps about 200 B.C.

Religious Significance.—In this threefold work (I Chron., II Chron., Ezra), which was an appendix to the record of the governor Nehemiah, the chronicler aims to show how the theocracy in Judah and Jerusalem came about, first through various well-deserved judgments of God but also, under the will of God, through the aid of the kings of Persia. The devout community worships joyfully in the Temple with sacrifice and praise, obeys the Law of Moses, now exalted to absolute greatness, and thus, sheltered and cut off from the world, achieves what one might almost call a static existence without history. For this reason the eschatological expectation is as good as totally missing, although this is proclaimed not only by the older prophets but also by Haggai and Zechariah, the prophets of salvation at the time of the rebuilding of the Temple (520 B.C.). Although the prophecy of Nathan about the house of David is repeated in I Chron. xvii, corresponding to II Sam. vii, neither there nor elsewhere is there any mention of the hope of a change, with political consequences, through the coming of the Messiah.

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CHRONOGRAPH. A chronograph is (1) an instrument which makes a graphical record of a sequence of events accurately co-ordinated with the passage of time; (2) the complete instrumentation used for measuring the velocity of projectiles or, less commonly, other moving objects; or (3) an instrument (properly chronoscope) which gives a visual indication of the time between two events without making a graphical record. Almost any oscillograph (*i.e.*, an instrument for indicating alternating-current wave form or other electrical oscillations) may be used as a chronograph if an appropriate time scale is provided.

A chronograph in the industrial sense is an instrument which can be used to measure elapsed time in terms of split seconds, seconds or minutes. In addition, some chronographs indicate day, month, year and phases of the moon on separate dials or openings which are superimposed on the face of the timepiece. A chronograph differs from conventional timepieces in that it performs a variety of functions other than just measuring mean time.

One form of chronograph is the stop watch commonly used in sporting events such as track, yachting, basketball or football (*see* WATCH). Another type is the instrument used in aircraft to record elapsed flying time. This is accomplished by means of a button which the pilot pushes as he takes off, setting the chronograph in motion. Upon landing he pushes the button again, stopping the instrument. The actual elapsed time is shown on the dial in terms of hours, minutes and split seconds.

Pilots can also use a chronograph as a navigational aid to tell what their ground speed is. To determine ground speed between two known points, either visually or by radio signal, a pilot merely has to look at his chronograph and see how long it took him to cover the distance. Stated another way, when time and distance are known factors, speed can be determined, or when speed and distance are known factors, time can be determined.

The first chronograph was invented in 1680 by Daniel Quare, an Englishman. It was a form of repeating watch which sounded the hours when a lever was pushed. The first ones were called "squeeze watches" because the owner had to push or squeeze a pin which protruded from the case. From this simple beginning came the present-day alarm watch which can be set to ring a bell or buzzer at any predetermined time.

In addition to the above uses, there are chronographs for virtually every function where measurement of time is important. For example, one form of chronograph is often used by doctors to tell them at a glance how often the pulse is beating. Another type is used by manufacturers to determine the length of time it takes to produce parts. The number and variety of modern chronographs is virtually unlimited. In many cases if a person wants a chronograph for a specific purpose, and the chronograph is not already on the market, it can be specially made. (R. F. S.)

ASTRONOMICAL CHRONOGRAPHS

Writing Chronograph.—For many years the commonest form of time-recording device in astronomical work was the writing chronograph, and instruments of this type were still widely used in the second half of the 20th century. A writing chronograph utilizes one or more pens, or scribers, writing on paper which moves at a uniform speed beneath them. Sometimes paper tape in roll form is used, while in other cases paper sheets are wrapped around cylindrical drums on which the pens draw spiral lines. The motion of the paper is actuated by weight-driven or electric motors, the speed usually being controlled by centrifugal governors. In the commonest form of the single-pen drum chronograph, the drum makes either one or two revolutions per minute. The pen is actuated by an electromagnet which is opposed by a spring. When the electric current flowing in the magnet is interrupted, the spring pulls the pen a short distance to the side, producing a jog in the line. A clock or chronometer is connected to produce timing signals, either on every second or on certain seconds of the minute.

When such a sheet is removed from the drum, the record for each minute (or half minute) appears as one line across the sheet, and the jogs in the line produced by the timing signals serve as marks for setting a scale. The timing signals should be of short duration so that they will interfere as little as possible with the signals being measured. In the usual forms of the single-pen chronograph it is possible to make measurements accurately to a hundredth of a second. When two pens are used, one of them serves to record the timing signals and the other records the signals which are being measured, thus eliminating interference between the two sets of signals. Several pens are used when signals from more than one source are recorded simultaneously.

Printing Chronograph.—Efforts to reduce the time required for analyzing the results of measurements with writing chronographs led to the development of printing chronographs. These devices generally print figures from rotating type wheels, which are periodically synchronized with a controlling clock by means of electric timing signals. In a typical instrument of this kind, three wheels alongside each other carry type to print the minute, second and hundredth of a second. The duration of the contact between the paper and the moving type wheels must be very brief, so as not to interfere with the continuous rotation of the wheels. This is generally accomplished by employing printing hammers which rebound quickly after pressing the paper against the type. One kind of printing chronograph, which was used at the U.S. Naval observatory, printed a series of small marks instead of figures, and the time to the nearest $\frac{5}{1,000}$ sec. was read from the positions of these marks.

Errors and Their Elimination.—Although the instruments so far described in this section are of much historical interest, they were becoming obsolete at mid-20th century because of their limited accuracy. Since they depend on the motion of mechanical parts, they cannot accurately measure intervals to a thousandth of a second. By driving the writing chronograph at high speed and employing a light pen, its errors could probably be reduced to two or three milliseconds, but the work of measuring the record would be burdensome. This work can, of course, be eliminated by the use of a printing chronograph. The accuracy of the old style printing chronograph is not very high, however, since the printing hammers have variable reaction times, and in addition there are errors resulting from the imperfect synchronization of the type wheels with the controlling clock.

The elimination of the errors which are caused by the moving mechanical parts has been made possible by the use of electron tubes and their associated equipment. These tubes make it possible for very feeble currents to control powerful ones without the use of mechanical relays, and with negligible time delay. Moreover, they have made possible a new type of timekeeper, the quartz-crystal controlled oscillator. In this device the vibrating crystal takes the place of the pendulum. Since the frequency of the crystal oscillations is high, a means is provided of dividing the second into small parts. Alternating current of various frequencies may be generated, making it possible to operate synchronous motors in unison with the crystals.

Spark Chronograph.—One of the earliest types of chronographs which was capable of accuracy to the millisecond was the spark chronograph. Instruments of this type perforate or mark the recording paper by means of electric sparks. Frequently the paper is waxed or chemically treated to make the record more legible. Such chronographs are particularly suited to making continuous comparisons of precision clocks. In a typical device of this kind, paper from a roll moves slowly under a row of 100 electrodes extending across the width of the paper. When a signal to be timed is received, a spark jumps from one of the electrodes through the paper to a fixed metallic ground strip. The position of the electrode from which the spark jumps indicates the time of the signal. In such a machine, designed by Alfred Loomis, an electric distributor connects the spark source with the electrodes in rotation. The period of rotation is $\frac{1}{10}$ sec., therefore each electrode is connected during an interval of 1 millisecond. In an instrument designed at the U.S. bureau of standards, the distributor is eliminated, and a rotating cylinder with a spiral ridge is substituted for the fixed ground strip. The sparks then jump from the electrode nearest to the spiral ridge at the time. If clock signals on every second are used to trigger the spark, it will jump from the same electrode every tenth revolution of the distributor or cylinder, provided that the clock does not gain or lose with respect to the chronograph mechanism. A straight line of perforations will then appear on the paper. If the clock gains or loses, however, the line of perforations will move to the right or left across the paper. Signals from several clocks may be recorded simultaneously, and the relative gain or loss of each clock with respect to the others may be determined.

Strobotron Flasher.—One form of chronograph which does not make permanent records, but which makes possible easily made readings having errors of less than a millisecond, is the strobotron flasher. A glass dial is mounted on one of the shafts of the movement of a quartz-crystal controlled clock. The dial usually rotates once per second, and has a scale engraved near its periphery, divided into milliseconds, with each tenth division numbered. A microscope is mounted so as to give a view of a fixed reference line superimposed on a portion of the rotating scale. Since the dial rotates in a dark chamber, nothing is visible except when incoming signals cause a stroboscopic lamp to flash. Although the duration of each flash is less than $\frac{1}{100}$ millisecond, the persistence of vision makes it possible for the scale to be read. In fact, it is not difficult for a practised observer to estimate the tenth of a division. In this manner readings accurate to two or three tenths of a millisecond are possible.

Decimal Counter.—Another type of chronograph, which usually does not provide permanent readings but may be adapted to operate a printing mechanism, is the decimal counter. This device, which was introduced at the Royal Greenwich observatory, requires a high precision electrical oscillator that produces an alternating current of a frequency corresponding to the fraction of a second to which the measurements are to be made. A frequency of 100,000 cycles per second is often used. At the beginning of each second a signal from the controlling clock starts an electronic counter, which then counts the number of oscillations until a signal from another source stops the count. This count gives the decimal fraction of the second, according to the controlling clock, when the signal which terminated the count was received. The results of the count may be exhibited by an array of small neon lamps, arranged in rows of ten, or they may be shown in figures by a mechanical device.

Cathode-Ray Chronograph.—The U.S. Naval Research laboratory designed a device which exhibits a row of marks on the face of a cathode-ray tube once each second. Each mark in the row is produced one millisecond later than the mark to its left. By means of three dials it is possible to set the device so that the first mark in the series is produced at the beginning of the second, according to the controlling clock, or any number of milliseconds later. Any other signal may be superimposed upon the pattern of the marks, and its time of occurrence thereby measured.

This method is chiefly useful for the comparison of a clock with a radio time signal. Since the operator may see the actual build-up of the radio wave as it comes from the receiver, it is possible for him to judge the reliability of weak signals. The field of view may be photographed, thereby providing a permanent record of the radio signal pattern. (P. Sr.)

CHRONOGRAPH EQUIPMENT

Chronograph equipment may be as simple as a stop watch or as complex as the means of co-ordinating observations made on a guided missile range covering thousands of square miles. The term may include the equipment used for observation as well as the recording instrument, but in all cases consideration of the characteristics of the observing equipment should influence the choice of recording equipment.

Consideration of a simple chronograph, a stop watch, will illustrate this point. A stop watch is used to record the elapsed time between two events. The observing device is a human being who must push a button starting the watch in reaction to the first event, and again push a button stopping the watch in reaction to the second event. The possible errors in such a system include errors made by the observing instrument, the human being; error in the watch, either in starting or in its running rate; and error in resolution of the watch, *i.e.*, the error in accuracy to which it can be read. There is obviously little utility in providing a watch with a reading accuracy of $\frac{1}{100}$ sec. if the human is subject to errors of $\frac{1}{10}$ sec. More accurate chronographic equipment must reduce the errors in observation, in rate and in resolution.

Errors in observation in a system of chronograph equipment are illustrated in the discussion of velocity chronographs below. The range of accuracies available in rate and resolution may be illustrated by discussion of various chronographs.

Le Boulengé Chronograph.—The Le Boulengé chronograph, invented by Capt. Paul Émil le Boulengé of the Belgian artillery, was widely used for the measurement of short time intervals, particularly at ordnance proving grounds, up until the end of World War I. In this instrument the distance of free fall under the acceleration of gravity is used as the basis of time measurements. The first event, the start of the time interval to be measured, breaks the current in an electromagnet, allowing a weight, a long rod, to fall freely. The time t for the weight to fall a distance of s cm. is given in seconds by the equation obtained from the simple relation for the free fall of an object starting from rest, $s = \frac{1}{2}gt^2$, by solving for t, *i.e.*, $t = \sqrt{2s/g}$, where g is the acceleration of gravity in centimetres per second per second and has a value at sea level ranging from 978.039 to 983.217 depending upon the latitude. The second signal, at the end of the interval, releases a second weight. This weight, in turn, releases a trigger, which allows a knife to fly out and mark the falling rod. If both weights are released simultaneously, the knife makes a mark at a distance s_0 corresponding to the dead time, $t_0 = \sqrt{2s_0/g}$. The actual time between the two signals is given by $t - t_0$. Under the conditions of measurement an error of $\frac{1}{1,000}$ in. in the measurement of the distances s and s_0 corresponds to an error of the order of $\frac{1}{20,000}$ sec. in the time. Because the actual errors are larger, the instrument has been superseded by other methods.

Aberdeen Chronograph.—The Aberdeen chronograph was developed during World War I for the U.S. army as a convenient and more accurate instrument than the Le Boulengé chronograph. It consists of a hollow cylindrical drum rotated by a synchronous motor operating from alternating current with an accurately controlled, or accurately measured, frequency of 60 cycles per second. A strip of waxed paper is held by centrifugal force against the inside surface of the drum and is marked by sparks that are triggered by the events being recorded. The sparks jump through the paper to the drum from sharp metallic needle points mounted close to the inner surface of the paper. The paper speed is exactly 1,500 cm. per second and an error of $\frac{1}{4}$ mm. in the measurement of the distance between two spark marks corresponds to an error of $\frac{1}{60,000}$ sec. An instrument of similar design with a more slowly rotating drum is used for measuring the time between the firing of a gun and the bursting of its explosive shell.

Galvanometer Chronograph.—The galvanometer chronographs include both direct-writing and photographic types. In the former, a pen is moved directly by a galvanometer in a direction perpendicular to the direction of motion of a moving strip of paper. Electric currents due to the events being recorded cause the pen, or pens, to be deflected and the events recorded. The paper may be driven at a constant known rate, as by a synchronous motor, or timing marks from a standard frequency generator may be traced by another pen. Both inking and electrical pens are used, the latter tracing on a special conducting paper by passing an electric current between the pen and a platen. The direct-writing types are generally limited in response to about 100 cycles per second, although with care a resolution of $\frac{1}{1,000}$ sec. may be attained.

In the photographic recording galvanometer chronograph, a light beam is reflected from the mirror of an oscillographic galvanometer to a photosensitive paper. (For a general discussion of galvanometers, *see* INSTRUMENTS, ELECTRICAL MEASURING.) A specialized version of this type is the drum-camera chronograph. In this instrument a strip of photosensitive paper is attached to the outer surface of a drum which rotates inside of a light-tight box, and at the same time moves slowly along its axis to prevent overlapping of traces made on successive turns. The reflected light from the galvanometer enters through a slit and makes a trace on the paper; deflections of the galvanometer are thus recorded. On the same record another galvanometer, driven by a standard frequency generator, produces time marks. The timing galvanometer is usually vibrated in the direction of motion of the photosensitive paper and with an amplitude such that the forward velocity of the beam of light, at the centre of its swing where it crosses the slit, is the same as that of the paper. Thus, during that phase of the motion, a sharp, intensely exposed line is produced on the paper, while in the opposite phase of the motion the light is not in contact with the paper long enough for production of a photographic image. Because of the lower mass of the moving parts, the photographic recording galvanometer chronographs have a considerably higher resolution than the direct-writing types, and time measurements with an accuracy of about ten microseconds may be achieved. In a more refined version of the drum-camera chronograph, the image of the luminous spot of a cathode-ray tube is focused onto the paper. The signals to be recorded are applied to the transverse deflecting plates of the cathode-ray tube and time marks are made by deflecting the beam at one-millisecond intervals to form short pips on the trace. From such a record, the time between two signals can be determined with an error of about two microseconds.

Raster Chronograph.—The accuracy and resolution of such a system is limited by the speed at which the photographic medium can be moved past the cathode-ray spot. In a modification designed to give greater time resolution, the cathode-ray beam is swept transversely to the motion of the photographic paper or film with a saw-toothed motion, at an accurately controlled frequency of 1,000 cycles per second. The signals are applied to the longitudinal plates, deflecting the beam in the direction of motion of the paper. Thus the linear distance on the record corresponding to 1 millisecond is equal to the amplitude of the sweep. The drum speed need be sufficient only to separate one sweep from the next. The resulting recording is similar to the raster (the pattern of scanning lines) of a television screen, and the instrument is called a raster chronograph. Measurement of the position of a signal along the sweep need be accurate only to 1 part in 100 to provide time resolution of 10 microseconds. A form of the raster chronograph which is capable of a tenfold higher resolution of time is one in which the cathode-ray beam scans the screen with several linear horizontal sweeps, each being separated from the preceding by a small vertical distance. The signals are applied to the vertical plates, and a photograph of the entire pattern is taken with an ordinary camera. If the lines of the raster are swept with a frequency of 10,000 saw-tooth cycles per second and the position of the signals can be determined within 1% of the sweep amplitude, the times can be determined within 1 microsecond. About 100 horizontal sweeps for a total time of 0.01 sec. are all that can normally be accommodated; this limits the usefulness of this type of device. In another form of raster chronograph which overcomes this limitation, a saw-tooth sweep of 10,000 cycles per second is photographed on 35-mm. film moving continuously. By this means a record lasting up to 100 sec. with a time resolution of 1 microsecond may be achieved.

Electronic-Counter Chronograph.—During the years just preceding World War II, and during that war, the electronic-counter chronograph came into use on an ever increasing scale. This device is based upon an electronic counting circuit first used by Wynn-Williams in England for counting radioactive rays registered by a Geiger counter. It has the great advantage that the time, in units of ten, or even of one, microseconds, can be read directly from the face of the instrument. The complete instrument consists of three parts: a crystal-controlled oscillator, which supplies consecutive pulses at the rate of 100,000 per second (or in the faster instrument at some higher rate), a gate circuit, which is opened by the signal from the first screen and is closed

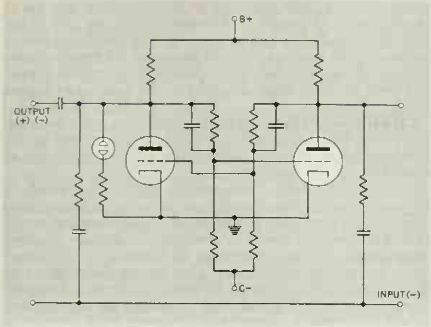

DIAGRAM OF ONE ELEMENT OF ELECTRONIC COUNTER CHRONOGRAPH (*see* TEXT)

by the signal from the second screen; and a counting circuit, which registers the number of pulses getting through the gate during the interval while it is open.

In its simplest form the counting circuit consists of a cascaded series of similar circuit elements, each of which may be called a binary pair. One such binary pair consists of two triodes connected together with resistors and capacitors in a so-called trigger circuit which allows one of the triodes to be in a conducting state while the other is held in the nonconducting state (*see* fig.). A negative pulse applied to the input point of the circuit reverses the state of the circuit, putting the triode which was formerly conducting into the nonconducting state. A small neon tube connected across one of the triodes glows when that side of the circuit is nonconducting. Finally, a negative pulse is generated by such a binary pair at every second alternation, and this may be used as the input pulse for the next binary pair in cascade. If a series of such circuits is restored to an initial state in which all neon glow tubes are extinguished, and a sequence of pulses is then fed into the input point of the first stage, the first lamp will glow after one pulse has been received, the second will glow after two pulses, the first and second will glow after three pulses, the third will glow after four pulses and so on. The total count is equal to the sum of a series of terms of the form 2^n where n has the values, 0, 1, 2—etc., corresponding to the first, second, third, etc., stages, respectively, and only those terms are to be included in the sum for which the corresponding neon lamps are glowing. By a slight modification, a circuit containing 4 such stages may be made to recycle to the initial state after 9 pulses have been received, instead of after the 15th, as would be the case without the modification. Thus, four binary pairs can be made to form a decade counter and the resulting numbers come out in the decimal system. The conventional electronic-counter chronograph used for measuring the speed of projectiles contains four such decades and it is pulsed at the rate of 100,000 pulses per second. Its range of measurement thus extends from 0.00001 sec. to 0.1 sec. and it gives the time between two signals to the nearest 0.00001 sec. Other counting circuits have operated at more than 1,000,000 pulses per second, and 10,000,000 pulses per second may not be impossible to count in this way. Similar circuits are available using transistors. Pulse rates of 30–50 million pulses per second can be handled by these circuits.

(N. W. A.)

VELOCITY CHRONOGRAPHS

The velocity of an object can be determined by measuring the time required for the object to travel a measured distance and dividing the distance by the time. A velocity chronograph usually consists of two signaling devices and a chronograph proper. The signaling devices (called screens in military usage because of the Aberdeen screen described below) are designed to detect the passage of the object past either end of the measured distance, and the chronograph records the two signals resulting from the passage. Velocity chronographs are used primarily by the military for measuring the velocity of projectiles. However, the devices used by police for measuring the speed of automobiles are also velocity chronographs. A common signaling device for police use is a pneumatic tube laid across the road. A clock which is started and stopped by the pressure in the pneumatic tube serves as the chronograph. The police-radar chronograph operates on the same principle as the microwave Doppler chronograph described below.

In the design of a velocity chronograph, particularly for ballistic applications, the first consideration is the accuracy required. In many of the military applications, accuracies of 1 ft. per second are necessary, and with projectiles traveling as fast as 3,000 ft. per second, the error must be less than 0.03%. Various methods of time measurement have been devised, and accuracies to 1 microsecond or less are possible. If 1 microsecond is to be less than 0.03% of the total time, the total time must be at least 0.003 sec. At a velocity of 3,000 ft. per second, the distance must therefore be about 10 ft. measured to within 0.003 ft. The distance between two screens 10 ft. apart can be measured to this accuracy, but because of uncertainties as to the position of the projectile when the screen gives a signal, it is generally advisable to use a longer base line.

Screens.—At least eight different types of screens have been used in the measurement of projectile velocities, the selection depending upon the conditions of the test and the accuracy required. One of the oldest is the Le Boulengé screen, a component of the Le Boulengé chronograph already described. This screen consists of a frame on which a fine wire is strung in many loops to form a fine network. A signal is produced when an electric current passing through the wire is interrupted as the projectile pierces the network. Since electrical contact may be made through the projectile itself, this type of screen is subject to excessive error. The mass of the wire itself may also appreciably change the velocity of the projectile. An improved version uses a grid of conducting ink on a thin sheet of paper.

The Aberdeen screen, first used extensively at the Aberdeen (Md.) proving ground of the U.S. army ordnance department, consists of two conducting foils separated by an insulating sheet. A signal is generated when contact is made between the two foils by the nose of the projectile. The screen has the advantage that it can be used many times. However, it may appreciably alter the velocity of the projectile, and there is intrinsic uncertainty about the time at which contact is first established.

The solenoid screen, widely used in many proving grounds, avoids the two main objections to the Le Boulengé and Aberdeen screens. It derives its signal from the voltage generated by magnetic induction when the magnetized projectile passes through a large circular coil of wire. The current induced in the circuit containing the solenoid coil flows first positively as the magnetic flux through the coil increases; when the magnetic centre of the projectile reaches the centre plane of the coil, the current reverses quickly and flows in the negative direction; finally, as the projectile recedes from the coil, the current falls gradually to zero. The sharp crossover from positive to negative current is generally used as the signal for marking the time of passage of the projectile. The exact position of the projectile at the time when this sharp crossover occurs is never known. It can be assumed, however, that the position of the projectile relative to the coils is not significantly different as it passes through the two successive coils. There may be some error caused by differences in yaw of the projectile as it passes through the two coils, or by differences in the centring alignment of the coils with respect to the trajectory.

Electrostatic induction has also been used to produce signals. In this case the screen consists of an insulated loop of wire which forms an antenna through which the projectile passes after it has acquired a static charge of electricity. The potential of the antenna gradually rises as the projectile approaches; it reaches a maximum when the projectile is centred in the loop; and then it falls again gradually to zero as the projectile recedes. By means of a suitable amplifier, the point of maximum potential can be converted into a pulse of short duration which serves as the desired signal.

Photoelectric screens have been used in two forms. In the telephoto screen an image of the silhouette of the projectile against the light background of the sky is projected by means of a lens upon an opaque disk containing a transparent slit at its centre. As the image passes over the slit, a photocell located behind the disk receives less illumination, and this causes a change in current through the cell. The sudden increase in illumination when the square base of the projectile image leaves the slit is converted in the amplifier into a sharp pulse which serves as the signal. This type of screen can be used with a 90-mm. or larger shell at distances of 200 ft. from the trajectory, and it thus forms a useful component of a field chronograph. It has the advantage of convenience in setting up, especially for firing tests at high angles of elevation. In another form of photoelectric screen the projectile is fired between a linear light source and a parallel slit behind which is mounted a photocell. When the light is cut off from the photocell by the shadow of the projectile there is a change in current which is used to generate a signal in much the same way as in the telephoto screen. This type of screen is used extensively in closed ranges for measuring velocities and drag coefficients of small-arms projectiles.

"Acoustic" screens operating from the impact of the bow shock wave of the projectile upon a microphone have also been used, but variations in the distance between microphone and trajectory introduce errors. The change in the angle of the bow wave with the velocity of the projectile is another source of error if the projectile experiences an appreciable change in velocity between the two screens.

Spark Photography.—For the most accurate measurements of velocity, the method of spark photography has distinct advantages (*see* PHOTOGRAPHY, SPARK). In one form the projectile is fired between a photographic plate and a spark gap. An acoustic pickup or one of the other forms of screens already described may be used to trigger the spark while the projectile is in front of the plate. The electric pulse generated by the spark constitutes a signal of less than one microsecond duration and the exact position of the projectile at the instant the spark is fired can be inferred from measurements made on the shadow of the projectile recorded on the plate. In another form, used by the German army during World War II, a photograph of the projectile was made with two stereoscopic cameras of conventional design using the light of an electric spark for illuminating the projectile against a dark background. After the plates were developed, the exact position of the projectile at the instant the spark was fired was reconstructed by reprojecting the images, using the cameras themselves as projectors. Again the spark served as a signal for the time measurements.

Microwave Chronograph.—The microwave Doppler chronograph differs from the velocity chronographs described above in that no screens are used. It is based upon the microwave techniques developed during World War II and has many advantages for field use. In this instrument electromagnetic radiations in the centimetre range of wave lengths are projected from behind the gun along a beam which intersects the trajectory and is as nearly parallel to it as the configuration of the gun will allow. Radiant energy reflected backward from the base of the projectile is modified in frequency by the Doppler effect (*see* LIGHT: *Waves and Interference: Doppler Effect*) and is received in the same instrument and allowed to beat against the outgoing frequency. Each of the resulting beats corresponds to an increment in the path of the radiation of one wave length of the initial frequency. Half of this distance multiplied by the secant of the angle between the trajectory and the line joining the projectile with the microwave projector is the corresponding distance through which the projectile has moved. In the microwave chronograph an electronic counter records the total number of such units of distance, while another electronic counter records the number of oscillations of a quartz crystal for measurement of the time. The accuracy of police radar operating on the microwave principle is not affected by the secant of the angle between the path of the automobile and the line joining the automobile and the microwave projector. The angle is kept small by placing the projector close to the road and directing the microwave beam toward a point well down the road; hence, the value of the secant is very close to one. (T. H. J.; N. W. A.)

CHRONOLOGY, a time scale, a method of measuring time. This article deals mainly with systems of chronology used by different peoples in recording their history, although other uses of chronology are also mentioned.

Scientific chronology, which seeks to place all happenings in the order in which they occurred and at correctly proportioned intervals on a fixed scale, is used in many disciplines and can be utilized to cover vast epochs. Astronomy, for example, measures the sequence of cosmic phenomena in thousands of millions of years; geology and paleontology, when tracing the evolution of the earth and of life, use epochs likewise of hundreds or thousands of millions of years. Geochronology reckons the more distant periods with which it deals on a similar scale; but it descends as far as human prehistoric and even historic times, and its shorter subdivisions consist only of thousands of years. (For details of these time scales, *see* COSMOLOGY; STAR; GEOLOGY; PALEONTOLOGY; GEOCHRONOLOGY.) Shortest of all are the chronological scales used in the recording of human events in a more or less systematic and permanent manner. They vary in scope, accuracy and method according to the purpose, degree of sophistication and skill of the peoples using them, as do the calendrical systems with which they are inextricably bound up; throughout this article, frequent reference therefore will be made to the article CALENDAR.

It is difficult to fix ancient historical chronologies in relation to scientific chronology. The terms of reference of ancient peoples were vague and inconsistent when judged by modern standards, and many of their inscriptions and writings have inevitably disappeared. The gaps in their records are increasingly filled in, and their inconsistencies removed, by the results of archaeological excavation. Guided by these findings, scholars can confirm, refute or amend chronological reconstructions already tentatively made. (*See* ARCHAEOLOGY.) Astronomical calculation and dating by radioactive carbon content are also extremely helpful in the work of fixing ancient chronologies (*see* RADIOCARBON DATING).

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(X.)

I. CHINESE

Chinese legendary history can be traced back to 2697 B.C., the first year of the Yellow Emperor, Huang Ti, followed by his many successors and by the Three dynasties, the Hsia (2205–1766 B.C.), the Shang (*c.* 1766–*c.* 1123 B.C.) and the Chou (*c.* 1122–256 B.C.). Recent archaeological findings, however, have shown that authentic chronology began with the Shang dynasty, though the exact date of its end remains a controversial topic among experts. The oracle bone inscriptions of the last nine Shang kings (1324–1123 B.C.) record the number of months up to the twelfth, with periodical additions of a thirteenth month, and regular religious services on the summer and winter solstice days, which indicates the adjustment of the length of the lunar year by means of calculations based on the solar year. Individual days in the inscriptions are named according to the designations in the sexagenary cycle formed by the combination of the 10 celestial stems and 12 terrestrial branches (*see* CALENDAR: *Chinese Calendar*). Every set of 60 days is divided into six ten-day "weeks." Also recorded are numerous eclipses which can be used to verify the accuracy of the Shang chronology. In the oracular sentences of the last Shang king, Chou-hsin, the year of his reign is referred to as "the king's *n*th annual sacrifice."

From the beginning of the following (Chou) dynasty the word "year" was etymologically identical with "harvest." Thus, "King X's *n*th harvest" meant the *n*th year of his reign. The lunar month was then divided into four quarters—*Ch'u-chi*, *Tsai-sheng pa*, *Chi-sheng pa* and *Chi-szu pa*—and the practice of using the 60 cyclical names for the days was continued. Thus in the inscription on a Chou bronze vessel a typical date would read: "In the king's *n*th harvest, in the *n*th quarter of the *n*th month, on the day X-y, etc."

The tradition of recording events by referring to the king's regnal year continued until 163 B.C. when a new system, *nien-hao* (reign-year title), was introduced by Emperor Wen of the former Han dynasty (202 B.C.–A.D. 8). Thereafter every emperor proclaimed a new *nien-hao* for his reign at the beginning of the year following his accession (sometimes an emperor redesignated his *nien-hao* on special occasions during his reign). In order to date any event in Chinese history, it is necessary to convert the year in the period of the designated *nien-hao* into the western calendar.

During the Chou dynasty the civil year began with the new moon which occurred before or on the day of the winter solstice. This "first month" of the Chou year (Chou *cheng*) was equivalent to the eleventh month of the Hsia year (Hsia *cheng*) or to the twelfth month of the Shang year. The First Emperor (Shih Huang Ti) of the short-lived Ch'in dynasty (221–207 B.C.) made the year begin one month earlier; *i.e.*, with the lunation before the one in which the winter solstice occurred. The Ch'in year was continuously used until 104 B.C., when Emperor Wu promulgated the *T'ai-ch'u* calendar by reverting to the Hsia *cheng*; *i.e.*, by taking the third month of the Chou year, or the second lunation after the winter solstice, as the first month of the civil year. This lunar year (or Hsia *cheng*) was used till the last day of the Ch'ing or Manchu dynasty (1644–1912). When in 1912 the first republic was founded, the solar year was officially adopted, but successive governments kept the *nien-hao* tradition by referring any date to the number of years since the establishment of the republic; *e.g.*, 1948 was chronicled "the 37th year of the Republic." It was in 1949, when the People's Republic of China was proclaimed, that the old system was replaced by the Gregorian calendar.

(WU S.-C.)

II. HINDU

Two kinds of chronological system have been used in India by the Hindus from antiquity. The first requires the years to be reckoned from some historical event (frequently from the consecration or accession of a king or from the beginning of a dynasty). The second starts the reckoning from the position of some heavenly body. The historical system is the commoner in modern times, and exists side by side with Muslim and international systems successively introduced.

1. Reckonings Dated From a Historical Event.—The inscriptions of Asoka (mid-3rd century B.C.) give the first epigraphical evidence of the mode of reckoning from a king's consecration (abhiseka). In these inscriptions (Middle-Indian language in India or Greek and Aramaean in what is now Kandahar, Afg.) the dates are indicated by the number of complete years elapsed since the king's consecration. But the earlier existence of a reckoning of duration of reigns and dynasties is evidenced by the testimony of the Greek historian Megasthenes, who in 302 B.C. was the ambassador of Seleucus I Nicator, founder of the Seleucid empire, to the court of Chandragupta Maurya, Asoka's grandfather. According to Megasthenes, the people of the Magadha kingdom, with its capital, Pataliputra (Patna), kept very long dynastic lists, preserved, though with many contradictions and discrepancies, in the later Sanskrit puranas (legends of the gods and heroes) and later Buddhist and Jain chronicles. They generally indicate, in years or parts of years, the duration of each reign.

Similar records of other periods and regions exist, so that a relative chronology may be established. Unfortunately, it is not always possible to connect them with any absolute chronology, the precise dates of the reigns given being still unsettled. For example, in the Scythian period of the history of northern India, several inscriptions are dated from the beginning of the reign of Kanishka, the greatest king of the Asian (Kushan) invaders, but his dates are still uncertain (A.D. 78, 128–129, 144, etc., have been suggested for the beginning of a Kanishka era).

Other records give regnal years which can be linked with absolute chronology through other data; *e.g.*, those of several rulers of the Rashtrakutas of the Deccan, of the Pallava Tamil kingdom, etc.

The dynastic eras, founded by several rulers and kept up or adopted by others, are also numerous. The most important were: the Licchavi era (A.D. 110) used in ancient Nepal; the Kalakurikedi era (A.D. 248) founded by the Abhira king Isvarasena, first used in Gujarat and Maharashtra and later (until the 13th century) in Madhya Pradesh and as far north as Uttar Pradesh; then there were the Valabhi era (A.D. 318, employed in Saurashtra) and the Gupta era (A.D. 319) used throughout the Gupta empire and preserved in Nepal until the 13th century. These differed only in the starting point of the year—the month Karttika (October–November) for the first, Chaitra (March–April) for the second. Later came the era of the Thakuri dynasty of Nepal (A.D. 595) founded by Amsuvarman; the Harsakala (A.D. 606), founded by Harsha (Harshavardhana), long preserved also in Nepal; the western Chalukya era (A.D. 1075) founded by Vikramaditya Tribhuvana Malla and fallen into disuse after 1162; the Laksmana era (A.D. 1118) founded by the king Laksmanasena of Bengal, still used throughout Bengal in the 16th century and preserved until modern times in Mithila; the Rajyabhisekasaka or Marathi era (1673), founded by Sivaji, but ephemeral.

Later, instead of the beginning of a reign or of a dynasty, the death of a religious founder was adopted as the starting point of an era. Among the Buddhists, the death of the Buddha and among the Jains the death of the Jina were taken as the beginning of eras. The Jain era (*virasamvat*) begins in 528 B.C. Several Buddhist sects (no longer existing in India) adopted different dates for the death (nirvana) of the Buddha. The Buddhist era prevailing in Ceylon and in the Indochinese peninsula (Burma, Thailand, Laos, Cambodia) begins in 544 B.C.

Historical events, now obscure, were the basis of the two most popular Indian eras: the Vikramakala and the Sakakala.

The Vikrama era (58 B.C.) is said in the Jain book *Kalakakaryakathanka* to have been founded after a victory of King Vikramaditya over the Sakas. But some scholars credit the Scytho-Parthian ruler Azes with the foundation of this era. It is sometimes called the Malava era because Vikramaditya ruled over the Malava country, but it was not confined to this region, being widespread throughout India. The years reckoned in this era are generally indicated with the word *vikramasamvat* or simply *samvat*. They are elapsed years. In the north the custom is to begin each year with Chaitra (March–April) and each month with the full moon. But in the south and in Gujarat the years begin with Karttika (October–November) and the months with the new moon; in part of Gujarat the new moon of Ashadha (June–July) is taken as the beginning of the year. To reduce Vikrama dates to dates A.D., 57 must be subtracted from the former for dates before Jan. 1 and 56 for dates after.

The Saka or Salivahana era (A.D. 78), now used throughout India, is the most important of all. It has been used not only in many Indian inscriptions but also in ancient Sanskrit inscriptions in Indochina and Indonesia. The reformed calendar promulgated by the Indian government from 1957 is reckoned by this era. It is variously alleged to have been founded by King Kanishka or by the Hindu king Salivahana or by the satrap Nahapana. According to different practices the reckoning used to refer to elapsed years in the north or current years in the south and was either solar or luni-solar. The luni-solar months begin with full moon in the north and with new moon in the south. To reduce Saka dates (elapsed years) to dates A.D., 78 must be added for a date within the period ending with the day equivalent to Dec. 31, and 79 for a later date. For Saka current years the numbers to be added are 77 and 78. In the Republic of India the official Saka year is the elapsed year, starting from the day following that of the vernal equinox. A normal year consists of 365 days, while the leap year, now introduced, has 366. The first month is Chaitra, with 30 days in a normal year and 31 in a leap year; the five following months have 31 days, the others 30.

A Nepalese era (A.D. 879) of obscure origin was commonly used in Nepal until modern times. The years were elapsed, starting from Karttika, with months beginning at new moon.

Another era, the use of which is limited to the Malabar coast (Malayalam-speaking area) and to the Tirunelveli district of the Tamil-speaking area, is connected with the legend of the hero Parasurama, an avatar (incarnation) of the god Vishnu. It is called the Kollam era (A.D. 825). Its years are current and solar; they start from the entering of the sun into the zodiacal sign of Virgo in north Malabar, and from its entering into Leo in south Malabar. It is sometimes divided into cycles of 1,000 years reckoned from 1176 B.C. Thus A.D. 825 would have been the first year of its third millennium.

2. Eras Based on Astronomical Speculation.—During the period of elaboration of the classical Hindu astronomy, which was definitively expounded in the treatises called *siddhantas* and by authors such as Aryabhata (b. A.D. 476), Varahamihira, Brahmagupta (7th century A.D.), etc., were developed the ancient Vedic notions on the cycle of years embracing round numbers of solar and lunar years together. On the one hand, greater cycles were calculated in order to include the revolutions of planets, and the theory was elaborated of a general conjunction of heavenly bodies at 0° longitude after the completion of each cycle. On the other hand, cosmologists speculated as to the existence of several successive cycles constituting successive periods of evolution and involution of the universe. The period calculated as the basis of the chronology of the universe was the *maha yuga,* consisting of 4,320,000 sidereal years. It was divided into four *yugas* or stages, on the hypothesis of an original "Good Order" (*dharma*) established in the first stage, the *krita yuga,* and gradually decaying in the three others, the *treta-, dvapara-* and *kali-yugas.* The respective durations of these four *yugas* were 1,728,000, 1,296,000, 864,000 and 432,000 years. However, according to the astronomer Aryabhata, the duration of each of the four *yugas* was the same; *i.e.,* 1,080,000 years. The basic figures in these calculations were derived from the brahmanical reckoning of a year of 10,800 *muhurta* (*see* CALENDAR: *Hindu Calendar*), together with combinations of other basic numbers such as 4 phases, 27 *nakshatras,* etc. The movement of the equinoxes was at the same time interpreted not as a circular precession but as a libration at the speed of 54″ per year. It is in accordance with these principles that the calculation of the beginning of the *kali yuga* was done, in order to fix for this chronology a point starting at the beginning of the agreed world cycle. Such a beginning could not be observed as it was purely theoretical, consisting of a general conjunction of planets at longitude 0°, the last point of the *nakshatra* Revati (Pisces). It has been calculated as corresponding to Feb. 18, 3102 B.C. (old style), 0 hour, and taken as the beginning of the Kali era. In this era, the years are mostly reckoned as elapsed and as solar or luni-solar.

In Hindu tradition the beginning of this era was connected with (1) events of the Mahabharata war; (2) King Yudhisthira's accession to the throne; (3) 36 years later, King Pariksit's consecration; (4) Lord Krishna's death. Its years are still regularly given in Hindu almanacs.

An era resting upon a fictitious assumption of a complete 100-year revolution of the Great Bear (*saptarsi*) around the northern pole was the Saptarsi or Laulika era (3076 B.C.), formerly used in Kashmir and the Punjab. The alleged movement of this constellation has been used in purana compilations and even by astronomers for indicating the centuries.

Two chronological cycles were worked out on a basis of the planet Jupiter's revolutions, one corresponding to a single year of Jupiter consisting of 12 solar years, and the other to five of Jupiter's years. The second, the Brhaspatrikaka, starts, according to different traditions, from A.D. 427 or from 3116 B.C. Before A.D. 907 one year was periodically omitted in order to keep the cycle in concordance with the solar years. Since 907 the special names by which every year of the cycle is designated are simply given to present years of the almanac.

Side by side with Hindu and foreign eras adopted in India, several eras were created in the country under foreign influence, chiefly of the Mogul emperor Akbar: Bengali San (A.D. 593); Amli of Orissa and Vilayati (A.D. 592); Phasli (A.D. 590, 592 or 593 according to the district); Sursan of Maharashtra (599).

(J. L. A. F.)

III. EGYPTIAN

The chronology of ancient Egyptian history is still only imperfectly known. The Egyptians, like other ancient peoples, dated events not by an era but by the regnal years of individual kings. In the earliest dynasties, a recurrent cattle census provided the only dating criterion. Egyptian monuments only very rarely contain statements of a general chronological nature; for instance, the compiler of the Turin papyrus noted that 955 years had elapsed between the beginning of the 1st dynasty and the end of the 8th; the inscription of Mes estimates that 59 years have intervened between the death of Amenhotep III (1379 B.C.) and a date late in the reign of Horemheb; and a Ramesside stela commemorates the 400th anniversary of the founding of the Hyksos capital of Avaris by King Nubti, perhaps an early Hyksos ruler. Although the Egyptians themselves were meticulous chroniclers and kept full records of the succession of their Pharaohs and the length of reign of each in years, months and even days, and also compiled annals recording the main events of each year, most of this detailed information is lost. Only fragments survive in, for example, the Palermo stone, containing part of the annals of some early dynastic and Old Kingdom Pharaohs, and in extracts preserved in inscriptions of the New Empire, including the various king lists which have wholly or partly survived. The latest and most complete of these lists is the one compiled from older sources by the priest-historian Manetho in the 3rd century B.C. for the (lost) history of Egypt which he wrote in Greek for the king Ptolemy I Soter. This list is preserved in the works of the 3rd-century Christian chronologer Sextus Julius Africanus and of the church historian Eusebius of Caesarea and was re-edited about A.D. 800 by the Byzantine chronicler and ecclesiastic George the Syncellus in his *Epitome of Ancient History.* Manetho's transliteration of Egyptian names into Greek, further mutilated by the misspellings of copyists, renders it often difficult to identify his royal names with those of the monuments and the native king lists. Of the latter the most detailed and reliable is the Turin papyrus, which, like Manetho, arranged the Pharaohs into family groups or dynasties and gave the length of the reign of each; but this valuable document is in a sadly fragmentary condition and ends before the New Empire. Shorter lists containing kings' names alone were inscribed upon monuments; of these three survive: (1) the list of Thutmose III from Karnak, now in the Louvre museum, Paris, containing 61 names; (2) the list of Seti I from his temple at Abydos containing 76 names and copied by his son Ramses II; (3) the Saqqarah list of 58 names, found in the tomb of a Ramesside architect. These lists omit kings considered illegitimate or unimportant at the time of compilation.

Valuable though the king lists are to the historian, they have to be used with caution when attempting to reconstruct the chronological framework of Egyptian history; in certain epochs, for instance, it appears that rival kings or even whole dynasties, listed consecutively by Manetho, were ruling at the same time. Contemporary monuments sometimes provide evidence of the exact length of a king's reign or of overlaps between the reigns of father and son resulting from coregencies (as when the 30th year of one Pharaoh is said to be the 10th of another). The autobiographies of nobles who held office under successive Pharaohs, the dates on the funerary stelae of Apis bulls which were born in the reign of one Pharaoh and died at a stated age in the reign of another, and even the quayside records of Nile levels can provide chronological data; sometimes the approximate age of the few surviving royal mummies can be estimated anatomically. With the aid of such data, a system of relative chronology can be tentatively reconstructed, and within this sequence may be placed all known rulers of importance, with the proviso that in times of divided rule and confusion, such as the First and Second Intermediate periods, even the names of some who claimed the title of Pharaoh may be missing.

It remains to establish an absolute chronology for Egyptian history in terms of universal chronology. Fixed dating points are obtained by various methods. There are a few synchronisms with dated events in the history of neighbouring peoples. These are especially valuable for the later history of Egypt: for example, the invasion of Palestine by Sheshonk I (Shishak) is fixed to about 930 B.C. by biblical and Assyrian evidence, and for the Ethiopian and Saite Pharaohs there are synchronisms with Assyrian kings whose dates are well established. Before the reign of Tiglathpileser I (1116–1076 B.C.), however, the Assyrian king lists contain uncertainties, and synchronisms during the Ramesside period and earlier between Egypt and its neighbours can only be approximately fixed. Ramses II fought the Hittite king Mursili II and concluded a treaty with his successor Hattusili III in the 5th month of the 21st year of his reign; the peace is indirectly referred to in a letter written by Hattusili to the Kassite king Kadashman Kharbe III, whose dates are approximately known by links with Assyrian history. Similarly, the Amarna letters say that Amenhotep III died very shortly before Kadashman Kharbe II, and that both this Pharaoh and his son Amenhotep IV (Ikhnaton) were contemporaries of Ashur-uballit of Assyria. In the 13th dynasty, Pharaoh Neferhotep sent presents to a prince of Byblos who is mentioned in the archives of the last king of Mari shortly before the latter's defeat by Hammurabi of Babylon; this fact would be of more value were the date of Hammurabi not a subject of dispute among scholars.

Archaeological synchronisms, obtained when an Egyptian object is found in some neighbouring country in a dated context, or when a dated foreign import is found in Egypt, are of rare occurrence and give only approximate results. For example, Sumerian motifs and objects of the late phase of protoliterate civilization in Mesopotamia, called the Jamdat Nasr period, to the north of Babylon, are found in association with the latest predynastic culture in Egypt, but the time-bridge thus established can be estimated only to within a century or two. Early dates can be estimated by the carbon-14 method, but again the result is subject to a wide margin of possible error. Four samples of a cypress beam from the tomb of the Pharaoh Sneferu at Meydum when analyzed by this method gave an average age of 4802 ± 210 years; *i.e.*, they indicated that the king was buried probably between 3060 and 2640 B.C. The death of Sesostris III was similarly calculated at between 1850 and 1490 B.C., but in this case a more accurate date, 1843 B.C., with a margin of error of perhaps only four years, has been obtained by the use of astronomical calculations.

This last is the most valuable, because the most accurate, method of obtaining absolute dates in Egyptian history. Astronomical observations were made by the priests from very early times in connection with the festivals of astral deities, and a few of their results have been preserved. A papyrus at Leiden, for instance, gives the date of a new-moon festival as the 27th day of the 6th month of year 52 of Ramses II. The only possible years within the 13th century B.C. in which a new moon could have been observed on that date in lower Egypt are 1250, 1239 and 1228; other than astronomical considerations make the first of these dates the most probable. More valuable than such observations, however, are the dates recorded for the heliacal risings of Sothis or Sirius, the Dog star. During a brief period each year, after long invisibility, the star is visible about 42 minutes before sunrise. This reappearance coincides more or less with the annual rise of the Nile, and the festival of Sothis was therefore associated with this phenomenon. It is twice mentioned as occurring on a specific date in the civil calendar. One of the Kahun papyri states that Sothis rose heliacally on the 1st day of the 8th month of year 7 of Sesostris III; the date of this event can be calculated astronomically as falling between 1876 and 1864 B.C. The other Sothic date occurs in the Papyrus Ebers, which states that the festival of Sothis was celebrated on the 9th day of the 11th month of year 9 of Amenhotep I; *i.e.*, in approximately 1540 B.C. A third date, during the reign of Thutmose III, falls between 1474 and 1464 B.C., but here the regnal year is missing.

Thus with the aid of Manetho and the other king lists, especially the Turin papyrus, approximate dates B.C. can be obtained for the Middle Kingdom and for the earlier period of the New Empire. Yet even the Sothic dates are subject to possibilities of error that have led certain scholars to deny their validity for determining chronology. In the first place, Egyptologists are not unanimous that all ancient Egyptian observations of solar and related phenomena were made in the latitude of Memphis or Heliopolis: some consider that the capital city (sometimes Thebes and sometimes located in the Fayyum area or in the delta) was a more likely site. If Thebes and not Heliopolis had been the observation post, a reduction in date of about 20 years would result. In the second place, the feast of Sothis may not have been celebrated on the day of the first viewing of the star, but on a subsequent day, after due preparation, and when the star was visible for long enough to enable an adequate liturgy to be addressed to it. There is also doubt as to the actual length of the "Sothic cycle"; *i.e.*, the period of 1,460 (4 × 365) years taken by the calendar to return to its starting point. (In fact, the figure of 1,460 years is too rigid and makes no allowance for variations in observation; it should rather be reckoned as between 1,460 and 1,456 years.) In historical times the Egyptian year was divided into three seasons each containing four months of 30 days apiece. Observation of recurrent natural phenomena, however (whether of the annual rise of the Nile or of an annual cycle of lunar months), soon made it evident that a calendar of 360 (12 × 30) days was too short, and accordingly five epagomenal days were added at the end of the last month. The resultant 365-day civil year was convenient enough but still not accurate, for the true solar year is slightly longer; *i.e.*, approximately 365¼ days.

When this calendar was first devised, the rise of the Nile was heralded, perhaps by a heliacal rising of Sothis, on the 1st day of the 1st month of the season of Inundation, but as time went on an ever-widening gap separated the inundation from the calendrical New Year's day, and in time the season names, Inundation, Sowing and Harvest, ceased to correspond at all with the seasons themselves. Every four years, therefore, the festival of "the Going Up of Sothis" fell one whole day earlier; it was thus carried backward through the seasons until on the 1,461st year of the Sothic cycle the Dog star rose again on New Year's day and the two festivals once more coincided. The Egyptians themselves, however, had no knowledge of such an era, nor did they base calculations upon it. But in the 3rd century A.D. the Roman scholar Censorinus noted that in A.D. 139 the two New Year's days had coincided, and backward calculations on the basis of a 1,460-year cycle give the dates 1321, 2781 and 4241 B.C. as probable commencements for earlier "cycles." Many scholars consider that the calendar must have been invented about 2781 B.C., which would bring it within the 2nd or 3rd dynasty. Others, denying an astronomical origin for the civil calendar, would ascribe its invention to the 1st dynasty or to the genius of Imhotep, the minister of King Zoser in the 3rd dynasty.

In spite of doubts of the validity of Sothic dating and uncertainties due to lack of information on the lengths of the reigns even of some well-known Pharaohs, an approximate chronology for the latter half of Egyptian history is agreed. Before the Middle Kingdom, all is still uncertain. The First Intermediate period, to which Manetho gives four dynasties, may have been quite short, judging by the evidence of archaeology. Dates varying by as much as 100 or 150 years are given for the earlier dynasties of the Old Kingdom, while "Menes," the founder of the first dynasty of united Egypt, is variously dated, by archaeologists and historians, to 3200, 3400, 3100, 3000 and 2850 B.C. (M. S. DR.)

IV. BABYLONIAN AND ASSYRIAN

1. Mesopotamian Chronology, 747 to 539 B.C.—The source from which the exploration of Mesopotamian chronology started is a text called Ptolemy's canon. This king list covers a period of about 1,000 years, beginning with the kings of Babylon after the accession of Nabonassar in 747 B.C. The text itself belongs to the period of the Roman empire and was written by a Greek astronomer resident in Egypt. Proof of the fundamental correctness of Ptolemy's canon has come from the ancient cuneiform tablets excavated in Mesopotamia, including some that refer to astronomical events, chiefly eclipses of the moon. Thus by the time excavations began a fairly detailed picture of Babylonian chronology was already available for the period after 747 B.C. Ptolemy's canon covers the Persian and Seleucid periods of Mesopotamian history, but this section will deal only with the period up to the Persian conquest (539 B.C.) which marks the end of Babylonian history.

As regards the chronology of Assyria, the chief problem in the early years of Assyriology was to reconstruct a sequence for the period after 747 B.C. This was done chiefly by means of the *limmu* lists, or eponym lists, several of which were found by early excavators. These texts are lists of officials who held the office of *limmu* for one year only, and whom historians also call by the Greek name of eponym. Annals of the Assyrian kings were being found at the same time as eponym lists, and a number of these annals, or the campaigns mentioned in them, were dated by eponyms who figured in the eponym lists. Moreover, some of the Assyrian kings in the annals were also kings of Babylonia and as such were included in Ptolemy's canon.

Good progress was therefore being made when, soon after 1880, two chronological texts of outstanding importance were purchased by the British museum. One of these, now known as king list A, is damaged in parts, but the end of it is well preserved, and this coincides with the first part of Ptolemy's canon, down to 626 B.C. The other text, the Babylonian Chronicle, also coincides with the beginning of the canon, though it breaks off earlier than king list A. With the publication of these texts the first phase in the reconstruction of Mesopotamian chronology was over. For the period after 747 B.C. there remained only one serious lacuna; *i.e.*, the lack of the eponym sequence for the last 40 years or so of Assyrian history. This had not been established by the early 1960s.

2. Assyrian Chronology Before 747 B.C.—German excavations at Ashur, ancient capital of Assyria, yielded further eponym lists. By World War I the full sequence of eponyms was known from about 900 to 650 B.C. A further fragmentary list carried the record back to about 1100 B.C., and on this basis Assyrian chronology was reconstructed, with little error, back to the accession of Tiglath-pileser I in 1116 B.C. Failing another eponym list, a king list was needed for substantial further progress. King lists found at Ashur proved disappointing. Those fairly well preserved did not include figures for the reigns, and those with figures were very badly damaged.

In 1933, however, an expedition of The University of Chicago discovered at Khorsabad, site of ancient Dur Sharrukin, an Assyrian king list going back to about 1700 B.C. But for the period before 1700 B.C. the list is damaged and otherwise deficient; and Assyrian chronology prior to this date is far from clear.

Before 747 B.C. it was the custom of the Assyrian kings to hold eponym office in their first or second regnal year. Thus in an eponym list the number of names between the names of two successive kings usually equals the number of years in the reign of the first of the two kings. It would have been easy to compile a king list from an eponym list, and there is evidence that this Assyrian king list was compiled from an eponym list probably in the middle of the 11th century B.C. As an eponym list is a highly reliable chronological source, since omission of a name entails an error of only one year, the king list, if based on one, will have preserved much of the structure of older eponym lists, now lost. (Except for one fragment, no known eponym list goes back further than the beginning of the 11th century B.C.)

3. Babylonian Chronology Before 747 B.C.—The Old Babylonian period in Mesopotamian history starts with the fall of the last Sumerian dynasty, the 3rd dynasty of Ur, shortly before 2000 B.C. according to the chronology here adopted. But it should be remembered that more than a century was to elapse thereafter before the accession of Sumuabu, the earliest king yet known to have reigned in the city of Babylon.

In the long interval between the beginning of the Old Babylonian period and 747 B.C. there are two substantial gaps in chronology, each about two centuries long. The earlier gap is in the 2nd millennium and covers most of the 16th and 15th centuries; *i.e.*, approximately the years 1600–1400 B.C. The later gap is in the 1st millennium and runs from the short reign of Ninurta-kudurri-usur II in about 941 B.C. to the accession of Nabonassar in 747 B.C. During these gaps the names of most of the kings are known, as well as the order, but usually not the length, of their reigns.

For the interval between the two gaps king list A provides figures from the accession of Kurigalzu II in about 1345 B.C. to Ninurta-kudurri-usur II in about 941 B.C. Though exact figures are not available for the earlier half of the 14th century B.C., other sources, chiefly letters from Babylonian kings to the Egyptian kings Amenhotep III and Amenhotep IV (Ikhnaton) found at Tell el-Amarna in Egypt, yield a close chronological outline back to Kurigalzu I who was reigning in 1400 B.C.

During this period of Babylonian history, texts were dated by the regnal year of a reigning king, and a considerable number are dated to the reigns for which king list A provides figures. These texts confirm the king list to the extent that none is dated by regnal years higher than the figures in king list A except for Kudurri-Enlil. This indicates that at least for the period from which these texts date (*i.e.*, *c.* 1350–1050 B.C.) king list A is a reliable source, though not completely free from error. There is reason to believe that it omits the seven years of Assyrian rule under Tukulti-Ninurta I, and it is certain that the figure it gives for Kudurri-Enlil should be corrected from six to nine.

A second means of checking the reliability of king list A is provided by the chronicles, annals and other historical inscriptions which show that a given Assyrian king was contemporaneous with a given Babylonian king. There are no fewer than 15 such synchronisms between 1350 and 1050 B.C., and when king list A is compared with the Assyrian king list they all fit in easily. Only one of them, however, enables the beginning and end of the Babylonian reign to be closely determined in relation to the beginning and end of the corresponding Assyrian reign. This synchronism shows that the two-year reign of the Assyrian king Ashared-apil-Ekur (1076–75 B.C.) is entirely comprised within the 13-year reign of the Babylonian king Marduk-shapik-zeri. The Assyrian's dates are probably correct to within one year. Hence if Marduk-shapik-zeri be dated so that equal proportions of his reign fall before and after that of Ashared-apil-Ekur, a date is obtained for the former which should not be in error by more than six years. This synchronism constitutes a key to the structure of Babylonian chronology by providing the base date for all the reigns in the interval 1400–941 B.C. for which king list A gives figures. All the dates thus obtained, naturally, are subject to the six-year margin of error.

There is other evidence to show that the error is not likely to have been much greater. Thus the Babylonian material and the Tell el-Amarna letters show that Burnaburiash II came to the throne a little before 1380 B.C., and that the event occurred not long before the accession of Ikhnaton in Egypt. Quite independently the combined evidence of the Egyptian material and the Hittite records yields about 1379 B.C. as a closely correct date for the accession of Ikhnaton.

As regards the chronological gaps in the 1st and 2nd millenniums B.C., there are some fairly close approximate dates for the kings of Babylonia between 940 and 747 B.C., although no figures are available for their reigns. This is because there is plenty of information on the chronology and history of Assyria during this period, and a number of the Babylonian kings then reigning are mentioned in connection with wars and treaties between Assyria and Babylonia.

The gap in the 2nd millennium, however, is not so easy to fill. The number of Babylonian kings between Karaindash and Kurigalzu II (*c.* 1345) shows that Karaindash must have died very soon after 1420, the date of the accession of the Assyrian king Ashur-bel-nisheshu, a contemporary of Karaindash. Similarly the number of kings and generations between Burnaburiash I and Karaindash renders improbable a date after 1500 B.C. for the former. On the other hand a synchronism between him and the Assyrian Puzur-Ashur III makes it difficult to date Burnaburiash before 1550 B.C. There is reason to believe that the Kassite king Agumkakrime was reigning about 24 years after the end of the 1st Babylonian dynasty, which the Kassites had overthrown; but his exact position within the Kassite dynasty is uncertain, though his father, Tazzigurumash, was the sixth or seventh king of that dynasty. Finally, it is known that a son of Burnaburiash I, Ulamburiash, brought to an end the dynasty of the Sea Land, a country near the Persian gulf which had broken away from Babylon. This dynasty, in king list A, follows on the 1st dynasty of Babylon, although in fact it began during the reign of Samsuiluna, the sixth king of the 1st dynasty. Whether any of the kings of the dynasty of the Sea Land ever ruled over Babylon is very uncertain.

These are the only significant chronological landmarks within the gap which follows the end of the 1st dynasty. The fact that the magnitude of this gap is uncertain constitutes the main problem in the chronology of the 2nd millennium B.C., and it affects also the chronology of the preceding, Sumerian period. The problem is not yet solved. Observations of the planet Venus made during the reign of King Ammi-saduqa, less than 50 years before the end of the 1st dynasty, permit only certain possible dates for his reign. Translated into dates for the end of the dynasty, the three most likely possibilities are 1649, 1595 and 1587 B.C. Space will not allow discussion of the evidence, which is not conclusive, and leaves uncertain what choice should be made among the three. The chronology adopted here is based on the second of these dates for the end of the 1st Babylonian dynasty; *i.e.*, 1595 B.C.

Prior to this gap in the 2nd millennium B.C. there is a period of five centuries with a well-established chronological structure. All the kings in the major city-states are known, as well as their sequence and the length of their reigns. Which sets of dates should be assigned to these reigns, however, depends on the date adopted for the end of the 1st dynasty of Babylon. This period of five centuries extends from the beginning of the 3rd dynasty of Ur to the end of the 1st dynasty of Babylon; *i.e.*, on the chronology adopted here, 2113–1595 B.C. During this period the Babylonians dated their history not by regnal years but by the names of the years. Each year had an individual name, usually from an important event which had taken place in the preceding year. The lists of these year names, called year lists or date lists, constitute as reliable a source in Babylonian chronology as do the eponym lists in Assyrian chronology. One of the events which almost invariably gave a name to the following year was the accession of a new king. Hence the first full regnal year of a king was called "the year (after) NN became king." In Assyria the number of personal names in an eponym list between the names of two successive kings normally equaled the number of years in the reign of the first king; and similarly in Babylonia the number of year names between two year names of the above kind nearly always equaled the number of years in the reign of the first king. Just as in Assyria the eponym lists are almost certainly the source of the king lists, so in Babylonia the king lists are based on the year lists. Several of these king lists, compiled at a time when the year lists were still in use, survive. One gives the 3rd dynasty of Ur and the dynasty of Isin, another gives the dynasty of Larsa. Both may be school texts.

The 3rd dynasty of Ur and the dynasty of Isin also figure in the Sumerian king list, which reaches far back into the Sumerian period. The original version probably ended before the 3rd dynasty of Ur, but later scribes brought it up to date by adding that dynasty as well as the dynasty of Isin.

The figures for the 1st dynasty of Babylon are missing in king list A but are given in another list, known as king list B. In the older source from which king list B was copied some of the figures for the kings of the 1st dynasty were damaged, and the author of king list B tried to make good this deficiency by substituting estimates. The 1st dynasty is, however, so well represented in the year lists that its chronology is known in almost every detail.

For two other important cities in the Old Babylonian period, Eshnunna and Mari, there are neither king lists nor year lists, but only synchronisms with the city of Babylon at the time of Hammurabi. These synchronisms provide a basis for an outline at least of the chronology of those two city-states. (M. B. Ro.)

V. JEWISH

The era at present in vogue among the Jews (*lizira* or *libri' ath 'olam;* from the creation of the world, *i.e.*, *Anno Mundi*, abbreviated to A.M.) came into popular use about the 9th century A.D.; it is traceable in dates recorded much earlier. This era has five styles conventionally indicated by Hebrew letters used as numerals and combined into mnemonics, which state the times of occurrence of the epochal mean conjunctions or *moladim* (*see* CALENDAR: *Jewish Calendar*) or the orders of intercalation in the 19-year cycle or both. These mnemonics are as follows:

1. For the first style, *DKTH* (= 4th day of the week, 20 hours counted from 6 P.M., 408 *halaqim*, *i.e.*, $22\frac{2}{3}$ minutes in the 21st hour).

2. For the second style, *BHRD* (= 2nd day, 5 hours, 204 *h.*) and *GWH'DZT* (indicating the years 3, 6, 8, 11, 14, 17 and 19 as leap years).

3. For the third style, *WYD* (= 6th day, 14 hours, 0 *h.*) and *BHZYGWH* (*i.e.*, years 2, 5, 7, 10, 13, 16 and 18 are leap years).

4. For the fourth style, *GKBTT'W* (= 3rd day, 22 hours, 876 *h.*) and *'DWTBHZ* (years 1, 4, 6, 9, 12, 15 and 17 are leap years).

5. For the fifth style, *GBGGGBG* (*i.e.*, the intervals between the leap years in the 19-year cycle are 3, 2, 3, 3, 3, 2 and 3 years, so that the years 3, 5, 8, 11, 14, 16 and 19 are leap years).

The respective epochs of these styles fall in the years 3762–3758 B.C., inclusive. By about the 12th century A.D. the second style, that which is in use at the present day, whose epoch is on Sunday (= Monday, because of the Jewish way of beginning the calendar day at 6 P.M.), Oct. 7, 3761 B.C., superseded the other styles of the era *Anno Mundi*.

The styles of this era arise from variations in the conventional rabbinical computation of the era of the creation. This computation, like hundreds of other calculations even more variable and no less arbitrary, is founded on synchronisms of chronological elements expressed in the terms of biblical and early postbiblical Jewish eras.

The biblical era *Anno Mundi* underlies the dating of events (mainly in the book of Genesis) prior to the Exodus from Egypt. This period of biblical chronology abounds in intractable problems. These are due: (1) To discrepancies between the Jewish and Samaritan Hebrew texts and the Greek version known as the Septuagint. From the creation to the birth of Abraham there are 1,946 years according to the Jewish Hebrew text, 2,247 years according to the Samaritan Hebrew text and 3,412 years according to the Septuagint. (2) To apparent inconsistencies in some of the synchronisms. For example, the period of the Egyptian bondage of Israel is given as 400 years (Gen. xv, 13), 430 years (Ex. xii, 40–41, Hebrew text) and 435 years (Ex. xii, 40–41, according to some manuscripts of the Septuagint); none of these figures seems to be reconcilable with the data (Ex. vi, 16–vii, 7) about the length of the life of Moses' ancestors and about his age at the time of the Exodus. (3) To uncertainties about the method of reckoning; *e.g.*, whether predating or postdating is used, etc.

During the period from the Exodus to the founding of Solomon's Temple, the only continuous biblical era (chiefly in the remaining books of the Pentateuch) is the era of the Exodus. With regard to a crucial date expressed in this era—"In the four hundred and eightieth year after the people of Israel came out of the land of

Egypt, in the fourth year of Solomon's reign over Israel, in the month of Ziv, which is the second month, he began to build the house of the Lord" (I Kings vi, 1)—there is again a discrepancy between the Hebrew text and the Greek of the Septuagint. Other problems to be met with during this period are due to the obscurity of chronological data in the book of Judges and in I and II Samuel.

During the following period, the Bible uses the eras of the regnal years of monarchs (the kings of Judah, Israel and Babylon) and of the Babylonian exile. This period of biblical chronology likewise poses numerous problems, mainly due to apparent inconsistencies of the synchronisms; *e.g.*, in the period from the accession of Rehoboam of Judah and of Jeroboam of Israel to the fall of Samaria "in the sixth year of Hezekiah [of Judah], which was the ninth year of Hoshea king of Israel" (II Kings xviii, 10) the years of the reigns of the southern kingdom exceed those of the northern kingdom by 25 years.

The biblical data might be easier to harmonize if the occurrence of coregencies were assumed. Yet, as an ever-variable factor, these evidently would not lead to the determination of the true chronology of this period, and scholars therefore seek additional information from sources outside the Bible. Such a source has been found in the inscriptions on Assyrian monuments, which are dated by the so-called eponym lists. Substantial use also has been made of the data in the king list known as Ptolemy's canon (compiled in the 2nd Christian century) commencing in 747 B.C. with the reigns of the Babylonian kings (*see* above, *Babylonian and Assyrian*). However, scholars differ widely in their interpretation of a great many details, and numerous chronological problems remain altogether unsolved. Only a few dates in this period can be fixed with any degree of confidence.

After the Babylonian exile, as evidenced by the data in the Bible and the Aswan papyri, the Jews reckoned by the years of the Persian kings. The chronological problems of this period are due to the apparent disorder in the sequence of events related in the biblical books of Ezra and Nehemiah and to the difficulty of identifying some of the Persian kings in question. For example, the King Artaxerxes of these books may stand for Artaxerxes I Longimanus (reigned 465–424 B.C.), for Artaxerxes II Mnemon (reigned 404–359 or 358 B.C.) or, in the case of Ezra at any rate, for Artaxerxes III Ochus (reigned 359 or 358–338 or 337 B.C.).

From the Grecian period onward, Jews used the Seleucid era (especially in dating deeds; hence its name *Minyan Shetaroth*, or Era of Contracts). In vogue in the east until the 16th century and possibly still used by some Yemenite Jews, this is the only Jewish era of antiquity that survived. The others soon became extinct; they were the national eras dating (1) from the accession of the Hasmonaean princes (*e.g.*, Simeon the Hasmonaean in 143/142 B.C.); and (2) from the anti-Roman risings ("era of the Redemption of Zion") in the years 66 and 131 of the common (Christian) era. Dates have also been reckoned from the destruction of the Second Temple (*lehorban hab-bayith*). The various styles of the latter, as also of the Seleucid era and of A.M., have often led to erroneous conversions of dates. The respective general styles of these eras correlate as follows: 3830 A.M. = year 381 of the Seleucid era = year 1 of the Era of the Destruction = year 69/70 of the common (Christian) era.

The earliest Jewish chronologies have not survived. Of the work of the Alexandrian Jew Demetrius (3rd century B.C.), which deduced Jewish historical dates from the Scriptures, only a few fragments are extant. In the Book of Jubilees, events from the creation to the Exodus are dated in jubilee and sabbatical cycles of 49 and 7 years. Scholars differ as to the date and origin of this book (*see* CALENDAR: *Jewish Calendar*). The era of the creation therein is unlikely to have been other than hypothetical.

The earliest and most important of all the Jewish chronologies extant is the *Seder 'Olam Rabbah*, transmitted, according to talmudic tradition, by Rabbi Jose ben Halafta in the 2nd Christian century. The author, whose date is unknown, was possibly the first to use the rabbinic Era of the Creation. His chronology extends from the creation to Bar-Cochba in the days of the Roman emperor Hadrian; but the period from Nehemiah to Bar-Cochba (*i.e.*, from Artaxerxes I or II to Hadrian) is compressed into one single chapter. The Persian phase shrinks to a mere 54 years, the variant reckoning of 250 years being corrupt (the typographically similar Hebrew numerals *RN* and *ND*, or 250 and 54, are easily confused).

The smaller work *Seder 'Olam Zuta*, probably written in the 8th century A.D., completes the *Rabbah*. It aims to show the Babylonian exilarchs, of whom it enumerates 39 generations, as lineal descendants of David.

Megillath Ta'anith ("Scroll of Fasting"), although recording only the days and months of the year without the dates of the years, is nevertheless an important source for Jewish chronology. It lists events on 35 days of the year which have been identified with events in five chronological periods: (1) pre-Hasmonaean; (2) Hasmonaean; (3) Roman (up to A.D. 65); (4) the war against Rome (65–66); (5) miscellaneous. The authors, or rather the last revisers, are identified with Zealot partisans guided by Hananiah ben Hezekiah ben Gurion and his son Eliezer. A Latin translation exists. (ER. WI.)

VI. GREEK

The concept of chronography, *i.e.*, of fixing the time-sequence of past events, did not develop in Greece until about the mid-5th century B.C. The difficulties which therefore surrounded the chronology of earlier Greek history were recognized by Thucydides, writing at the end of that century, and the only modern advantage in overcoming them is the existence of archaeological evidence, which can be used side by side with the literary sources but which also raises its own problems of interpretation.

The first theories about the dating of earlier Greek history were developed chiefly through the study of various lists, such as those of the Olympic victors drawn up by Hippias of Elis, of holy officials such as the Argive priestesses, or secular ones such as the Athenian archons (both used by Thucydides and others) and genealogies of royal and aristocratic families such as the Spartan king lists.

1. Spartan King Lists.—The Olympic victor lists were distrusted even by Plutarch; and it is doubtful whether by 776 B.C., when they purport to begin, writing was current in Greece, so that the names were probably recorded only in oral tradition.

An indication of how far the Spartan king lists were used by ancient historians and how far they were reliable may be found in the fact that while Herodotus, writing in the 5th century, places the lawgiver Lyçurgus in the Agiad royal line, later writers, including Ephorus (writing in the 4th century) place him in the Eurypontid line, showing that there cannot have been agreement as to the content of these lists, or that information in them was liable to be distorted. Some names too are clearly fictitious; *e.g.*, Lycurgus' father, Eunomos ("of good laws"), is clearly a reference to Lycurgus' lawgiving. Names earlier than Agis and Eurypontus, eponyms of the royal lines, may be mere inventions to synchronize with other genealogies, as well as to explain the names of the three tribes and the existence of the double kingship. Archaeology, however, shows that the dating given for the Trojan War and the great migrations (traditionally known as "the Return of the Heraclidae"), which was certainly related to the Spartan king lists, was approximately correct. The chronological scheme of Eratosthenes dates the Trojan War to 1192–83 B.C., the Thessalian and Dorian migrations to 1124–04: before him, Thucydides dated the Dorian invasion to the 80th year after the fall of Troy (probably both reflected Hellanicus, who had written a history of Troy).

The evidence of imported Mycenaean pottery fixes the end of the period of the settlement of Troy VIIa (identified with the Troy of Priam and of the Trojan War) at about 1250 B.C. This agrees well enough with the date given by Herodotus and is not irreconcilable with the scheme of Eratosthenes if allowance is made for different estimates of the length of a generation. Archaeological evidence also supports the placing of the date of the migrations some time after 1200. It remains doubtful, however, whether the king lists were adapted to fit ancient tradition about those dates or whether they were themselves substantially reliable in spite of detailed anomalies.

2. Athenian Archon Lists.—The Athenian archon lists for the early period were based chiefly on the traditions of the aristocratic families such as the Alcmaeonidae and Pisistratidae and on the body of popular legend. Tradition could supply a framework for accurate dating, for example, the chronology of the Pisistratid tyrannies in Herodotus, and this was worked up in the 4th–3rd centuries B.C. by the Atthidographers, writers like Androtion and Cleidemus who wrote histories of Attica. But one important question is how the archon names were linked to events, since the list as a rule did not contain annotations. In some cases, such as the dating of Cylon to the archonship of Megacles, the two names were evidently linked in the tradition, but there must have been various blocks of dates whose relationship with each other would remain in doubt. One case in which they may have been wrongly related is the supposed 30-odd-year interval between Solon (archon 594–593 or 592–591) and the first tyranny of Pisistratus (561–560) in the Attic tradition, which is filled in with "anarchies" (*i.e.*, years in which there was no archon). Many scholars would like to bring down the date of the Solonian reforms (whatever they may have been) to about 575, which would also relate Solon more easily to Croesus, Amasis and Philocyprus, as Herodotus does. It is unlikely that for the period of the tyrannies and before the reforms of Cleisthenes any help was given by extant decrees in pinpointing dates, and the so-called "laws of Solon" were simply the body of old laws prior to the revision of 410–403. The difficulty of forming a sound chronology even for a period almost contemporary is shown by the problems encountered by Thucydides in the chronology of the period known as the *Pentekontaetea* or Fifty Years (480–431); and Thucydides also criticized the method of dating by relation to eponymous officials, which allowed a wide margin of inaccuracy because the various eponyms took office at different times of the year and because the official and campaigning years did not coincide and could therefore be confused; for example, a period dated by two eponymous officials might cover a few weeks or nearly two years. When dates could not be extracted from the tradition and were based solely on calculation, they are now known to be generally wrong; an example is Herodotus' dating of Gyges, tyrant of Lydia, which the Assyrian records show to be 40 years too early. Genealogical tables with their exclusively "father to son" descent and equalized generations are too schematic to carry historical weight, except insofar as they may reflect a genuine tradition with which they have been synchronized.

3. Checking Dates Calculated by Ancient Historians.—This is often difficult because of the fragmentary state of surviving texts and the loss of most of the relevant lists (though, for instance, a fragment of the Athenian archon list has survived). In many cases the interpretation of earlier datings depends upon the evidence of later chronographers, and much of the most valuable chronographical work, such as that of Eratosthenes, survives only at second hand, through Diodorus or Eusebius, the Parian chronicle (*qq.v.*) and "Suidas." It is then necessary to distinguish between the sources of these late works in order to evaluate their various datings, Eusebius, for example, being bedeviled by his desire to correlate all history with the Bible. This, again, is quite apart from the further difficulty of determining what figures are intended, which is frequently uncertain as a result of the corruption of the texts (*see* below, *Christian*).

4. Contribution of Archaeology.—Archaeology has furnished much of modern knowledge of Greek prehistory from Neolithic times onward, both adding to, confirming and checking other sources such as the Homeric and other poems, myths and histories. This knowledge has been acquired both through direct excavations, such as those at Knossos, Mycenae, Troy, Pylos and Korakou, and also by comparison with the archaeology of Egypt and the near east, which provide most of the links of Greek to world history and are thus most important for chronology. The evidence of archaeology has also been helpful for 7th- and 6th-century chronology (for example in checking foundation dates of colonies) and has made possible, *e.g.*, the dating of the introduction of hoplite warfare, on which depends much modern interpretation of mainland history from the 8th to the 6th centuries. (X.)

VII. ROMAN

The establishment of a sound chronology for Roman history, as for Greek, depends on the assessment of the evidence available, which falls into two categories, literary and archaeological.

1. Literary Evidence.—Although by the late 3rd century B.C. Eratosthenes was working on the systematization of chronography, and a series of learned historians had used the documentary method—notably, for Roman history, Timaeus (*q.v.*) of Tauromenium, to whom are probably due many of the synchronizations of Roman history with Olympiads—unfortunately this tradition of documentation and concern for chronology did not immediately pass over into Roman historiography. According to Cicero in *De oratore*, the earliest Roman historians did no more than "compile year-books"; for example, Fabius Pictor in the late 3rd century B.C., L. Calpurnius Piso in the 2nd and the so-called "Sullan annalists" in the 1st (*see* ANNALISTS). Of these authors it is possible to judge only at second hand, and only those of the 1st century were much used directly by the historians whose work survives in any quantity, notably Livy, Dionysius of Halicarnassus and Diodorus Siculus. In these authors, as in other 1st-century historians such as Sallust, there is little concept of documentation or research other than comparison of literary sources; for none was chronology a direct concern, and in many cases dramatic effectiveness and validity as *exemplum* would take priority over fidelity to truth. Apart therefore from the Greek Polybius, who treated the rise of Roman power in the Mediterranean from 264 to 146 B.C. and regarded himself as the successor of Timaeus, it was not until Cicero's time that the conception of historical scholarship developed in Rome. Cicero's friend Atticus not only was concerned to draw up a chronological table in his *Liber annalis* but had undertaken research to that end, and the great scholar M. Terentius Varro and a little later the learned M. Verrius Flaccus produced a vast body of erudite work, nearly all lost. To this source must probably be ascribed the *Fasti Capitolini*, a list of magistrates from the earliest republic to the contemporary period, set up in the *regia* (the office and archive of the *pontifices*) at the end of the 1st century B.C. This work, being inscriptional, is sometimes given precedence over literary evidence, but as a compilation should be subjected to the same evaluative scrutiny.

2. Sources Used by Roman Historians.—The traditionally early extant bodies of law such as the Twelve Tables (*q.v.*) were of little chronological value, and juristic *commentarii* were liable to mislead through their zeal for precedent; while Cicero, in spite of Polybius' claim to have inspected early treaties preserved in the *aerarium* (*q.v.*), definitely states in *De legibus* that there were no public records of early laws. A source frequently referred to is the *Annales maximi*, a collection made in 130 B.C. of the annual notices displayed on a white board by the *pontifices*, and containing notes of food prices, eclipses, etc. Dionysius of Halicarnassus implies that they gave a date for the foundation of the city, but is reluctant to accept their authority; and one of the eclipses is referred to by Cicero (*De republica*, i, 25) as being mentioned also by Ennius, but unfortunately the number of the year "from the foundation of the city" (A.U.C., *ab urbe conditâ* or *anno urbis conditae*) is corrupt in the text. Although it is possible to calculate the dates of eclipses astronomically in terms of the modern era, it is difficult to link these to Roman chronology because of the uncertainty of the figures and because of the anomalous state of the Roman calendar before the Julian reform (*see* CALENDAR: *Western Calendar*). Another difficulty is that the early records were said to have been burned in 390 B.C.; also that they would probably have been largely unintelligible if authentic.

Livy quotes the 1st-century annalist Gaius Licinius Macer as having found in the temple of Juno Moneta "linen rolls" giving lists of magistrates; but he also says that Macer and Aelius Tubero both cited the rolls for the consuls of 434, but gave different names. In any case, it is unlikely that the list could have been older than the temple, which dates from 344 B.C. It is clear that the chief sources for the lists were family pedigrees, such as those of the Claudii Marcelli, Fabii and Aemilii drawn up by Atticus; but Cicero and Livy agree that tendentious falsifications had in many cases corrupted the records, and other suspicious facts are the appearance of obviously later or invented *cognomina* or third names and of plebeian gentile names for the earliest period, when only patricians bore them. Many scholars, however, accept the general authenticity of the lists—one reason being the appearance in them of extinct patrician families—but prefer Livy's version to that of the Capitoline lists, which show signs of late revision, often give names in incorrect order and contain other anomalies. (*See* also Fasti.)

The question therefore remains whether Roman chronography was dependent on the lists of magistrates or whether these were adapted to fit other known datings. The apparent advantages of the existence of a terminal date, the "foundation of the city," is illusory for Roman chronology, since it depended on back reckoning and was not agreed even in antiquity. It is difficult to imagine how a genuine contemporary "fix" of such a date could be preserved, though parallels may be seen in the foundation dates of colonies, *e.g.*, in Thucydides, which are roughly substantiated on other grounds. There may have been traditions about the intervals between certain events, but the accepted reckoning of 244 years of kingly rule seems to be a calculation merely, based on the conventional 35-year generation for the rule of the seven legendary kings. Polybius claimed that the dating of the first republican consulship to 508/7 (supported by Dionysius) could be substantiated by an extant copy of a contemporary treaty. Combined with the traditional kingly period this would give a foundation date of 751–750 reckoned inclusively (Polybius' dating, with which Diodorus and Cicero agree), 752–751 exclusively (so Cato in the *Origines*). But Polybius and Dionysius disagree about the date of the sack of Rome, Polybius (and Diodorus) giving the year of the Peace of Antalcidas (387–386), Dionysius that of Pyrgion's archonship at Athens (388–387), though this may be simply a case of ambiguous overlap. In any case, the chronological scheme worked out by Varro pushes these dates back two years by adding two colleges of *decemviri*, and the modern modification accepts one of these, giving a foundation date of 753–752 for the Varronian 754–753. But it remains uncertain whether the dating depended on the magistrate lists or whether these were "doctored" to synchronize with given dates or intervals, whether these were traditional or calculated in some other way. Anomalies such as Livy's five-year anarchy 15 years after the Gallic invasion, Diodorus' repetition of magistrates' names, and the "dictator years" in the lists are perhaps attempts to synchronize the various pedigrees.

3. Contribution of Archaeology.—Archaeology can provide many dates useful to the detailed study of Roman history, especially from coins and inscriptions, but for the general scheme of early chronology its value is mainly negative. It shows, for example, that Rome rather evolved over 200–300 years than was "founded," though a "foundation" date might perhaps refer to the first common celebration of the *Septimontium* or festival of the seven hills; again, if that dating is dependent on the seven kings, archaeology shows that the tradition about them, though it may preserve genuine names and events, is largely legendary.

4. Datings After 1st Century B.C.—In this better-documented period datings to consul years, or later to the years of tribunician or other powers of the emperors, are normally intelligible, despite a few notorious cruxes, although up to the Julian reform the state of the calendar has to be taken into account. In parts of the empire, however, different eras were used, *e.g.*, that of the Seleucids, and from the 4th century A.D. dates were often calculated in terms of the *indictio*, which had come to mean the 15-year period covering three quinquennial tax assessments, a method which continued in use for many centuries in spite of difficulties such as lack of synchronization among the various provinces.

(Jr. W.)

VIII. CHRISTIAN

The Christian era is the era now in general use throughout the world. Its epoch, or commencement, is Jan. 1, 754 A.U.C. = *anno urbis conditae*, "from the foundation of the city [of Rome]"; Christ's birth was at first believed to have occurred on the Dec. 25 immediately preceding. Years are reckoned as before or after the Nativity, those before being denoted by the letters B.C. (before Christ) and those after by A.D. (*Anno Domini*, "in the year of the Lord"). Chronologers admit no year zero between 1 B.C. and A.D. 1. The precise date of commencing the annual cycle was widely disputed almost until modern times, Dec. 25, Jan. 1, March 25 and Easter day each being favoured in different parts of Europe at different periods.

The Christian era was invented by Dionysius Exiguus, a monk of Scythian birth resident in Italy (*fl. c.* A.D. 496–540); it was a by-product of the dispute which had long vexed the churches as to the correct method of calculating Easter (for which *see* Easter). Many churches, including those in close contact with Rome, followed the 95-year tables evolved by Theophilus, bishop of Alexandria, and by his successor, St. Cyril; but some western churches followed other systems, notably the 532-year cycle prepared for Pope Hilarius (*c.* 465) by Victorius of Aquitaine. In 525, at the request of Pope St. John I, Dionysius Exiguus prepared a modified Alexandrian computation based on Victorius' cycle. He discarded the Alexandrian era of Diocletian, reckoned from A.D. 284, on the ground that he "did not wish to perpetuate the name of the Great Persecutor, but rather to number the years from the Incarnation of Our Lord Jesus Christ."

This, on grounds that appear to have been historical rather than computistic, Dionysius reckoned to have occurred in 753 A.U.C.; but the Gospels state that Christ was born under Herod (*q.v.*) the Great; *i.e.*, at the latest in 750 A.U.C. Dionysius' dating was questioned by the English saint Bede in the 8th century and rejected outright by the German monk Regino of Prüm in the 9th. Nevertheless it has continued in use to the present day; and as result the Nativity is reckoned to have taken place in or shortly before the year 4 "B.C." when Herod died.

The new chronology was not regarded as a major discovery by its author; Dionysius' own letters are all dated by the indiction (*see* below). The use of the Christian era spread through the employment of his new Easter tables. In England the era was adopted with the tables at the Synod of Whitby in 663. But it was the use, above all by Bede, of the margins of the tables for preserving annalistic notices, and the consequent juxtaposition of historical writing with calendrical computations, that popularized the new era. Outside Italy it is first found in England (in a charter of 676), and shortly after in Spain and Gaul. It was not quickly adopted in royal diplomas and other solemn documents, however, and in the papal chancery it did not replace the indiction until the time of John XIII (965–972). The era did not become general in Europe until the 11th century; in most of Spain it was not adopted until the 14th, and in the Greek world not until the 15th.

Of the alternative chronologies used by Christians the most important were: (1) the indiction; (2) the Era of Spain; (3) the Era of the Passion. The indiction (*indictio*) was a cycle of 15 years originally based on the interval between imperial tax assessments but during the middle ages always reckoned from the accession of Constantine in 312. Years were given according to their place in the cycle of 15, the number of the indiction itself being ignored. This chronology was the most widespread in the early middle ages, but its use diminished rapidly in the 13th century, although public notaries continued to use it until the 16th. The Era of Spain was based on an Easter cycle which began on Jan. 1, 716 A.U.C. (38 B.C.), marking the completion of the Roman conquest of Spain. First recorded in the 5th century, it was in general use in Visigothic Spain of the 6th and 7th centuries and, after the Arab invasions, in the unconquered Christian kingdoms in the north of the Iberian peninsula. It was abolished, in favour of the Era of the Incarnation, in Catalonia in 1180, in Aragon in 1350, in Castile in 1383 and in Portugal in 1422. The Era of the Passion, commencing 33 years after that of the Incarnation, enjoyed a short vogue, mainly in 11th-century France. (J. A. R.)

IX. PRE-COLUMBIAN AMERICAN

A. Maya and Mexican

1. Lowland Maya.—The calendar of the lowland Maya is partly based upon a year of 365 days, but in counting from one date to another the Maya never used that year. No glyph for it exists and no name for it is found in Maya writings of the colonial period; in the Maya view 365 days were one tun (360-day period) and five days. The five days formed an interlude when life was in a state of suspension; they were nameless and extremely unfortunate. There were no intercalations of leap days. (*See* CALENDAR: *Middle American Calendars.*)

Units for counting time were the tun of 360 days and its multiples in a vigesimal system: the katun (20 tuns); the baktun (20 katuns); the pictun (20 baktuns); the calabtun (20 pictuns); and the kinchiltun (20 calabtuns). In practice few reckonings were carried beyond the baktun, but there were rare occasions when a term beyond the kinchiltun may have been used. The tun itself was divided into 18 uinals ("months") each of 20 kins or days. Maya numerals are transcribed with periods between each unit, starting with the largest. Thus, 9.10.6.5.9 means 9 baktuns, 10 katuns, 6 tuns, 5 uinals, 9 kins. By this vigesimal system the Maya recorded the time elapsed from a particular date, 4 Ahau 8 Cumku (often written incorrectly, Cumhu), which came at the end of 13 baktuns and which was, at the same time, the starting point of their era. By it they fixed dates in the "Long Count," as this system of recording is called. The position of a date in the Maya era is shown by what is termed an Initial Series because, on the carved monuments of the Classic period, it usually begins the inscriptions. For example, the Calendar Round date 8 Muluc (one of the 260-day positions), falling on 2 Zip (second day of the third month in the 365-day year), will recur every 52 years, but expressed as an Initial Series (9.10.6.5.9 8 Muluc 2 Zip) its position is pinpointed in what amounts almost to eternity. Its next recurrence will be 9.12.19.0.9 8 Muluc 2 Zip.

The Initial Series commences with an introductory glyph containing the name-glyph of the deity who rules over the 20-day month (Zip in the above example) reached by the series. Then follow the glyphs for the periods in descending order of length, starting with the baktun, each with its appropriate numeral attached, and after these the terminal date. More often than not the day (8 Muluc in this example) is separated from the month position (2 Zip) by the name-glyph of the god who rules over the night and by the lunar series which records the age of the moon and its number in a group of five or six lunations on the date in question. In such cases the month follows immediately after the last glyph of the lunar series.

A shorter method of recording dates in the Long Count was by means of "Period Endings," that is, by the end of baktuns, katuns, half katuns, 13 tuns or 5 or 15 tuns. For example, a date 13 Ahau 13 Muan, 13 tuns, inscribed on a stone at Palenque, can only occur at 9.17.13.0.0, for as it will not repeat for 949 tuns, it would be outside the range of Maya inscriptions placed 949 tuns earlier or later. A Period Ending such as 1 Ahau 8 Kayab, completion 10 katuns, is even more securely fixed. It has the Long Count position 9.10.0.0.0 1 Ahau 8 Kayab, and will not repeat in that position for 18,980 tuns; *i.e.*, more than 18,000 years.

A much abbreviated form of Period Ending was sometimes used in Classic times: it is nearly universal in the post-Columbian records written in Maya with European characters. In this system only the day Ahau on which the katun ends is given. As there are 13 days Ahau it follows that a date recorded as Katun 4 Ahau will repeat every 13 katuns (257 Gregorian years). As the day Ahau repeats every 20 days and all Maya units (tun and multiples of a tun) are divisible by 20, a Maya period can only end on that day.

Calendar Round dates were sometimes placed in the Long Count by adding the glyph of the god who ruled the night. There were nine of these gods who, ruling in succession, formed a re-entering cycle of nine nights. As the 18,980 days which form a Calendar Round are not divisible by 9, but leave a remainder of 8, each successive Calendar Round is accompanied by a different god of the night in retrogressive order. A date with the glyph of the appropriate god is therefore securely placed in a period of 468 years.

Many dates on the monuments of the Classic period are connected with one another by distance numbers or "secondary series," which comprise so many kins, uinals, tuns and so on. These numbers and periods, in contrast to the periods of the Initial Series, are given in ascending order of size, with but a few rare exceptions, and are usually followed by a glyph which indicates, by means of variable affixes to the counting sign, whether the count is forward or backward. For example, the Tablet of the 96 Glyphs, at Palenque, opens with the date 9.11.0.0.0 12 Ahau 8 Ceh. There follow a distance number of 11 kins, 1 uinal, 2 tuns, the count forward glyph and the date 9 Chuen 9 Mac. Tables show that the date reached by the addition, 9.11.2.1.11, corresponds to the Calendar Round date given. Another distance number, this time of 17 kins, 4 uinals, 8 tuns, 2 katuns, with the count forward glyph, is followed by the Calendar Round date 5 Lamat 6 Xul. Added to the last date, the distance number reaches the Long Count position 9.13.10.6.8, to which the date 5 Lamat 6 Xul corresponds. Several dates were often linked together in this way or by direct addition to the starting date, and, with that fixed, their position in the Long Count is unequivocable. The last inscribed date of a series is often that of the monument's dedication. Thus, the Tablet of the 96 Glyphs has as its last and undoubtedly dedicatory date 13 Ahau 13 Muan 13 tuns, with the clearly established Long Count position 9.17.13.0.0, which is 6 katuns and 13 tuns (approximately 130 Gregorian years) later than the opening date of 9.11.0.0.0 12 Ahau 8 Ceh.

Practically all Maya dates, both on the monuments and in the Dresden codex, were counted from the base 13.0.0.0.0 4 Ahau 8 Cumku, which was already approximately 3,000 years in the past when the Long Count came into use. This date surely represents some mythological event, perhaps the last re-creation of the world. According to the most generally accepted correlation with the Gregorian calendar it is the equivalent of Aug. 12, 3113 B.C. Dated monuments of the Classic period cover a span of 617 years. The earliest is Stela 29, Tikal (found in 1959), with the Initial Series 8.12.14.8.15 (A.D. 292); the latest is 10.4.0.0.0 recorded, as a form of Period Ending, at Uxmal, at Chichen-Itzá and on a jade bead. The date 10.5.0.0.0 may be recorded on a stela at the small site of San Lorenzo, Campeche. The latest Initial Series in the Dresden codex extends the use of the series another two centuries, but there were probably few Maya priests who understood the Initial Series when Maya culture was extinguished by the Spaniards.

The Long Count reached an almost illimitable distance into the past and could be extended similarly into the future. One calculation on a stone tablet at Palenque leads nearly 1,250,000 years into the past, but the farthest probings of eternity seem to have been made at Quiriguá, where there are recordings, on different stelae, of 13 kinchiltuns ending on 1 Ahau 3 Zip and 7 Ahau 3 Pop. According to one reconstruction of the greater Maya periods these would have fallen 90,000,000 years and 400,000,000 years in the past respectively. Even if complete proof of these interpretations is elusive, there is no doubt at all that the Maya thought in terms of millions of years a millennium before western Europe abandoned the belief that the world was only about 6,000 years old.

The Maya conceived of time as a journey through eternity in which the deified numbers carried the periods on their backs, the load supported by a tumpline (a band passing round the brow). At the end of each day's journey there was a resting place at which the carriers whose periods were completed exchanged places. Thus, at the end of the day 9.10.6.5.9 8 Muluc 2 Zip, the god of number 9 who carried the burden of the baktun, the god of number 10 who carried the katun, and the gods of numbers 6 and 5 who carried the tun and the uinal respectively rested; the god of number 9 who had carried the kin, the god of 8 who had carried the day and the god of 2 who had carried the month handed over to the gods of numbers 10, 9 and 3 so that the procession restarted as 9.10.6.5.10 9 Oc 3 Zip, the bearers of the periods for the following day. Much imagery and ritual grew out of this concept of the passage of time, which survives in the sculptural art of the Classic period. The fine full-figure glyphs of Stela D, Copán, represent vividly the moment at which the gods are putting down their burdens at the end of the day 9.15.5.0.0 10 Ahau

8 Ch'en, and the god of the night is rising from the ground with the night sky as his burden.

The Maya concept of time also embraced the belief that events were linked with particular katuns. The return, for example, of a katun 8 Ahau would bring a repetition of events which had happened in the previous katun 8 Ahau, 257 Gregorian years before, and of those in the one before that, 514 years past. Thus, by studying the past one could foretell the future. This belief brought into being, or was itself the product of, a fatalistic attitude and an unusual inability to distinguish between past and future. This mingling of events in different katuns with the same name has been a severe handicap to students of Maya history and chronology.

The correlation of the Maya calendar with the Gregorian depends on a number of factors. The 260-day count of the Maya survives to this day among several Maya groups in the highlands of Guatemala, and although these centres are isolated from one another, their counts are in complete agreement. Jan. 1, 1960, was the day 13 Eb in all these villages, although the villagers' name for this day would have varied according to their dialect. Projected backward, the equation Jan. 1, 1960 = 13 Eb is valid for double entries of this kind in the 16th, 17th and 18th centuries, and for the time of the Spanish conquest of Guatemala (1524). It gives the equation 12 Kan = July 15, 1553 (old style). This is in complete agreement with the best evidence on the Aztec calendar and with the present-day calendar of the remote Mixe of Oaxaca; it is one day off the equation which can be deduced from the writings of Bishop Diego de Landa, who was in Yucatán during the first years of the Spanish conquest of this area and left a full account of the Maya calendar. It can be brought into agreement with Landa by assuming that he omitted to allow for the leap day of 1552 in his calculation, something which could easily have happened.

As the Maya calendar has survived four centuries of Spanish attempts to exterminate it without losing a single day, it is reasonable to suppose that there was no break in pre-Spanish times, when it was universal and a part of the national religion. The fact that it synchronizes with the Aztec and Mixe counts is very strong evidence against any such break. However, 12 Kan 1 Pop, like every other Calendar Round date, repeats every 52 years, and so the equation of 12 Kan with July 15, 1553, does not alone serve to correlate the Maya and Gregorian calendars. The Spanish conquest of Yucatán, completed in 1542, fell very shortly after the completion of a katun 13 Ahau. These two occurrences allow a choice of four Long Count positions, each 260 years apart, for the 12 Kan 1 Pop of July 15, 1553. Each would be either correct to the very day or else 260, 520 or even, in two cases, 780 years wrong. Lunar data on monuments of the Classic period eliminate three of these positions: the lunar series which accompanies most Initial Series records the age of the moon upon each such date. Thus the Maya recorded that on the date 9.17.0.0.0 13 Ahau 18 Cumku there was a new moon (it is not completely certain whether they calculated from the disappearance of the old moon, from conjunction or from the appearance of the new crescent, so there is room for a one- or two-day error here). By converting the Maya into the Gregorian date according to the various correlations, it is easily seen that only one of these places a new moon at 9.17.0.0.0. This is the Goodman-Martinez-Thompson correlation, according to which the katun 13 Ahau of the Spanish conquest was 11.16.0.0.0 13 Ahau 8 Xul, and which makes 9.17.0.0.0 the date Jan. 23, A.D. 771.

This correlation similarly meets the test of dates for heliacal risings of the planet Venus obtained from the tables in the Dresden codex; the other correlations fail here. It is also supported by archaeological evidence, particularly that obtained from the study of pottery and of the sequence of cultures in distant Tula and the Valley of Mexico. The technique of carbon-14 dating at first favoured a correlation which made Maya dates 260 years earlier, but with refinement of the technique and with reliance not on isolated specimens but on multiple runs from a single sample the carbon-14 evidence came into line with the rest in support of the 11.16.0.0.0 correlation.

2. Highland Maya.—The calendar of the highland Maya group called the Cakchiquel is the only other known era in ancient Middle America. Their system was purely vigesimal, the units being the kih, sun or day, the uinak of 20 kih, the a of 20 uinak and the may of 20 a. As it was functioning at the time of the Spanish conquest of Guatemala, the starting point was a certain revolt at Iximche in A.D. 1493. Thus the era was only about 30 years old when the Spaniards arrived, although it is reasonable to suppose that there had been previous eras. But there is no direct evidence of this and there are no calendrical texts on stone monuments in the Cakchiquel area. The 400-day a ran concurrently with the 260-day count and this synchronized perfectly with all other 260-day counts in Middle America. The unit was probably the a (the name comes from that of the day of the revolt which started the era); for may, the next highest unit, means "twenty" in highland Maya languages. Thus the 400-day a would correspond in function to the 360-day tun of the lowland Maya.

B. AZTEC

The chronological system of the Aztec and related peoples of central Mexico was based on the Calendar Round of 52 years. The completion of this was called the *xiuhmopilli*, "the binding up the years," represented in sculpture as a neat bundle of rods tied together rather like the Roman fasces. At the conclusion of the 52 years very elaborate ceremonies were held to save the world from the destruction then expected to overwhelm it. At the time of the Spanish conquest the 52-year cycle started with 2 Tochtli, but there is a source indicating that it originally commenced with 1 Acatl, the previous year-bearer. There is weak evidence that the *xiuhmopillis* were numbered to form a greater epoch, and in the Aztec Codex Bourbon the arrangement of the nine gods of the nights gives ground for believing that Calendar Round dates were differentiated by their accompanying gods of the nights. This would have produced a cycle of 468 years such as certainly was used by the lowland Maya. Such a system was not used in the historical codices, so that much confusion resulted: the same event is placed by different scholars at varying numbers of Calendar Rounds before the Spanish conquest.

Maya year-bearers fell on the first day of the year, but there is far less certainty with respect to the Aztec bearers. It has been argued that the Mexican year was named from the last day of the year. Thus the year-bearer 3 Calli which gave its name to the Aztec year in which the Spanish conquered Tenochtitlán, the present Mexico City (Gregorian Aug. 1521), was the last (360th) day of that year, and fell on Jan. 18, 1522 (old style). This view, however, has been strongly opposed. Other scholars hold that several unsynchronized calendars functioned at the same time in central Mexico.

Histories covering several centuries are given in several Mixtec hieroglyphic codices, but a dated event can be assigned to a particular Calendar Round only by its position in the sequence of painted events. In Mixtec codices month positions are never given, merely the day name and the year-bearer of the year in which it fell. Of the chronological systems of the Zapotec and La Venta (Olmec) cultures very little is known. Rarely, La Venta monuments have arrangements of bars and dots resembling the Maya Initial Series of the Dresden codex, but there is no certainty that they functioned in the same way or that they were counted from the same base of 13.0.0.0.0 4 Ahau 8 Cumku, as has been assumed without any evidence. (J. E. S. T.)

See also references under "Chronology" in the Index volume.

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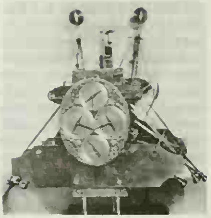
CHRONOMETER. A timekeeping device of great accuracy, particularly one used for determining longitude at sea. The word was originally used to denote any time-measuring instrument. The first instance of its employment in connection with marine timekeeping is to be found in Jeremy Thacker's "The Longitudes Examined . . . " (London, 1714).

History.—The possibility of determining longitude at sea by the use of a timekeeper was first pointed out by the Flemish astronomer Gemma Frisius, in a work on navigation published at Antwerp in 1530. At that date, however, and for long afterward, the mechanical difficulties in the way of constructing an accurate marine timekeeper appeared to be insurmountable. The first attempt to put Frisius' suggestion into practice was made in 1662–70 by the celebrated Dutch scientist Christiaan Huygens of Zulichem, who constructed several marine timekeepers controlled by pendulums and subjected them to actual tests at sea. It was found that the timekeeping of the machines was quite unreliable, owing to the effects of temperature and of the ship's motion. Many later inventors fared no better, but during 1729–60 John Harrison, a self-taught Yorkshire carpenter, invented and constructed four practical marine timekeepers, with the fourth of which (now preserved, in going order, at Greenwich observatory) he won the reward of £20,000 offered in 1714 by the British government for any means of determining a ship's longitude within 30 nautical miles at the end of a six weeks' voyage. It may be noted that a timekeeper fulfilling this condition would have to keep time within three seconds per day—a standard which, at the date when the reward was offered, had not been attained by the best pendulum clocks on shore.


BY COURTESY OF THE TRUSTEES OF THE NATIONAL MARITIME MUSEUM, GREENWICH, AND THE LORDS COMMISSIONERS OF THE ADMIRALTY

FIRST OF FOUR MARINE TIMEKEEPERS DEVELOPED BY JOHN HARRISON

Harrison's mechanism, although unquestionably efficient, was complicated, delicate and costly—the Board of Longitude paid Larcum Kendall, a London watchmaker, £450 for a duplicate of the No. 4 timekeeper. Accordingly, it had little direct effect upon the evolution of the modern chronometer. But in 1765 Pierre Le Roy, of Paris, invented and constructed a marine timekeeper whose mechanism embodied, in an embryonic but perfectly recognizable form, practically all the essential features of the modern chronometer. This machine, or a contemporary duplicate, is preserved in the Conservatoire des Arts et Métiers in Paris. Le Roy's work was followed up by Ferdinand Berthoud in France and by John Arnold and Thomas Earnshaw in England. The last-named produced, as early as 1785, several chronometers which, both in appearance and mechanism, are scarcely distinguishable from the machine of today.

Description.—The modern chronometer is, broadly speaking, a large, well-made watch, suspended in gimbals (a set of two bearings at right angles, connected by a ring) and so poised as to remain horizontal whatever the inclination of the ship. It is thus safeguarded from those alterations of position which slightly affect the timekeeping of even the best watches. In addition, it differs somewhat in its mechanism from an ordinary watch, the spiral balance spring and lever escapement of the latter being replaced by a helical balance spring and a spring detent or "chronometer" escapement. This form of escapement is mechanically superior to any other, and requires no oiling, but it is unsuitable for use in pocket watches, because if stopped it has no tendency to restart itself. For the purpose of equalizing the force of the mainspring, almost all chronometers are fitted with a device known as a "fusee," which has for some time past been discarded in watches, and chronometer compensation balances, by which the effects of heat and cold upon their timekeeping are practically nullified, also differ in some respects from the ordinary watch type, as well as being considerably larger and heavier.

Accuracy.—The modern chronometer is capable, with fair usage, of going with what must be regarded, in view of the unfavourable conditions to which it is necessarily exposed on board, as astonishing accuracy. Both during the official tests at Greenwich observatory (which were held annually, on practically unaltered lines, from 1844 to 1914) and in their subsequent service afloat, many hundreds of chronometers have shown themselves capable of keeping time in all ordinary variations of temperature for six months at a time with an error not exceeding a second a day—an amount which, in a month's voyage along the equator, would involve an error in the ship's final position of less than eight nautical miles.

U.S. Marine Chronometer.—During the years 1942 to 1944 a marine chronometer of very high precision was developed in the United States by the Hamilton Watch company. In general appearance, this chronometer is like any other, but certain changes have been made in the escapement. The hairspring used is nickel steel; the balance wheel is uncut and has a stainless steel rim with an invar arm. There are a number of timing screws, as in a watch, which permit very close adjustment of the rate. This chronometer shows a practically uniform variation with temperature, with daily rates at 5° C. and 35° C. differing by only a few tenths of a second. The rate during run-down remains uniform for 48 hours after winding.

See also CLOCK; NAVIGATION; TIME MEASUREMENT; WATCH.

(R. T. Go.; X.)

CHRYSANDER, KARL FRANZ FRIEDRICH (1826–1901), German musical scholar, a founder of modern musicology. Born July 8, 1826, at Lübtheen, Mecklenburg, he studied at Rostock until 1855. He devoted most of his life to research on Handel, whose complete works he published singlehandedly and at his own expense in 93 volumes (1858–94); the *Deutsche Handelgesellschaft,* founded in 1856 to promote the edition, existed only nominally. His biography of Handel (three volumes, 1858–67), though unfinished, remains a classic, despite errors of judgment and the additional findings of later scholars. He also edited the works of other 17th- and 18th-century composers; and inaugurated the German *Denkmäler* movement, which by publishing library editions of the music of earlier periods has contributed greatly to knowledge and appreciation of it. He died at Bergedorf, near Hamburg, Sept. 3, 1901. (H. Ga.)

CHRYSANTHEMUM, a genus of about 100 species of annual or perennial herbs of the family Compositae (*q.v.*); popularly the name given to forms of certain old world species of this genus which have been remarkably developed by cultivation. Most varieties of the so-called Chinese and Japanese chrysanthemums extensively grown by gardeners and florists are blended hybrids or other forms derived from *C. morifolium* and *C. indicum,* natives of eastern Asia. Other species of interest to flower growers are *C. coccineum* (pyrethrum), *C. parthenium* (feverfew) and *C. frutescens* (marguerite). Other representatives of the genus are *C. balsamita* (costmary) and *C. leucanthemum* (oxeye daisy), the latter often a pestiferous weed.

J. HORACE MCFARLAND CO.

MARGUERITE CHRYSANTHEMUM (C. FRUTESCENS)

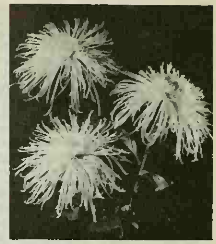
The common chrysanthemum has probably been known for at least 2,500 years. In Japan, where it can be traced back many centuries, it is the national flower. Breynius in 1689 was the first European to mention the chrysanthemum, giving it the name of *Matricaria japonica maxima.* Pierre Louis Blancard introduced the first large-flowering chrysanthemum into England in 1789. This first flowered in 1790. Just when the plant was introduced into the United States is uncertain, although horticultural chrysanthemums were exhibited in Philadelphia in 1827 and in Boston the next year. The work of hybridization was first taken up by H. P. Walcott and later in the 1880s by John Thorpe, who organized the Chrysanthemum Society of America in 1890.

The only species of economic importance are certain forms of *C. coccineum,* much grown for the aromatic flower heads, the source of pyrethrum powder, widely used in insecticides.

Chrysanthemums are popular with the gardeners, both professional and amateur, as an exhibition flower because of their great size and variety of shape and colour, and also because some varieties are extremely hardy, which permits their use in the perennial garden. Chrysanthemums owe their popularity with commercial growers not so much to their value as a crop as to the fact that they may be planted in the late spring and early summer when the greenhouse otherwise would be empty. Moreover, the chrysanthemum is a quick-maturing crop, many varieties being grown without artificial heat, since they bloom from late August to December.

The cultural requirements for chrysanthemums may be adjusted to many rotation schemes, so that the same greenhouse may be used for growing other floral crops, such as calendulas, sweet peas, stocks, snapdragons, annuals and lilies.

Propagation.—The chrysanthemum is generally propagated by cuttage, seedage or division. Cuttage is by far the most satisfactory, since insects and diseases may be controlled by the careful selection of clean stock. Plants grown from cuttings make better growth, give better flowers and are easier to stake and tie in the garden. Nearly all chrysanthemums grown in commercial greenhouses are produced from cuttings. Division is practised by many outdoor gardeners. Seedage is practised only by breeders who seek new varieties.



JOHN J. SIMPKINS FROM NATIONAL AUDUBON SOCIETY

SPIDER CHRYSANTHEMUM, HORTICULTURAL VARIETY

Plants for propagation are packed in flats, benches or cold frames, after the flowering season, and wintered over in either a cold greenhouse or frame. In March or April the strong shoots are ideal for making cuttings two to four inches long. If aphides are present, the cuttings should be placed in a 1-to-500 or 1-to-800 solution of nicotine sulfate in water before planting. Cuttings root best in clean sand, which should be firmly packed and watered. The bed should be lightly shaded for a few days to prevent wilting. Wilted cuttings generally die, but if they root the resulting plants are stunted. Syringing on warm days will help to keep the cuttings fresh. A temperature of 50° F. is sufficient, but quicker rooting is obtained if 60° F. is maintained.

When the roots are about one-half inch long the plants should be potted in a fibrous loam soil. If allowed to remain too long in the cutting bed, they become hard and are not responsive to good culture. The plants are usually ready for their permanent quarters by early June or July. A good fibrous, well-drained loam is the ideal soil medium for chrysanthemums. If this soil is packed before planting or directly afterward, the new growth becomes firmer and the internodes shorter. Newly set plants should be watered only lightly, since wet soil is unfavourable for their growth. The tops of the plants may, however, be syringed often to keep them fresh.

The planting distances vary with the different types. Commercial growers vary the planting of the large flowering chrysanthemums as follows: 6 by 6 in., 7 by 8 in., 7½ by 8 in. and 10 by 10 in. Pompons are planted 12 by 12 in. and 12 by 15 in. inside, while outdoors 15 by 15 in. and 18 by 18 in. is the general practice.

As soon as the plants are placed they should be staked and tied. The tying should be done as the plant grows so that the stem will remain straight. When the stem becomes 6 in. long the plant should be "topped" (top pinched out), if more than one stem is desired. Topping should continue for small-flowered plants until August. Watering, syringing and tying are of chief importance during the summer months.

The plants should be kept as cool as possible by spraying and syringing and by wetting the walks.

In the late summer and early fall "disbudding" becomes a factor. The first bud to appear is generally the crown bud. This bud will flower early and give a large flower, but the shape, colour and habit are not so desirable for commercial use as are flowers from lateral buds. The crown bud is surrounded by vegetative shoots, one of which may be saved to produce the desired flower bud. The terminal bud of the final shoot is surrounded by other buds, which should be removed if only one large flower is desired.

If the soil is a good composted fibrous loam, no fertilizer should be given until the bud is selected. Thereafter, liquid manure should be given once a week until the buds show colour. Continued use of any fertilizer, especially those that are too strong, will cause the flowers to "blast" and "burn." The foregoing cultural directions apply equally as well to the chrysanthemums in the garden. Systematic fumigation and the propagation of clean stock are the greatest factors in the prevention and control of pests. Upward of 3,000 named varieties of the chrysanthemum are listed in catalogues and horticultural works, and new forms are constantly being produced.

Kinds of Chrysanthemums.—Gardeners have several methods of sorting the over 3,000 varieties in cultivation. The simplest and most practical comprises only two types: (1) those grown in the greenhouse and forced for winter bloom, comprising mostly the incurved group in the classification below; and (2) the hardy chrysanthemums for outdoor culture which bloom from August to frost, depending on the variety.

Specialists and breeders have a much more elaborate scheme of classification, mostly depending on the number, shape and arrangement of the ray flowers.

The six main types, and some subdivisions of them, are:

1. *Singles.* With not more than five rows of rays, the head never doubled, hence an open daisylike head.
2. *Anemone-Flowered.* Resembling group 1 but with a prominent central, cushionlike disk. A subdivision of this, the so-called "irregular anemone," has the rays irregularly arranged.
3. *Pompons.* With very small, usually globose heads.
4. *Incurved.* Having very large, close, tight showy heads of hundreds of incurving rays.
5. *Incurving.* Resembling no. 4 but the incurved rays irregularly and loosely arranged.
6. *Reflexed.* With the inner rays incurving but the outer rays drooping or reflexed.

Many subdivisions of these basic classes are preferred by some specialists but most of them are minor. Some of these are known as spoon, quill, thread, spider, etc. There is also a profuse-flowered, cushionlike plant known as azaleamum (not an azalea).

For more extensive details, *see* L. H. Bailey, *The Standard Cyclopedia of Horticulture* (1933); A. J. Macself, *Chrysanthemum Grower's Treasury* (1947); *National Chrysanthemum Centenary Book, 1846–1946;* A. Laurie and D. C. Kiplinger, *Garden and Greenhouse Chrysanthemums* (1946); E. L. and A. H. Scott, *Chrysanthemums for Pleasure* (1950); C. Ackerson, *Complete Book of Chrysanthemums* (1957).
(H. O. Y.; N. Tr.)

CHRYSIPPUS (*c.* 280–206 B.C.), Greek philosopher, third head of the Stoic school, born at Soli in Cilicia (Diogenes Laërtius, vii, 179). He went to Athens and studied possibly under Zeno, certainly under Cleanthes. He is reported also to have studied under Arcesilaus and Lacydes in the Middle Academy, where he perfected his outstanding skill as a dialectician. He was probably the only Stoic with a genuine scientific interest in pure logic, a subject to which he devoted more than 300 works ("If the gods have any logic, then it is that of Chrysippus," Diog. Laërt., vii, 180). In addition to refining earlier logical doctrine, he laid the foundations of propositional logic.

His intense intellectual industry led him to systematize Stoic teaching, which survived to later ages chiefly in the form given to it by Chrysippus. More than 700 treatises are attributed to him, but only fragments survive. The style is said to have been crabbed, the argument lucid. *See* also STOICS.

BIBLIOGRAPHY.—For the fragments *see* J. von Arnim (ed.), *Stoicorum veterum fragmenta*, vol. ii and iii (1903). *See* further J. F. Richter, *De Chrysippo Stoico fastuoso* (1738); F. Baguet, *De Chrysippi vita, doctrina et reliquiis* (1822); C. Petersen, *Philosophiae Chrysippeae fundamenta* (1827); A. B. Krische, *Forschungen auf dem Gebiete der alten Philosophie* (1840); R. Nicolai, *De logicis Chrysippi libris* (1859); R. Hirzel, *Untersuchungen zu Ciceros philosophischen Schriften*, vol. ii (1882); A. Gercke, *Chrysippea* being supplementary vol. xiv of the *Jahrbücher für Philologie* (1885); J. E. Sandys, *History of Classical Scholarship*, vol. i, 3rd ed. (1922); E. Bréhier, *Chrysippe* (1910); M. Pohlenz, *Stoa und Stoiker* (1950); A. Virieux-Reymond, *La Logique et l'épistémologie des Stoïciens* (1950).
(A. R. C. D.)

CHRYSLER, WALTER PERCY (1875–1940), U.S. automotive industrialist who pioneered in developing high-compression engines and other improvements, was born April 2, 1875, in Wamego, Kan. He began work as an apprentice in a Union Pacific machine shop. He was plant manager for American Locomotive company when, in 1912, he left to become works manager of the Buick company, at half his previous salary. By 1916 he was president of the company. In 1920, having made Buick the strongest unit of General Motors, he resigned. His retirement lasted six months. He then assumed direction of Willys-Overland company and of Maxwell-Chambers Motor company, which became the Chrysler corporation in 1925. When Chrysler and Dodge merged in 1928, the Chrysler corporation became a major company in the U.S. automotive industry.

Chrysler died Aug. 18, 1940, at Great Neck, N.Y. His autobiographical *Life of an American Workman* was published in 1937 (new edition, 1950).
(J. R. Lt.)

CHRYSOBERYL, a yellow or green gem stone, remarkable for its hardness, being exceeded in this respect only by corundum and diamond. Highly prized as a gem, chrysoberyl is not infrequently cloudy, opalescent and chatoyant, displaying a luminous band like that seen in a cat's eye in the dark, and is then known as "cymophane," from the Greek for cloud The cloudiness is referable to the presence of multitudes of microscopic cavities. Some of the cymophane when cut with a convex surface forms the most valuable kinds of cat's-eye (*q.v.*). Alexandrite (*q.v.*) is a remarkable and highly prized dichroic variety of chrysoberyl, changing colour from green to red when viewed from different directions.

Most chrysoberyl comes from Brazil, chiefly from the state of Minas Gerais; fine twinned crystals occur at Collintina in Esperito Santo. The cymophane is mostly from the gem gravels of Ceylon. Chrysoberyl occurs chiefly in granite pegmatites and mica schist, and as stream pebbles and grains. In the United States it is found at various localities in New England, notably Greenwood and Stoneham, Me., and Haddam, Conn. It is known also in the province of Quebec, from near Gwelo in the Federation of Rhodesia and Nyasaland, and in the Ural Mountains. Chrysoberyl is an oxide of beryllium and aluminum ($BeAl_2O_4$), and it is orthorhombic in crystallization. The crystals often are twinned to form pseudohexagonal aggregates. Chrysoberyl is often mistaken by its colour for chrysolite (*q.v.*), and has been termed oriental chrysolite, but it is a harder and denser mineral. A contrast of their chief character follows:

	Chrysoberyl	Chrysolite
Hardness	8.5	6.5 to 7
Specific gravity	3.65 to 3.75	3.34 to 3.37
Chemical composition	$BeAl_2O_4$	Mg_2SiO_4

Chrysoberyl has been synthesized commercially by the flame-fusion process, but the material is inferior in quality to the finest natural gems. *See* GEM.
(CL. F.)

CHRYSOCOLLA, a hydrous copper silicate occurring as a decomposition product of copper ores. It is found in most copper mines, especially in arid regions. It is never found as crystals, but always as encrusting and botryoidal or rounded, grapelike masses. It is green or bluish-green in colour, and often has the appearance of opal or enamel, being translucent and having a conchoidal fracture with vitreous lustre; sometimes it is earthy in texture. Some specimens are used as ornamental stones in place of turquoise. Not being a definite crystallized substance, it varies widely in chemical composition, the copper oxide (CuO), for example, varying in different analyses from 17% to 67%. The hardness (2 to 4) and specific gravity (2.0 to 2.8) are also variable. The mineral occurs in the upper parts of veins of copper ores, and has resulted from their alteration by the action of waters containing silica in solution. Pseudomorphs of chrysocolla after various copper minerals (*e.g.*, cuprite) are not uncommon. The name chrysocolla, from the Greek for gold and glue, was applied by Theophrastus and other ancient writers to materials used in soldering gold, one of which, from Cyprus, may have been identical with the mineral now known by this name. Borax, which is used for this purpose, has also been called chrysocolla.

CHRYSOLITE, a transparent green gem stone. The name chrysolite, from the Greek, meaning "golden stone," has been applied to various yellowish gems, notably to topaz, to some kinds of beryl and to chrysoberyl. The true chrysolite of the modern mineralogist is a pale green olivine (*q.v.*). For comparison of the chief characteristics of chrysolite and chrysoberyl, which is often mistaken for it, *see* CHRYSOBERYL.

CHRYSOLORAS, MANUEL (*c.* 1350–1415), Greek scholar, was a pioneer in spreading Greek literature in the west. Born in Constantinople *c.* 1350, he was a pupil of the philosopher Gemistus Pletho. The Byzantine emperor Manuel II Palaeologus sent him to Italy to get help against the Ottoman Turks. From 1394 onward he traveled in Europe and accompanied Manuel on his tour of the European countries. After Manuel's return to Constantinople in 1403, he remained for the most part in the west.

He was engaged in promoting Greek studies; he taught Greek at Florence and was well known as a translator of Homer and Plato. He was also active in trying to arrange for a general council to discuss the union of the Greek and Latin churches. He was on his way to the Council of Constance, having been chosen to represent the Greek Church, when he died suddenly on April 15, 1415. He left the *Erotemata* ("Questions"), a Greek grammar based on the question and answer method; some letters; the *Syncrisis*, a comparison of old and new Rome (in which Rome and Constantinople confront each other); and a Latin translation of Plato's *Republic*.

John Chrysoloras, a relative of the above, had also studied and taught at Constantinople and had then gone to Italy, and he shared Manuel's reputation as one of those who spread the influence of Greek letters in the west. His daughter married the Italian humanist, Francesco Filelfo.

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CHRYSOSTOM, SAINT JOHN (*c.* 347–407), Christian orator, scriptural exegete, patriarch of Constantinople and Church Father, one of the four great doctors of the East, was born at Antioch about 347. Schooled in rhetoric and law under the pagan sophist Libanius, he gave early promise of the eloquence which earned his surname (from the Greek for "golden-mouthed"). Baptized in 370, he quit his legal practice to study Scripture as a monk and hermit. Broken health forced his return to Antioch where he was ordained priest in 386 and began his brilliant preaching career. His fame spread throughout Christendom. When Patriarch Nectarius of Constantinople died, many rivals sought the post. Emperor Arcadius settled the dispute by calling John to the capital, where, in 398, he was consecrated bishop by Theophilus, patriarch of Alexandria. Zealous for reform, John stripped his household to give to the poor; he called the clergy to task; he berated the rich for not regarding their wealth as a trust and charity to the poor as their chief obligation. A host of enemies thus arose, led among the clergy by Theophilus, who had supported a rival candidate for John's bishopric, and at court by the empress Eudoxia, who took John's assaults on luxury as meant for her and believed reports that he had referred to her as Jezebel. In 403, after John had sheltered some Egyptian monks whom Theophilus had excommunicated, Theophilus came to Constantinople, summoned an illegal synod and deposed John *in absentia* on trumped-up charges, including high treason for the alleged slander of Eudoxia. John left for exile, but threats of tumult among the people occasioned his immediate recall. Two months later, the riotous dedication of a statue of Eudoxia in the cathedral square moved John to remonstrate, possibly in a sermon which spoke of "Herodias again asking for John's head on a platter." This sermon may have been spurious, but Eudoxia's rage was genuine. The edict of exile was reissued, and in 404 John left Constantinople for the last time. He appealed to Pope Innocent I, who, with the western emperor Honorius, ordered a new synod. Their envoys were imprisoned at Constantinople, the synod never convened, and Innocent broke off communion with the guilty parties until John's name, only posthumously, was restored to honour. From exile John corresponded with his church and friends who often visited him at Cucusus in Armenia. Even this solace was gone after he was ordered to more remote Pityus. He got as far as Comana in Pontus, where he died in 407, exclaiming, "Glory to God for all things!"

John's oratorical style was elaborate, sinewy and incisive. He often had to chide the people for applauding in church. As an exegete, he was the outstanding representative of the Antiochene school and gave the Scriptures their literal and grammatical sense. He seldom used allegory but spoke plainly and combined penetrating insight into the meaning of Scripture with a genius for its personal application; each sermon had its moral or social lesson. Both the Greek and Latin Churches revere him as a Father and a proponent of orthodox dogma. The Greek Orthodox Church celebrates his feast on Nov. 13, the Latin Church on Jan. 27.

St. John Chrysostom's works include many treatises (*e.g.*, *On the Priesthood*), sermons (*e.g.*, *On the Statues*, *For Eutropius*), significant commentaries on Scripture (*e.g.*, on *Genesis*, *Psalms*, *Matthew*, *John*, *Acts* and *Romans*) and over 200 letters. The standard text is in J. P. Migne, *Patrologia graeca*, vol. xlvii–lxi. Some important works have been translated in *Nicene and Post-Nicene Fathers* (1889–90).

See also references under "Chrysostom, Saint John" in the Index volume.

See C. Baur, *S. Jean Chrysostome et ses oeuvres* (1907), for a critique of the enormous literature on Chrysostom. D. Attwater, in his excellent biography *St. John Chrysostom* (1939), notes most of the lamentably few works in English. (P. W. Hs.)

CHRYSOTILE, a variety of serpentine, is the principal mineral used in commerce under the name asbestos (*q.v.*). A hydrous silicate of magnesia, chrysotile is characterized by a fine, more or less silklike fibrous structure. The name is derived from the Greek words for gold and down or hair, literally "hair of gold."

CHUANG, a term applied to one of a group of tribes called T'ai or Thai, once inhabiting most of the lowlands of south China but now chiefly applied to the cultural descendants of these tribes in Kwangsi province of south China.

Characteristic cultural traits of the Chuang include a preference for valley lands adjacent to streams, wet-rice cultivation with the use of buffalo or oxen, and platform houses on piling. Social customs differing from the Chinese customs include premarital sexual freedom and free marriage without middlemen, the bride staying at home with her parents until the birth of the first child, at which time the marriage is considered consummated. Magical rites, sorcery with human figurines, the ancestral cult and burial in coffins (but also at times the practice of cremating the dead) are other distinguishing elements.

The Chuang or T'ai culture appears to have had its maximum geographical spread during the early period of its contact with Han Chinese culture about 2,500 years ago, evolving in the regions of Szechwan and the lower Yangtze valley. The advance of the Han Chinese culture and empire pushed the T'ai culture and its exponents southward. Today, the cultural heirs of these early people include the Thai of Thailand, the Lao of Laos, the Shan (*q.v.*) of Burma, and the south China tribes of Pa-yi, T'ai-lü and T'ai-noi in Yünnan, of Chung-chia (*q.v.*) in Kweichow and of Chuang in Kwangsi. These different groups still retain strong linguistic and cultural affinities.

Within China, in 1953, the Communist regime organized the tribespeople, where locally dominant, into so-called autonomous minority districts or regions. Thus, there came into being a T'ai autonomous district in Yünnan and a Chuang autonomous region in Kwangsi. In the latter region, people of this ethnic and blood group in the second half of the 20th century were reported to constitute about 34% of the estimated total population of about 20,000,000. (H. J. Ws.)

CHUANG-TZU (d. *c.* 300 B.C.), "Master Chuang," Chinese philosopher, whose fame rests entirely upon the book known as *Chuang-tzu*. Little is known about his life. Although the book clearly includes the work of more than one author, Chuang-tzu is credited with having written its most important sections. It may include the earliest writings of the Taoist school of philosophy and is one of the most important works of Taoism (*q.v.*). It is indeed one of the outstanding books of philosophy in any language and may possibly be the hardest to understand. Its ideas, never obvious, are expressed in such abstruse Chinese that different translators derive quite different meanings from the same passage.

Taoist philosophy arose in a time when life was becoming increasingly regimented. The Taoists declared their independence from everything. The *Chuang-tzu* relates that one day when Chuang-tzu was fishing, two ambassadors from the great state of Ch'u came to invite him to become its prime minister. He declined without even turning his head, refusing to interrupt his fishing. The story is historically dubious but typically Taoist. There are various types of Taoism, but that most characteristic of the *Chuang-tzu* regards all government as bad and holds that all things will go well if left to themselves. In any case the wise person will avoid both government and society. Many of the characters in the *Chuang-tzu* are recluses, fishermen or farmers, living close to nature.

The "Tao," the central conception of Taoist philosophy, is Nature, the totality of everything that exists. Thus it is the great substance, in which all other substances are included. But the fundamental meaning of the word *tao* is "way," and "the Tao" for the Taoists means both the substance of the cosmos and the manner in which it acts. This is not unlike the tendency of modern physics to explain matter in terms of energy. It has been observed that the ancient Taoist conception of the universe is in many ways similar to the thinking of contemporary biologists and physicists. The Taoist like the physicist holds that, while all things are constantly changing, for each action there is a simultaneous reaction, so that the cosmic balance is forever the same. While there seem to be differences in things, therefore, these do not exist from the cosmic point of view, which the Taoists hold to be all that matters.

The second chapter of the *Chuang-tzu* says:

> There is nothing that is not (from the point of view of something else) a "that," and nothing that is not (from its own point of view) a "this." But nothing can see itself as a "that," but only as a "this." These conceptions produce each other. . . . The idea of "right" depends on that of "wrong," and vice versa. Therefore the sage does not look at things in this way, but from the point of view of the whole. He sees the ultimate identity of the "this" and the "that," and recognizes that for each individual there is a different conception of "right" and "wrong," depending upon the point of view. . . . To cause the "this" and the "that" not to be opposed to each other is the pivot of the Tao. It is only at the pivot of the circle of existence that we find the unchanging centre which corresponds to the endless transformations of the periphery.

Reality, thus, cannot be divided, and since all parts of the whole are inseparably related individual objects do not really exist. Furthermore, everything is ceaselessly changing. Thus words cannot truly stand for reality, since they designate parts of the whole, and since they cannot change; words like "mile," "pound" and "true" are useless if their meaning is not constant, but there are no constant realities to correspond to them. Consequently thinking, which necessarily operates with such abstract terms, does not reveal facts about the real world. Thus we cannot *know* reality, but since we are part of it we may *by not thinking* apprehend it intuitively. This Taoist position has been called mystical, but it differs fundamentally from most mysticism in that the Taoist state of communion with ultimate reality is not usually either a transient or an ecstatic experience. Neither do the Taoists consider man's mind to be akin to the essential stuff of the cosmos.

Since Taoism deplores activity it might seem to point to death as the ideal state, but only a few passages in the *Chuang-tzu* carry matters this far and suicide is never advocated. In general the *Chuang-tzu* is far from pessimistic, but is full of an almost naïve delight in the wonderful working of nature. This book has profoundly influenced the Chinese character; some of its aphorisms circulate as proverbs even among the uneducated. It has made for skepticism, tolerance and a slightly humorous detachment. Some of the Buddhist monks who founded Zen Buddhism were close students of the *Chuang-tzu,* and it seems clearly to have influenced Zen (*q.v.*).

The best translation of the first seven chapters of the *Chuang-tzu*, which are considered its earliest part, is Fung Yu-lan, *Chuang Tzu* (1933). The best complete translation is James Legge, "The Writings of Kwang-zze," in *Sacred Books of the East*, vol. xxxix–xl (1891; reprinted 1959). The most accurate translation of most but unfortunately not all of the work is in German, that of Richard Wilhelm, *Dschuang Dsi* (1912). (H. G. C.)

CHUB, a name applied to several minnows (Cyprinidae) common in Europe and North America. Most chubs have broad heads and strong jaws. They eat numbers of small fishes including their own young. During spring many of them dig pits in the bottom of streams, and bring in small rocks and pebbles on which the eggs are laid.

Chubs attain rather large size. The European chub (*Leuciscus cephalus*) may weigh 12 lb.; the North American species seldom exceed 18 in. and 2 lb. The creek chub (*Semotilus atromaculatus*) and various members of the genus *Hybopsis* inhabit eastern North America. Members of the genera *Gila* and *Siphateles* are the chubs of western North America. All chubs are good bait fish, and the largest individuals can be used for sport or food. (C. Hu.)

CHUBB, THOMAS (1679–1747), English deist, regarded by Voltaire as one of the most logical of his school (*see* Deism), was born at East Harnham, near Salisbury, on Sept. 29, 1679. The son of a maltster, he was apprenticed to a glovemaker and subsequently worked for a tallow chandler. He appeared as an author during the Arian controversy with an essay, *The Supremacy of the Father Asserted*, published with help from William Whiston (*q.v.*) in 1715. He then went to London to live for a time, apparently as a servant, in the house of the master of the rolls, Sir Joseph Jekyll, but eventually returned to Salisbury, where he died on Feb. 8, 1747. Chubb's works include *Discourse Concerning Reason* (1731), *The True Gospel of Jesus Christ Vindicated* (1739) and *Discourse on Miracles* (1741). They betray the deficiencies of the autodidact, and he was often treated disparagingly by more erudite theological controversialists. His tracts tended to limit the Christian religion to three fundamental tenets: belief in the divinely ordained moral law; belief in the need of sincere repentance for sin; and belief in future rewards and punishments. The *Discourse on Miracles* took the position that they provided merely a "probable proof" of revelation. His *Posthumous Works,* two volumes, appeared in 1748. (F. E. M.)

CHUBUT, a southern province of Argentina and part of the area generally known as Patagonia (*q.v.*), is bounded on the east by the Atlantic and on the west by Chile. Pop. (1960) 142,195; area 86,751 sq.mi. Except for the Andean foothills, which are forested and fertile, and the land along the banks of the Chubut river, the country consists of arid plateaus cut by deep canyons. The scrub vegetation is scanty. There are some shallow saline lakes, and there are large lakes among the Andes.

The fertility of the Chubut valley is threatened by salts which have come to the surface after many years of irrigation. Rainfall is slight and strong winds blow constantly, raising clouds of dust. A party of Welsh nationalists arrived in 1865 and founded the well-known Welsh colony, which was incorporated in the Argentine republic in 1884. Chubut was accorded the rank of a province in 1955.

The provincial capital is Rawson (pop. [1956 est.] 2,507), the busiest commercial centre is Trelew (7,795) and the best port is Puerto Madryn on Golfo Nuevo. Rawson and Trelew are connected with Madryn by rail. The Welsh established sheep ranches in the sheltered upper valleys, and wool is the province's chief product. (Ge. P.)

CHUCK-A-LUCK: *see* Dice.

CHU HSI (Chu-tzu) (1130–1200), the most influential Chinese thinker after the 3rd century B.C., public official and scholar, came of a family that for two generations had held moderately important government posts. His father, Chu Sung, dismissed from the ministry of personnel after patriotically opposing a projected peace with the Tungusic occupiers of north China, retired to a mountain valley inland from the port of Foochow. There Chu Hsi spent his youth. Left fatherless at 13, the younger Chu continued his education with neighbouring scholars whom his father had recommended. At the early age of 17 he passed the difficult final civil service examination and became recorder in a subprefecture, where he proceeded to reform management of taxation and police, improve the library and the standards of the local school, and draw up a code of proper formal conduct and ritual, none being available. Transferred to the custodianship of a sacred mountain temple, he met Li T'ung, who influenced his future thinking decisively. Li was one of the ablest followers of the 11th-century Neo-Confucians who had created a new metaphysical system to compete with Buddhist and Taoist philosophy and regain the Confucian intellectual ascendancy lost for nearly a millennium. Chu's boyhood teachers had been Confucian scholars, but like many in their time they had also studied and practised Buddhism and Taoism. Chu had followed their example. But while he now retained respect and sympathy for the other beliefs, his allegiance turned definitely to Confucianism.

His life thereafter was increasingly dedicated to Confucian studies. He continued his civil service career and administered several important prefectures. He promoted local welfare diligently and successfully, but in leisure hours and in occasional periods of retirement he found time for intensive study of the classics, observation of nature, teaching and writing. While administrator of Nan-k'ang, near Lake P'o-yang, he revived the once-famous private academy of the White Deer Grotto, which had been founded in the 9th century and in the 10th century enjoyed an endowment of land and regularly more than a thousand students, but had later fallen to ruin. The prestige restored to it by Chu was to last through eight centuries. On several occasions during his career Chu was invited to the imperial court, and seemed destined for more influential positions, but his invariably frank and forceful opinions and his uncompromising attacks on corruption and political expediency each time brought his dismissal or a new post conveniently distant from the capital. On the last occasion, near the end of his life, his enemies retaliated with virulent accusations concerning his views and conduct, and he was barred from political activity. He was exonerated and invited once more to the capital in the year before his death, but remained in the vicinity of his early home, to which he had returned, and devoted his last days to writing and teaching.

A generation after his death, tablets in Chu Hsi's honour were officially placed in Confucian temples. In later centuries, rulers more authoritarian than those he had criticized, discreetly forgetting his political and intellectual nonconformity, made his philosophic system the sole orthodox creed, which it remained until the end of the 19th century.

Chu Hsi's philosophy emphasized logic, consistency and conscientious observance of classical authority, especially that of Confucius and his follower Mencius. Chu answered questions on the nature of man and the cosmos raised by the Buddhists and Taoists but not explicitly treated by early Confucians. His ideas sometimes reflected non-Confucian theories and concepts, but he scrupulously based his explanations on Confucian texts. His commentaries on the latter sought to establish the essential consistency of statements in early Confucian canonical writings. He held that the universe has two aspects: the formless and the formed. The formless is supreme natural law, which determines the patterns of all created things. This law combines with a gaseous matter to produce things having form. In human beings the law (manifested as human nature) is essentially perfect, and defects—including vices—are introduced into the body and mind through impurities of matter. Man may eliminate his mental imperfections through study, "investigation of things." This last term has been variously understood, but it is possible that Chu intended a kind of study that could have opened the path to scientific investigation; he himself looked for natural explanations of such phenomena as the appearance of sea fossils on mountain tops. Chu differed with the eminent contemporary Neo-Confucian Lu Chiu-yüan (Lu Hsiang-shan), who saw no duality between natural law and matter and believed in human perfectability through meditation. In his political thought, Chu criticized vigorously the imperial system based on force and motivated by desire and selfishness; like others of his school he accepted as an ideal the more benevolent methods of ancient kings who governed through virtuous example.

Chu Hsi left voluminous writings, including the thereafter authoritative textual commentaries on the classics; his major philosophic treatise, *Modern Thought;* critical essays on the classics and on later Confucian thinkers; and a great digest of Chinese history to illustrate the operation of moral laws. Soon after his death his disciples published several compendia of his lectures and conversations (among the earliest preserved examples of vernacular Chinese) and an extensive collection of his poems, letters, government papers and other documents. Most of these writings are preserved in modern editions. *See* also CONFUCIANISM.

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CHUKCHI, a group of people, about 12,000 in number, inhabiting the northeasternmost part of Siberia, the Chukchi peninsula, on the Asian shore of Bering strait in the Kamchatka *oblast*, U.S.S.R. They are divided into two chief subgroups, Reindeer and Maritime Chukchi. The Reindeer Chukchi inhabit the interior of the peninsula; Maritime Chukchi inhabit the arctic and Bering coasts. They form part of a larger linguistic group called the Paleo-Asiatic or Paleo-Siberian language family, which includes neighbouring peoples, Koryak and Kamchadal (Itelmen) and probably Eskimo; the inclusion of Eskimo is under discussion (*see* PALEO-ASIATIC LANGUAGES).

The climate is rigorous and much of the cultural arrangements are concerned with problems of cold and snow. The livelihoods of the two subdivisions are indicated by their names: the Reindeer Chukchi live, in addition to hunting and fishing, from domesticated herds of reindeer which they pasture in the tundra. These herds supply them with means of transport, milk and meat for food, and pelts for clothing and shelter. The Maritime Chukchi live by hunting arctic sea mammals, seals and whales, and by fishing.

Their dwellings vary according to their subsistence pattern. Maritime Chukchi live in fixed villages; their houses are semi-subterranean, with an earth cover of great antiquity in the north. Reindeer Chukchi are nomadic and live in tents, changing residence according to seasonal change in pasture of their herds. Transportation is on sledges pulled by reindeer or dogs harnessed in pairs. The Maritime Chukchi travel in boats with wooden frames and skin covers.

The social organization is simple, there being no fixed classes or ranks. However, they are divided into clans. An important social institution is the *varat*, a group of families closely connected and interdependent for mutual support. The commonest form of marriage arrangement is bride service, in which the son-in-law works for a specified period for his bride's family. In past centuries they also had slaves.

Their religion is a form of shamanism (*q.v.*), wherein a man acquires, after painful experiences, a spirit-familiar with which he communicates in a state of trance. Shamanist ceremonies are conducted for divination and healing. Chukchi have other spirits with which they populate this world and the afterlife.

Much of the knowledge about these people has been gained by the work of political exiles of the tsarist period who lived among them, the most valuable being that of V. G. Bogoraz. At present they are undergoing changes of sovietization, being settled on collective farms.

See also KAMCHATKA: *The North.*

See V. G. Bogoraz, *The Chukchee,* Jesup North Pacific Expedition, vol. vii, and American Museum of Natural History *Memoirs*, vol. xi, 3 parts (1904–09); Taeki Odulok, *Snow People,* Human Relations Area Files (1954). (L. K.)

CHUKCHI SEA (CHUKOTS SEA; Russian CHUKOTSKOYE MORE), a coastal sea of the Arctic ocean, directly north of the Bering strait, through which it connects with the Bering sea, lying between Wrangel Island in the west, the Alaskan coast in the east and the continental slope in the north. Ice covers the whole sea in winter but retreats northward between July and October, permitting coastal navigation both eastward and westward. Some warm water enters the sea through the Bering strait (which is too shallow to permit much, however), while ice-bearing currents flow southeastward along the Siberian coast. Seals of several species and walrus are indigenous, while whales and many sea birds are summer visitors. (T. E. A.)

CHUKOT (CHUKCHI) **NATIONAL OKRUG** (Russian CHUKOTSKI NATSIONALNY OKRUG), an administrative district (created 1930 within the former Far Eastern territory) covering extreme northeastern Siberia. It has been part of Magadan *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., since 1953. Area 284,826 sq.mi. The population (46,689 in 1959) is now chiefly Russian but includes about 11,000 Chukchi (*q.v.*), 1,100 Asiatic Eskimo on the shores of Bering strait, and some Eveny (Lamut), Koryak, Yakut and Yukaghir elements. In the north there is a true arctic climate, with the warmest monthly mean not exceeding 40° F., but the Bering sea coast is warmer. Elevations reach 5,900 ft., but much of the region is low-lying tundra. Trees are found only in the south. The average growing period for vegetation nowhere exceeds 98 days a year. Fauna includes bear, fox, wolf, wolverine, squirrel and lemming and other small rodents. Birds and insects abound, and salmonoid fish are found in the rivers. Seal and walrus breed on the coast.

The main industries are reindeer-raising, hunting, fishing and mining. The first three have been practised for many years, but with Soviet rule collectivization was introduced and mining developed. Hunting is for fur-bearers, which are also bred on collective farms, and for sea mammals. The tin mines in the Chaun region and at Iultin have national significance. Coal is obtained at Ugolny on the Bering sea coast and near Anadyr (*q.v.*), the administrative centre. The ports of Pevek, on Chaun bay, and Provideniya on the Bering sea are important stopping places on the Northern Sea route, a maritime link developed in the 1930s and responsible for the economic growth of the northern part of the region. (T. E. A.)

CHULALONGKORN (Rama V; full name Somdeth Phra Paramindа Maha Chulalongkorn) (1853–1910), king of Thailand, eldest son of King Mongkut, was born on Sept. 20, 1853, and succeeded his father on the throne on Oct. 1, 1868. The young king, who had according to custom been brought up in a Buddhist monastery, retired into seclusion until he came of age in 1873, the government being entrusted to a regency. He then took the step, unprecedented for an eastern Asian potentate, of traveling outside his dominions, in India and the Netherlands Indies. The fruits of his appreciation of foreign institutions appeared in the reforms he instituted in Thailand: abolition of slavery, simplification of court etiquette, grant of liberty of conscience, erection of schools and hospitals and development of the army and navy. He established a standard coinage, postal and telegraph services, and the policing, sanitation and lighting of Bangkok. Several of his sons, including the crown prince, were educated in England, and he himself visited Europe in 1897. He died at Bangkok on Oct. 23, 1910.

CHULA VISTA, a town of San Diego county, Calif., U.S., on the east side of San Diego bay south of National City, is a part of the San Diego metropolitan area. Chula Vista's city limits almost touch the Mexican border. The name of the city is derived from both Spanish and Indian, *vista* being Spanish for "view" and *chula* meaning "pretty" in a Mexican dialect.

The town was founded during the Southern California land boom of 1888 by the San Diego Land and Town company as a suburban area of fruit farms of from 2½ to 10 ac. It was incorporated in 1911. Subsequently truck gardening increased in importance. Population growth was slow until after World War II, when development of the aircraft industry in the San Diego area contributed to the growth of Chula Vista as a residential community. There are plants manufacturing subassemblies in the town itself. For comparative population figures *see* table in California: *Population.* (A. P. N.)

CHUMBI VALLEY lies on the southern slope of the Himalayas between Bhutan and Sikkim. Before the border dispute between India and China in the early 1960s reduced trade to nearly nothing, the most-used trade route between India and Tibet passed through the valley, which belongs to Tibet. Its average elevation is 9,500 ft., and the climate is delightful all year. A large amount of Tibetan wool, yak tails and borax formerly were exported annually from the region to India in exchange for petroleum, textiles, hats, dried nuts and cooking utensils. A motor road, opened to traffic in Nov. 1955, joins Lhasa with Phari and Yatung, two principal towns in the Chumbi valley, and Yatung is connected by highway with Gangtok, capital of Sikkim. The Chumbi valley was occupied by the British in 1904–08 during the Younghusband expedition. Under the Tibet trade regulations of 1908 China granted Great Britain the right to maintain a trade agency and armed guards at Yatung. This treaty was superseded by the Indochina agreement on trade with Tibet of 1954, in which India was permitted to retain its trade agency but promised to withdraw its military escorts. The trade agreement lapsed after 1961. (T.-L. S.)

CHUMNUS, NICEPHORUS (*c.* 1250–1327), Byzantine scholar and statesman, left a number of writings, some still unpublished, including letters and orations on occasional philosophical and religious topics, some of which are also of historical value. He belonged to a family distinguished for its service in church and state, owning extensive property around Thessalonica. Chumnus came at an early age to Constantinople where he was educated by George (Gregory) of Cyprus. He held imperial office and about 1272–75 went on a mission to Persia. He rose to be prefect of the secretariat, and became chief minister of Andronicus II. In 1303 his daughter Irene married Andronicus' son, the despot John. Toward the end of 1309 he became governor of Thessalonica and his influence seems to have been overshadowed by Theodore Metochites (*q.v.*). He took the monastic habit and name of Nathaniel shortly before his death in Constantinople on Jan. 16, 1327.

He was deeply attached to the classical tradition, in so far as it did not conflict with Christian teaching. In the lively intellectual controversies of his day he sided with the "ancients" against the "moderns"; this led to a rift with Theodore Metochites whose ardent pursuit of mathematics and astronomy he bitterly attacked. Though moved by keen intellectual curiosity he was a man of letters rather than of learning, and thus typical of the more conservative element in cultured court circles of late 13th-century Byzantium.

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CHUMPHON, the name of a province (*changwat*) and its capital in peninsular Thailand on the east coast of the Isthmus of Kra. The town, with a population of 10,355 in 1957 (est.), is located on the Southern railway 185 mi. S.S.W. of Bangkok. Rice, fruit, charcoal and tin are shipped from its roadstead harbour. It is one of the important fishing ports on the Gulf of Siam. The *changwat* has an area of 2,219 sq.mi., and in 1960 it had a population of 165,158. Much of the province is too hilly for cultivation. (T. F. B.)

CHUNCHO (Anti), a term used to distinguish several South American Indian tribes on the eastern slope of the Andes, *e.g.*, the Arawak (*q.v.*), Campa and others, from the Quechua and the Aymara (*q.v.*) of the highlands. (J. H. Sd.)

CHUNG-CHIA (P'u-yi), an ethnic group, related to the Siamese, inhabiting large parts of Kweichow province in southwestern China. They have been in southern China since early times and were found in Kiangsi during the 6th and 7th centuries B.C. Their language is similar to Thai, but they had no written script of their own until recently when the Chinese Communists supplied them with a script based upon the Latin alphabet. Animistic beliefs and superstitious practices are prevalent. An account in Chinese records of A.D. 1730 relates that the Chung-chia were a group of former Chinese banished to Kweichow in pre-Christian times. However, they were most likely a Thai group forced from more favoured agricultural lowlands into the poorer valley lands of the Kweichow plateau and hills. As with other Thai-related ethnic groups, they are fond of wet valley-bottom locations where they may practise wet-rice cultivation.

The Chung-chia or P'u-yi in 1951 were reported to number about 1,600,000 in Kweichow, mostly distributed in the south of the province and centred in and about the *hsien* or districts of Ts'eheng and Wang-mo in the valley of the Nan-P'an Chiang (river). It is possible that this figure included the related T'ung tribes. The Chinese Communist estimates of 1953 listed about 1,248,000 P'u-yi and about 690,000 T'ung persons. The latter inhabit the districts east of the P'u-yi where Hunan, Kwangsi and Kweichow provinces join.

Many of the P'u-yi have become so sinicized that they are no longer counted as tribesmen. In the higher hills around these valley tribes in Kweichow are numerous Miao (*q.v.*), hill tribesmen who traditionally have practised a slash-burn shifting cultivation. The Communist regime has organized their districts into a number of so-called "autonomous minority nationality districts." Thus, in southern Kweichow is the Ch'ien-nan (South Kweichow) P'u-yi and Miao autonomous *chou* (district). T'ung and Miao tribes in eastern Kweichow are similarly organized. (H. J. Ws.)

CHUNGKING (Ch'ung-ch'ing), Yangtze river port and primary commercial emporium of the important and densely populated inland basin of Szechwan province in western China, 1,400 mi. from the sea. Pop. (1953 census) 1,772,500. The core of the city occupies a rocky peninsula between the Yangtze river and the confluence of the Kialing, the most easterly of the great rivers draining the Red basin. Chungking therefore is the natural gateway through which Szechwan communicates with the rest of China by river, and the city serves as the primary regional trade centre for all of west China and much of eastern Tibet.

Chungking claims a long and colourful history as a centre of independent kingdoms and rebellious regional rulers. A local leader was deputized as the regional ruler under the Chou kings about 1100 B.C. In the 4th century B.C. the city became the capital of the kingdom of Pa, which was absorbed under the Ch'in dynasty near the end of the 3rd century B.C. Numerous rebellions against dynastic rulers were centred on Chungking, and the revolution that overthrew the Ch'ing dynasty began there in Sept. 1911. The treaty of Peking opened Chungking as a treaty port in 1890, but river navigational problems prevented steamer traffic for some years. Although amphibious planes had established regular schedules to the city in late 1931 and motor roads were in existence outside the city, the first roads for wheeled traffic inside Chungking proper were built only in 1933.

Chungking was the wartime capital of China from Oct. 1938 to 1945. In 1940 the municipal limits were extended to include territory on all river banks at the confluence of the Kialing with the Yangtze, increasing the area to 116 sq.mi. Extensive damage to the city was caused by Japanese bombings from 1938 to 1941. The city became a U.S. air base during 1944–45.

Commercial trade and handicraft manufacturing predominated prior to 1937. Beginning in 1938 many coastal industries and down-river Chinese moved to Chungking to escape the Japanese, and by 1945 the city had grown markedly, industry augmenting its trade patterns. The Communist Chinese continued the industrialization of the city, which lies down-river from important coal deposits. Small steel plants, chemical and fertilizer manufacturing, cement, cotton and silk textiles, and food processing are the major industrial activities.

A rail line between Chungking and Chengtu, in northwest Szechwan, begun by the Nationalists, was completed by the Communists in 1952, and Chungking became connected to the rest of China by rail in 1956, via the Chengtu-Pao-chi line, tying into the Lung-hai system. Chungking is a centre of highway transport and an air terminal. (J. E. Sr.)

CHUQUICAMATA, copper-mining company town in Antofagasta province, Chile. Pop. (1952) 24,018, (1959 est.) 30,476; elevation 9,000 ft. The ore body is the largest proved copper deposit known. Large-scale open-pit mining of oxide ores began in 1915. Annual capacity of the foreign-owned operation has been expanded to 250,000 tons of metal. Depletion of the oxide ores and the potential of underlying sulfide ores resulted in the addition (1952) of a flotation and smelting unit to the older leaching and electrolytic plant. Copper is shipped, and food and supplies carried to the desert country mine, from Antofagasta (*q.v.*) by way of a spur from the Antofagasta-Bolivia railway. Highway carriers operate on surfaced roads between the coast (Antofagasta and Tocopilla) and the mine. Water requirements are met by a net of aqueducts which reaches almost to the Bolivian frontier. *See* also Chile: *Mining*. (J. T.)

CHUQUISACA, a department in southeastern Bolivia (pop. [1959 est.] 320,189; area 19,893 sq.mi.), was established in 1826. It is bounded north by the departments of Cochabamba and Santa Cruz, south by Tarija, west by Potosí and east by Paraguay and Santa Cruz. From 1563 to 1776 the *audiencia* of Charcas, established in Chuquisaca, covered most of the territory of modern Bolivia and included the administrative districts of Paraguay, Buenos Aires and Tucumán, southern Peru and the coastal region of Atacama. With the founding of the viceroyalty of La Plata in 1776, Charcas became Alto Peru and retained that name until the republic was founded in 1825. Chuquisaca gained a leading position as a centre of culture and learning, and its influence outside Charcas earned it the title of "the Athens of America." (*See* Bolivia: *History*.)

Geographically the department consists of plateaus and lowlands with contrasting arid and humid climatic conditions. The eastern plains are subject to annual inundations followed by extreme aridity. The Pilcomayo river flows northwest to southeast into the Paraguay. Livestock grazing and the cultivation of cereals are the principal occupations on the plateau. Sugar cane, corn, rice, tobacco and tropical fruits are grown in the lowlands. Mineral resources comprise gold, silver, iron, copper and sulfur. The highway and railway linking Sucre and Potosí are the main arteries of communication in the department. Sucre (*q.v.*), the legal capital of Bolivia, is also the departmental capital. (J. L. Tr.)

CHUR (Fr. Coire; Ital. Coira; Romansh Quera), a city of eastern Switzerland, capital of Graubünden (Grisons) canton, is located on the Plessur, 119 km. (74 mi.) S.E. of Zürich by rail. Pop. (1960) 24,825. The town is situated 1,949 ft. above sea level, at the entrance to the deep Schanfigg (Plessur) valley. The cathedral of St. Lucius was built 1178–1282 on the site of an older church and the episcopal seminary nearby stands on the ruins of a 6th-century foundation. The Raetian museum contains a collection of local historical objects. Chur is the terminus of a standard-gauge railway from Sargans. Its main industry is tourism, but it is also an important trading centre, especially for Valtelline wine. The meeting point of routes from Italy over several of the Alpine passes, it was important in Roman times when it was known as Curia Rhaetorum. The episcopal see, first mentioned in 452, probably existed a century earlier. The bishops became princes of the empire in 1170 and played an important role in the history of Graubünden (*q.v.*).

CHURCH, FREDERICK EDWIN (1826–1900), U.S. landscape painter, the most prominent member of the Hudson river school of American artists, was born at Hartford, Conn., on May 4, 1826. He was a pupil of Thomas Cole at Catskill, N.Y., where his first pictures were painted. Developing unusual technical dexterity, Church from the beginning sought for his themes such marvels of nature as Niagara falls, volcanoes in eruption and icebergs. He was greatly influenced by the writings of Alexander Humboldt, and visited South America in 1853 and 1857. He portrayed the beauties of the Andes and tropical forests with great skill. In the management of light, colour and the phenomena of rainbow, mist and sunset his renderings were plausible and effective. In their time these paintings awoke the wildest admiration and sold for extravagant prices—collectors in the United States and in Europe eagerly seeking them. In 1849 Church was made a member of the National Academy of Design. His "Great Fall at Niagara" (1857) is in the Corcoran Art gallery, Washington, D.C. Among his other canvases are "Andes of Ecuador" (1855), "Heart of the Andes" (1859), "Cotopaxi" (1862), "Jerusalem" (1870) and "Morning in the Tropics" (1877). After 1877 illness left him incapable of work. He died on April 7, 1900, at his house on the Hudson river above New York city, where he had lived and worked for many years.

CHURCH, GEORGE EARL (1835–1910), U.S. geographer whose explorations of the Amazon made him the leading authority on that region of South America, was born in New Bedford, Mass., on Dec. 7, 1835. He was educated as a civil engineer, and was early engaged on the Hoosac tunnel. In 1858 he joined an exploring expedition to South America. During the American Civil War he served (1862–65) in the army of the Potomac, rising to the command of a brigade and the rank of colonel; and in 1866–67 he was war correspondent of the *New York Herald* in Mexico. His Amazonian explorations took place subsequently (1868–79). In 1880 he was appointed U.S. commissioner to report on Ecuador, and in 1895 visited Costa Rica to report on its debt and railways. He wrote extensively on South and Central American geography, and became a vice-president of the Royal Geographical society (London), and in 1898 president of the geographical section of the British association. Church died on Jan. 4, 1910.

CHURCH, SIR RICHARD (1784–1873), British soldier and philhellenist, who commanded the Greek forces during the War of Greek Independence, was born at Cork, Ire., the second son of Matthew Church, a Quaker merchant there. Before he was 16, he ran away from school to join the army, becoming an ensign in the 13th (Somersetshire) light infantry and serving under Sir Ralph Abercromby in Egypt in 1801. Having accompanied Sir James Craig's secret expedition to Calabria in 1805 and fought at the battle of Maida (1806), he then served as captain commandant of upper Capri (1806–08) and carried out several missions on the French-occupied mainland. He was Gen. John Oswald's chief of staff on the expedition (1809) to the Ionian Islands where he met Theodoros Kolokotrones and other Greeks in exile from the mainland. Already a philhellenist and sympathetic toward ideas of Greek independence, he obtained permission to form two Greek regiments in English pay, his object being to give the Greeks military training. These regiments were disbanded in Sept. 1814. In vain Church pleaded the Greek cause not only in London but at the congress of Vienna. He entered the service of the Neapolitan government in 1816, became military governor of Apulia in 1817 and was made in 1820 commander in chief of Sicily, whence he was almost immediately expelled by the revolutionaries. When the Greeks rebelled in 1821, he "sighed to be with them," but did not arrive in Greece until March 1827. In April he was appointed commander in chief of the Greek forces.

After his campaigns in western Greece (*see* GREEK INDEPENDENCE, WAR OF), Sir Richard (he had been knighted in 1822) dramatically resigned his command before the national assembly of Argos (Aug. 1829) in protest against the government of Count Kapodistrias, to which he and other British philhellenists encouraged opposition. In 1830, in a pamphlet sent to England for the information of parliament, he pleaded for the recognition of the frontier he had won for Greece. After the convention of 1832, he settled permanently in Greece and became a Greek citizen, member of the council of state and inspector general of the army. He was the confidential adviser to Sir Edmund (later Baron) Lyons, first British minister to Greece, and he played a conspicuous part in the revolution of 1843. He died in Athens on March 30, 1873.

See Stanley Lane-Poole, *Sir Richard Church* (1890); E. M. Church, *Sir Richard Church in Italy and Greece* (1895). (D. DN.)

CHURCH, RICHARD WILLIAM (1815–1890), dean of St. Paul's cathedral, London, one of the most distinguished Anglican preachers and writers of the 19th century, played a mediating role in the ritualist controversies and was one of the few churchmen of his day who took a balanced and positive view of the scientific and intellectual developments of the period. Born on April 25, 1815, at Lisbon, he spent many years in Florence, went to Oxford in 1833, was elected a fellow of Oriel college (1838) and became an intimate friend of J. H. Newman (*q.v.*). He was closely associated with the Tractarians, and in 1844 as junior proctor in the university was influential in preventing the public censure of Newman's Tract 90. Newman's conversion in 1845 did not shake his own allegiance to the Church of England, nor did it break up their personal friendship. From 1852 to 1871 he was rector of Whatley, Somerset, and became well known for the quality of his writing in the Anglican paper the *Guardian* on historical, literary and theological themes. In 1871 his friend Gladstone persuaded him to accept the deanery of St. Paul's. He died in Dover on Dec. 9, 1890.

Of a quiet but singularly generous disposition, Church combined a deep-rooted belief in the Catholic nature of the Church of England, with a remarkable liberality of outlook. His book *The Oxford Movement* (published 1891) is, after Newman's *Apologia,* the finest account of the events of 1833–45 to come from a contemporary hand. He had a great love of Dante and published an influential work, *Dante and Other Essays* (1888).

See B. A. Smith, *Dean Church* (1958). (A. MACD. A.)

CHURCH. The word "church" refers both to the Christian religious community and to the building used for Christian worship. This article, which deals separately with the two subjects, is intended only as a summary. As Christians differ greatly in their beliefs about the nature of the church, further information should be sought in the individual articles on each church. The section on church buildings can be supplemented by the relevant architectural articles.

THE RELIGIOUS COMMUNITY

Emergence of the Church.—The Greek word ecclesia, which came to mean "church," was originally applied in the classical period to an official assembly of citizens. In the Septuagint translation of the Old Testament (3rd–2nd centuries B.C.) the term ecclesia is used for the general assembly of the Jewish people especially when gathered for a religious purpose such as hearing the Law (Deut. ix, 10; xviii, 16; etc.). In the New Testament it is used of the whole body of believing Christians throughout the world (*e.g.*, Matt. xvi, 18), of the believers in a particular area (*e.g.*, Acts v, 11) and also of the congregation meeting in a particular house—the "house-church" (*e.g.*, Rom. xvi, 5).

The conclusion is natural that as there is continuity from the Septuagint to the New Testament in the use of the word, so there should be a continuity in that which it represents. In fact it has been the traditional view among theologians that there is a church of the Old Testament as well as of the New. After the Jews had returned to Palestine from exile in Babylon they had tried, under the teaching of Ezekiel and the later practice of Ezra and Nehemiah, to refashion their nation on the lines of a church. When the people as a whole failed to respond, the faithful were taught to look forward to a messianic kingdom in which the remnant would enjoy the full privileges of the covenant, as both a kingdom and a church.

Jesus Christ proclaimed the coming of that Kingdom. It was indeed expressed in his own person. He had come not to destroy all that had been taught before but to fulfill the promise it contained. Those who attached themselves to him in faith and allegiance were already in the Kingdom. It is sometimes said that Jesus expected the Kingdom to come in a more explicit sense, putting an end to the present temporal age, immediately upon his own sacrificial death, and that therefore he had no need of a church. It is true that the term church is only twice put into his mouth (Matt. xvi, 18; xviii, 17), that these references are merely incidental and that even so they are suspect to some scholars on critical grounds. It can scarcely be denied however that in gathering round him a picked band of followers and using them for the propaganda of the Kingdom, Jesus had already formed the nucleus of an organization and revealed a purpose for a church.

History.—In any case that is how his immediate followers interpreted the situation. They themselves were the remnant; they had succeeded to the promises; they were the new Israel, the heirs of the old church in a new guise. Inspired by the events of the resurrection and the descent upon them of the Holy Spirit they set themselves with immense fervour to carry out the task allotted to them. Twenty years after the crucifixion St. Paul was so full of the church, its opportunities and its needs that the thought of the Kingdom had already begun to fall into the background. In fact a theology of the Kingdom never was worked out. When its full coming was seen to be delayed, attention was inevitably riveted on its current representative, the church.

As the first task of the church was to proclaim the gospel of the Kingdom, the second was to shepherd those who were converted. It was natural that the efforts to hold the flock together should follow the lines already familiar in the organization of Judaism. It is evident from the scrolls discovered at Qumran that even a semimonastic sect like the Essenes took the greatest care to emphasize the notes of authority and unity among themselves. That the early Christian community did the same from the start is learned from Acts. Their first corporate action was to fill the place in the apostolic band left vacant by the death of Judas (Acts i, 15–26).

The nascent Christian church was soon disowned and even persecuted by the Jewish authorities. It set up its own headquarters in Jerusalem corresponding to the Sanhedrin and directed its evangelism from there. When Christianity reached the provincial towns of the Roman empire, the story of imitation was repeated. Rebuffed from the local synagogue, the Christians were compelled to build up an organization of their own. They appear to have repeated the system with which they were already familiar. As the synagogue was ruled by elders, so the local Christian community must be ruled by elders. St. Paul, whose conversion had brought great accessions of gentiles to the church not only in Syria but also in Asia Minor and Europe, saw to it that elders (Gr. *presbyteroi*) were appointed in every city (Acts xiv, 23; Tit. i, 5). (*See* also MINISTRY, THE CHRISTIAN.)

What was even more important than arrangements for the ministry was the decision as to what should determine membership in the church. At first the Christian community was an enclave within Judaism, a special synagogue of such Jews as accepted Jesus as Messiah. But hard upon the success of the gentile mission came the question whether the new converts must first become Jews before they could become Christians. Must they be circumcised as well as baptized? At the Jerusalem council (Acts xv) it was decided that henceforth acceptance of the Christian faith and baptism would be sufficient to qualify for membership; circumcision would not be demanded. Later, under the stress of persecution, when it was necessary to afford the fullest possible support to all believers, this rule would be further relaxed to allow of the inclusion of catechumens. Not only the baptized but also those who were under preparation for baptism would count as Christians.

It is probable that persecution hastened the organization of the ministry. When Jewish opposition made it clear that Christianity had no claim to be a national religion, the Roman government soon began to look upon it as a dangerous international organization and an "unlicensed" religion. In self-defense against the sporadic persecution that followed the church had to tighten its discipline and define its ministry. Clement of Rome, writing about A.D. 96, rebukes the Corinthians for allowing disturbances in the orderly succession of officers. Ignatius, bishop of Antioch, journeying to his death in the Roman arena about 115, exhorts the churches, to which he writes on his way, to rally round their bishop as the one sure centre of the resistance movement. By the fourth quarter of the century other dangers had appeared in the shape of heresy (false doctrine) and schism (breach of unity); and a formidable rival of the church had arisen in the theosophical body known as the Gnostics, who claimed to have an esoteric doctrine handed down through their teachers from the Christ himself (*see* GNOSTICISM). Irenaeus, bishop of Lyons (*c.* 185), found in the bishops the main defense against this corrosive influence of false teaching, particularly in the bishops of the great apostolic sees. By this time the three orders of bishop, priest and deacon stood out clearly as the essential structure of the ministry (*see* HOLY ORDERS). The general system of the "great" or "catholic" church was thus now clearly developed and was to hold together through the further period of conflict with the Roman empire.

When that period ended in first the toleration (313) and then the establishment (381) of the church in the empire, it was succeeded by a period of grave internal troubles over questions of faith and order. The government, anxious to use a common religion as the means of cementing together the various elements that made up the empire, placed its resources at the disposal of the bishops in order that they might meet together from the four corners of the civilized world and settle their differences. There followed the four great councils universally recognized as "ecumenical," Nicaea (325), Constantinople (381), Ephesus (431) and Chalcedon (451), at which, in correction of the one-sided doctrines of certain Christian teachers, the fundamental truths about the Trinity and about the person of Christ were stated. At Nicaea the relation of Jesus to the Godhead was defined in a test creed for bishops which, slightly adapted, has since become, under the name of the Nicene Creed, a part of Christian worship. At Chalcedon the doctrine that Christ is one person in two natures, divine and human, received what has since been recognized as its final form in the Chalcedonian definition (*see* also COUNCIL; CREED).

These agreements were not reached without leaving behind some dissentients. The Nestorians (*q.v.*), who divided Christ into two persons, and the Monophysites (*q.v.*), who united his two natures into one, used these theological differences as an excuse to free countries lying on the eastern borders of the empire from the dominance of Constantinople. In the 7th century this dissidence made the area an easy prey to the invading Muslims. The consequent losses in turn accelerated the development of bad feeling between Constantinople and Rome, while theological disagreements afforded an excuse for the ventilation of personal and political rivalries. The chief doctrinal point at issue concerned the Trinity, the Eastern Church holding that the Father is the sole source of the Spirit, the Western that the Spirit proceeds also from the Son. On both the political and the religious level, the papal claim to jurisdiction over the Eastern patriarchates as well as the Western proved unacceptable to the Byzantine empire. In the 11th century the result was the great schism between east and west, between Orthodox and Catholic, which has not yet (in spite of one nearly successful attempt in the 15th century; *see* FERRARA-FLORENCE, COUNCIL OF) been healed.

Throughout the later middle ages east and west each developed its own type of spirituality and its own method of working with the state. As in the 7th century, the disunity of Christians again gave an opportunity to Islam. In 1453, to the consternation of Christendom, Constantinople was captured by the Turks. Thereafter the Orthodox in Asia Minor, Greece and eastern Europe apart from Russia became, like the separated Monophysite and Nestorian Christians, subordinate groups in a Muslim world. In these countries it was the church that kept the nation distinct from its conqueror and that in the 19th century led the movement for freedom from the Turks. In the 20th century Orthodoxy became better known in the west largely through widespread emigration to the United States and the exodus of Russian theologians after the communist revolution in 1917. The Eastern Orthodox form one united church, though its traditional organization in national groups sometimes causes practical difficulties for its members dispersed in the west.

During the 16th century the Western Church was split by schism as heterodox opinions, familiar since the times of John Wycliffe and John Huss, achieved a fresh vogue, drawing strength from the revival of Greek studies and from a widespread anticlericalism among the people. The invention of printing propagated the doctrines of reformers such as Luther, Calvin and Zwingli, and gave Protestantism such a widespread and popular basis that the church, despite the work of the Counter-Reformation, could no longer prevent those of different dogmatic views from establishing their own ministries and forms of worship. But the feeling that a state must have religious as well as political cohesion died very hard, and for about 100 years western Europe was troubled by religious warfare, particularly within France and Germany. The strife was at length stilled by exhaustion and by the growing spirit of toleration and of indifference nurtured by the rationalist movement of the 18th and 19th centuries. All branches of the Western Church suffered in some measure from the effects of this movement, partly from the direct assaults upon religion made by its adherents and partly because it led to a decline of doctrinal conviction among their members. Ultimately most denominations met the danger by a reassertion of the supernatural element in Christianity; for example, the Church of England in the renewed stress upon dogma inaugurated by the Oxford movement, and the Roman Catholic Church in the condemnation of modernism by St. Pius X in 1907.

Missionaries of the various branches of the church were often the pioneers in the opening up of America, Asia, Australasia and Africa; the divisions of Western Christendom thus were repeated in the new states. But the divisions among Christians, often passively accepted at home, proved a greater embarrassment and scandal in the mission field, and it is perhaps not surprising that the great 20th-century movement toward reunion first achieved practical results in these areas (*see* ECUMENICAL MOVEMENT). Some protestant denominations merged in 1925 to form the United Church of Canada; and the Church of South India, established in 1947, represents the culmination of a movement in which former Anglican, Methodist, Congregational, Presbyterian, Lutheran and Dutch Reformed churches have taken part. The World Council of Churches (*q.v.*; established 1948) exists to further the integration of belief and action; the Roman Catholic Church also has shown much concern with the need to recover Christian unity.

Statistics about church membership are notoriously difficult to acquire and to interpret, but it has been estimated that in the mid-20th century about one-third of the world's population was

Christian. In round terms, of the 900,000,000 Christians half were Roman Catholic (450,000,000) and a sixth Orthodox (150,000,000), while the remaining third (300,000,000) belonged to more than 600 other churches. The influence and importance of some of these are much greater than their relatively small membership would suggest.

Doctrine.—In view of the tendency to division shown by the church in history, it is pertinent to inquire what the church in fact believes itself to be. There are, it is true, divisions in it that are natural and in no way hinder its essential unity. In view of the commonly expressed belief in the communion of saints, most Christians would accept the traditional division of the church into militant, expectant and triumphant, meaning the church on earth, the church in "hades" or purgatory and the church in heaven. But this of course does not allow for any divisions here upon earth. The Roman Catholic and Eastern Orthodox church alike regard these divisions as irrelevant, each believing that its own respective organization is exclusively to be identified with the church that Christ founded (without, however, denying all possibility of salvation to those outside it). The same claim has been made in the past by some of the smaller churches, though these generally tend now to assert the ideal unity of the church while making every effort to approximate as closely as possible to it in effective organization. The fact that many Christians hold nominal beliefs and do not act like followers of Christ has been noted since the 4th century, when the church ceased to be persecuted. To account for this St. Augustine propounded the theory that the real church is an invisible entity known only to God. Luther used this theory to excuse the divisions of the church at the Reformation, holding that the true church has its members scattered among the various Christian bodies but that it is independent of any organization known upon earth. The majority of Christians, however, while recognizing the obvious truth that God alone can know the hearts of men, still believe that Jesus intended to found one visible church here upon earth. The growing acceptance of that view is one of the most impressive features of Christian thought in the 20th century.

The four marks or characteristics by which the church is said to be distinguished are recited in the Creed: one, holy, catholic and apostolic. The first, that of "unity," appears to be contradicted by the diversity referred to above. It is held however that since baptism is the rite of entry into the church, the church must consist of all baptized people, who form a single body irrespective of the denomination to which they belong. It is held also that since, as St. Paul contends, the church is the Body of Christ, and each baptized person is "grafted" into him, there is a mystical unity that binds together all the members in Christ in spite of their superficial divisions. The "holiness" of the church does not mean that all its members are morally perfect but that as the special sphere of the Holy Spirit it forms a school of character in which the members are trained in holiness. The term "catholic" meant originally the universal church as distinct from the local churches, but it came to imply the "great" church as contrasted with the sects. The term also embodies the idea of authoritative and orthodox doctrine as opposed to the teaching of heretics and schismatics. Finally the title "apostolic" implies that the church is "built upon the foundation of the apostles and prophets, Christ Jesus himself being the chief cornerstone" (Eph. ii, 20). In other words, in both its teaching and ministry the church is historically continuous with the apostles and so with the earthly life of Jesus.

The importance of these distinguishing marks is that they are signs and expressions of an inward and spiritual life. The outward organization is a sacramental means of an inner vitality, that of Christ and his Spirit, in which all the members share. The church does not merely perpetuate the horizontal line of history linking the present believer with the past life of Jesus of Nazareth; it also presents a vertical line striking directly from the Christ enthroned in heaven to the heart of the believer upon earth here and now. The method of this communication is twofold. The first is psychological, in which the faith of the Christian responds to the challenge of Christ and accepts his rule in obedience and love. Those Christians who lay specially great stress on the experience of personal conversion are inclined to regard this first method as the one of overwhelming importance. The second is ontological, by which the believer is first incorporated into Christ by baptism and then continually nourished by participation in the sacrament of the Eucharist. The life thus engendered in the soul of the Christian is nourished in the regular worship that is the primary duty of the church and in the atmosphere of brotherly love that should characterize the community. As the original followers of Christ after his ascension "devoted themselves to the apostles' teaching and fellowship, to the breaking of bread and the prayers" (Acts ii, 42), so the Christians of today follow the same practice and receive the same benefits.

The church is intended to follow Christ under the inspiration of the Holy Spirit in a way of life that marks it off from the world in which it is set. Although this aim is far from being fully realized, it cannot be denied that the church, throughout its history, has inculcated a high standard of morality. If in some instances, as in its persecution of heretics, it has grossly misinterpreted the teaching of Jesus, it has nevertheless been largely responsible for the building up of what is known as western civilization, and has conferred considerable benefits on mankind. As the leaven that leavens the whole lump it may perhaps be said to exercise a less conspicuous but more penetrating influence in the 20th century. Its task in the world is to inspire each individual to contribute his abilities toward preparing the way for the coming of the Kingdom of God by proclaiming that coming and facilitating its progress. (J. W. C. W.)

THE BUILDING

Early Christian.—The first meetings for Christian worship were held in the homes of converts, in rooms which in many cases may have been set aside and furnished for this particular purpose. Christianity spread within the Roman empire into Asia Minor, Greece and Rome itself with surprising rapidity, but continued persecution from the time of Nero until the so-called Edict of Milan (313), which granted religious tolerance, made secrecy necessary. Gatherings and services therefore took place in private houses and catacombs (*q.v.*) where existing subterranean cells could be enlarged and used with little fear of discovery. These small chapels cut in the rock, of which the best known are those in Rome, are the first examples of Christian architecture in its simplest form.

As the church grew and gained recognition, the old desire of men to erect buildings to the glory of their God found fresh outlet. When Constantine I (d. 337) embraced the Christian faith, he gave it an endorsement that immediately widened the prospects for church building.

Early church buildings are generally said to have been adapted from the existing common form of the Roman basilica (*q.v.*). A rectangular plan with entrance at one end and projecting semicircular apse at the other was divided into a wide nave or central space with lower-roofed aisles along each side. The altar was centrally placed at the junction of nave and apse, with seats behind for the bishop and clergy, as magistrates' seats had been arranged behind an altar for the taking of oaths in secular basilicas. A screen (Lat. *cancelli*) stood between the altar and the congregation, reserving the sanctuary for the priesthood. This screen later gave its name to the chancel and enclosed an area for use by the choir. In some churches an additional open space before the altar, the bema, formed part of the sanctuary and may be regarded as forerunner of the transepts. Two ambos or pulpits were also placed at the sides of the chancel for reading of Scripture. From that on the left the Gospel was read and from that on the right the Epistle.

The church was approached through the porch or narthex, often by way of a cloistered atrium. Penitents and those not admitted to full church membership could listen to the services from the narthex.

The so-called basilican church, with long open nave, side aisles and apsidal end, admirably fulfilled its function as a building for the celebration of the Eucharist. Whatever the detail of its derivation, it was certainly rooted firmly in the architectural traditions of the Roman empire, and churches of this type dating from an early period have been found throughout the Mediterranean area where Rome had dominated. (*See* also EARLY CHRISTIAN ARCHITECTURE.)

Byzantine.—An alternative type of church plan also occurs at an early date but has had less significant influence on the development of Christian architecture. This is the circular or polygonal centralized plan usually roofed with a dome and deriving from earlier tomb and temple forms. An interior colonnade provided an encircling aisle or ambulatory and in most cases an apse was added, linked to the central space by the usual bema. Examples occur in Armenia, Greece and Italy, with the 6th-century Byzantine churches of Hagia Sophia, at Istanbul, Turkey, and S. Vitale, at Ravenna, Italy, remaining as two of the finest. Except for such ceremonies as baptism, this form was more suited to the eastern rite than to the congregational nature of the Roman services. Although St. Mark's, Venice, was reconstructed on a Greek cross plan in the 11th century and imitated a century later in the church of St. Front, Périgueux, France, these are isolated instances in the west, while in the Balkans and in Russia variations on the centralized plan persisted into the middle ages and beyond. (*See* also BYZANTINE ARCHITECTURE.)

Romanesque.—The coronation of Charlemagne in 900 preceded the restoration of some degree of order for troubled successors in the west to the Roman empire. More settled conditions encouraged a fresh approach to art and architecture, and from confused and widely separated sources the Romanesque style emerged. It was characterized by the return to masonry-vaulted roofs, probably influenced by the remains of classical Roman buildings still then widely extant. Northern Italy, Germany, France and Britain—as a result of the Norman conquest—all produced differing developments until Romanesque in its turn gave way to Gothic in the 12th century with the introduction of the pointed arch and many-ribbed vault in place of the round arch and barrel vault.

An aisled nave was almost universal in larger Romanesque churches, with a chancel or presbytery between this and the east end to accommodate the larger numbers of clergy and monks. At the junction of nave and chancel transepts were added, producing a cruciform plan shape. The semicircular apse was still commonly used, but less frequently in England than elsewhere.

From early Christian times it had been the custom for a tomb or relics of saints to be placed beneath the altar or in the crypt. Many of these relics increasingly became objects of veneration and pilgrimage. Thus, circulation space for processions and for large numbers of people made the ambulatory a necessary feature. (*See* also ROMANESQUE ARCHITECTURE.)

Gothic.—The religious fervour that transmuted the massive northern Romanesque into the fine flowering of Gothic in Germany, England and France also produced substantial endowments for the saying of masses in chantries or chapels. Many additional altars were required in the greater churches for this purpose, and these most frequently opened off the ambulatory, giving rise to the characteristically French Gothic chevet or series of chapels surrounding the east end. The most important of these was usually the lady chapel dedicated to the Blessed Virgin.

While abbey churches and cathedrals served the needs of monastic or urban communities, village life centred on the small parish church, of which some of the finest and most varied examples occur in England. Many of these occupy sites of early Saxon churches, though few pre-Conquest structures remain. Most parish churches may be classified according to three basic types of plan. The first consists of a simple rectangular nave with smaller rectangular or apsidal sanctuary, and in the second a chancel is introduced between nave and sanctuary. The third type developed as in the earlier, larger churches into the cruciform plan with added transepts and central tower.

Elaborate schemes of symbolism have been put forward in relation to church plans and other architectural features, but it is doubtful whether most of these are valid. The piecemeal extensions and reconstructions that took place throughout the medieval period tend to discount the idea of the church plan as representing the body of Christ crucified.

Separation of clergy from laity continued until the Renaissance. The timber rood screen was the simplest form of barrier, surmounted by the crucifix and with open traceried panels beneath. It is the nearest Western approach to the closed iconostasis of the Eastern Church. In English cathedrals and collegiate churches, a stone screen separated choir from nave. Later in many cases the organ was supported on this screen in an ideally central position. Occasionally in monastic churches both rood screen and choir screen were built to give seclusion to the monks. In France and Germany, where the larger churches more commonly were of lay origin, the solid dividing screen was rare.

As the middle ages advanced, the churches became the setting for works of art in stone, marble, alabaster, wood and stained glass. From the beginning, colour played a large part in internal effect. Pigments were lavishly employed on ceilings, on the surface of piers and walls and on furniture as well as in the richness of great areas of stained glass. In such prodigality of colour, the medieval mind found the fullest satisfaction of its religious ideals. (*See* also GOTHIC ARCHITECTURE.)

Renaissance.—The revival of Roman architecture began, naturally enough, in Italy, where the tradition had survived and where Gothic building had never been widespread. Gradually it spread to the rest of Europe, with modifications based on local conditions. In northern Europe the Reformation checked the building of churches, and in England no great church was built between the completion of Bath abbey (*c.* 1539) and Sir Christopher Wren's St. Paul's cathedral (begun in 1675). As Wren had observed, the main requirement of the reformed religion was a preaching space or auditorium, and most of his city churches are skilful variants on a basic rectangular plan with only a shallow recess for the altar. This plan persisted in England throughout the 18th century and is seen in many North American churches of this period. Even on the continent, in countries untouched by the Reformation, the Renaissance produced a similar plan.

The Counter-Reformation within the Roman Catholic Church also encouraged the spread of the baroque hall-type preaching church which was closely associated with the Jesuits, in which the domed cruciform plan had contracted, reducing the side aisles to a series of small chapels and the sanctuary to a low platform with altar rail, set once more in a small apse. The church of the Gesù in Rome became the prototype for innumerable churches, particularly in Austria and Bavaria, where exuberance of decoration developed into the light and colourful rococo.

Similar trends of baroque church design in France and Spain were gradually curtailed by the growth of a severe neoclassicism. (*See* also RENAISSANCE ARCHITECTURE; BAROQUE AND POST-BAROQUE ARCHITECTURE.)

19th Century.—With the waning vigour of classic forms, the 19th century became an age of eclecticism in architecture. The Gothic revival competed with Greek, Roman and Byzantine designs but in northern Europe came to supersede all others in being considered the most suitable form of church building. The church plan itself varied little whether the outward dressings were Gothic or classic.

The Oxford movement within the Anglican Church, reacting against the scientific materialism of mid-Victorian England, turned for visual expression to medievalism. A reinterpretation of the ideals of the earlier period and of its forms and decoration became the life work of such men as John Ruskin and William Morris.

A gradual change of outlook preceded the more fundamental changes that have occurred in the 20th century and that are dealt with at length in the article on RELIGIOUS ARCHITECTURE.

See also references under "Church" in the Index volume.

(E. C. D.)

CHURCH AND STATE. Before the advent of Christianity the religious and political orders were not clearly defined. Men worshiped the gods of the particular state in which they lived, religion in such cases being but a department of the state. In the case of the Jewish people the revealed Law of the Scripture constituted the Law of Israel. The Christian concept of the secular and the spiritual is founded on the words of Christ: "Render to Caesar the things that are Caesar's, and to God the things that are God's" (Mark xii, 17). Two distinct, but not altogether separate, areas of man's life and activities had to be distinguished; hence a theory of two powers came to form the basis of Christian thought and teaching from earliest times.

In the apostolic age the apostles, living under a pagan empire, taught respect for and obedience to the governing powers, even when the ruler was not a good ruler. But this obedience did not extend to commands that contradicted the divine law; obedience to God took precedence over obedience to man. A part of man's life, and that the most important, was governed by a higher law outside political jurisdiction.

Among the Fathers of the Church the emphasis on the primacy of the spiritual was even more emphatic. Most of these early Christian leaders lived in a period when Christianity had become the religion of the empire. They insisted upon the independence of the church and the right of the church to judge the actions of the secular ruler, who, after all, was a son of the church, was within the church and could claim no exemption from the law of God as interpreted by the church. In the 5th century Pope Gelasius I reminded the emperor that there are two powers by which the world is governed, the power of civil authority and the power of the priests, and that the priests bear a heavier responsibility in that they have the care of man's immortal soul. The life eternal is man's destiny; the present life is a period of trial in preparation for the life to come.

The divine law, therefore, is superior to any man-made ordinance or command. Another law, however, governs men and is evident to the reason of men without a knowledge of the Scriptures. This is the universal and unchanging natural law, a law spoken of by Cicero and the pagan Stoics, which teaches men to observe the rights of other men in their lives and property. Its first principle is "Do good and avoid evil," engraved, as St. Paul said, in men's hearts. If this law is natural to men, it was created by the God of nature. Two laws, therefore, govern men as rulers, the natural law and the divine law.

Middle Ages.—With the decline of the Roman empire in the west, civil authority, not by design but by necessity, fell into the hands of the only educated class that remained—the churchmen. The church, which formed the only organized institution, undertook the slow and difficult mission of converting the barbarians who had overrun the empire. Against great odds it brought the humanizing teachings of Christianity to rough uncivilized peoples. While it still steadfastly taught the doctrine of the two powers, for several generations it held both. In the east the empire, with civil authority centred in Constantinople and attacked on its borders by barbarians and Muslims, carried on a precarious existence till the 15th century. While within it the Christian doctrine of the supremacy of the spiritual was asserted, the two powers, civil and ecclesiastical, for the most part were lodged firmly in the hands of the emperor. Throughout the history of the Byzantine empire the civil authorities dominated the ecclesiastical.

In the west, where the church had assumed temporal power, the independence of the ecclesiastical authority was defended even after the restoration of civil authority. In 800, under Charlemagne, the empire was restored in the west. For many centuries afterward the civil power took as advisers the educated class, the churchmen, but as the civil power grew in strength and prestige under vigorous rulers conflict with the ecclesiastical powers increased. Kings and emperors found that large areas of their domains were held under the jurisdiction of bishops and abbots. The civil rulers demanded not only control of the ecclesiastics but also the right of naming and investing them, and by the 10th century these powers had been gathered into the hands of rulers in many parts of Europe. The general result was not a happy one for the church. Men who had little learning, secular or ecclesiastical, were able to obtain high positions in the church largely through political connections. A general lowering of religious fervour, devotion and even morals among the clergy brought vigorous action from a line of reforming popes, the most famous of whom was Gregory VII. Gregory's efforts to bring under control of the church the naming and investiture of bishops brought him into conflict with Emperor Henry IV. In the ensuing struggle Henry was brought temporarily into submission, but, regaining the support of many of his nobles, drove Gregory into exile, where he died (*See* also GREGORY; INVESTITURE CONTROVERSY.)

The following centuries were marked by a dramatic struggle between emperors and kings and the popes. Nonetheless, during the 12th and 13th centuries the papal power greatly increased. During the period of most intense struggle both disputants accepted the theory of the two powers, but the application of the theory became more difficult as the civil power attempted to extend its jurisdiction into fields hitherto largely occupied by ecclesiastics. Two events in particular aided the civil power in the struggle: The recovery of Roman law, framed as it was during the period of absolute rule by the emperors, furnished the defenders of civil rulers with strong arguments in defense of temporal power; and the growth of the nation-states, which brought a greater national sense to the people, aided the civil rulers in their struggles against the universal papal authority. Despite the recurring disputes between the church and the civil powers it was still possible in the 12th century for people on both sides to hold to the ideal of one Christian commonwealth with the two powers representing two aspects of life. As Charles Howard McIlwain has written:

> The contest was not for either party a struggle between "Church and State" in our modern sense, for neither of them could conceive of a society that was not at the same time both Church and State. The *civitas Dei* and the *civitas terrena* were only two aspects of the life of man on earth which must remain mingled together till death or the day of judgment, as St. Augustine had said. Society was but one, and the State and the Church alike were only different aspects of this oneness. The contest for supremacy was not between two rival institutions, a State and a Church, it was between two sides of human life, two elements in the constitution of man, two powers that claimed his obedience, the *regnum* and the *sacerdotium* (*The Growth of Political Thought in the West;* New York, The Macmillan Co., 1932).

In the 13th century the greatest scholar of the age, St. Thomas Aquinas, borrowing from Aristotle, aided in raising the dignity of the civil power by declaring the state a perfect society (the other perfect society was the church), a positive good in the natural order for the promotion of men's temporal needs, and a necessary good inasmuch as men could not live without a civil society. The state did not exist solely to restrain the evil in men, for, Aquinas asserted, some form of government was necessary even in a society of angels.

The medieval struggle between secular and religious power came to a climax in the 14th century. The leading nations of Europe had now grown in strength and internal unity. The universities, among the greatest contributions of the middle ages to western civilization, had turned out leaders in Roman and canon law. Learned laymen were now assuming positions of importance at the courts of kings. The endeavours of the popes to settle the constant wars among the nations embroiled them ever more deeply in the growing complexities of international politics. The independence of the church within the nations in the maintenance of its own courts and administration challenged the policy of internal unity that the strong monarchs now pursued.

France, the most powerful of the nations, was governed during the first part of the 14th century by Philip IV the Fair, whose aim was not merely the spread of French power but also control of the papacy and attainment of the title of Roman emperor. The papacy in the early years of the century was occupied by one of the great canonists of the time, Boniface VIII. The immediate cause of the dispute was the right of the king to tax church property in the event of war. Canon law forbade a king to tax such property to support a war against another Christian king without the consent of the church; Philip proceeded to tax church properties in one of his recurring wars with England. The ensuing dispute, which raged for several years, involved all the old questions of the proper spheres of the religious and the secular powers. The distinct difference in this controversy, however, which neither side appeared to recognize, was the rising force of nationalism. Noteworthy too was the prominence of lawyers, both royalist and canon. The subtleties, the distinctions, to say nothing of the rigidities of the arguments on both sides lent to this particular controversy a flavour lacking in previous centuries. Even older arguments when put forth by the canonist Pope Boniface had a ring of severity and dogmatism lacking in most earlier papal statements. (*See* also Boniface.)

Giles of Rome put forth a theory that all secular power was derived from the church. Equally extreme was the royalist defender Pierre Dubois in claiming supreme authority of the king over the pope. More moderate views came from the theologian John of Paris, who claimed that the state existed by natural law, with a proper end or purpose of its own, and not owing its creation to the church: both church and state owed their existence to God, each with its own independent ends to serve; the church served spiritual ends and for its purposes used spiritual means; it was not justified in calling upon the state to serve its ends; the church enjoyed a primacy, but a primacy of prestige and not a primacy of power. Not many years later, Marsilius of Padua was to declare in his *Defensor pacis* that all power in church and state was derived from a primary assembly of the people. The church was just another social agency in the state, and as such derived whatever privileges or powers it enjoyed from the state. (*See* Marsilius.) The medieval struggle between priestly and kingly powers came to a disastrous close for the papacy, first in the removal of the popes to Avignon under French influence, and second with the Great Schism attendant upon an effort to bring the popes back to Rome. Church discipline was relaxed and church prestige fell in all parts of Europe.

While the struggle of the middle ages did at times involve an ungodly power effort, it was by no means for the most part of that nature. Whatever natural vigour and esteem Christianity enjoys today it owes in no small measure to the efforts of churchmen in the middle ages to preserve the church from domination by the secular powers. In addition some of the most treasured theories of popular government were enumerated by canonists—the source of authority in the people, limited executive power and the binding force of law on rulers. Of this period William Ebenstein says, in writing of John of Salisbury, a papal apologist:

> From the modern secularist viewpoint, the church ought to stay in its place and not contend with the state for temporal power. But John of Salisbury and the papal apologists, in seeking to curb the authoritarian claims of kings and princes, or to gain at least equal authority for the church, were (knowingly or unknowingly) fighting a cause that was larger than their own: the whole issue of human liberty was at stake, and it was a more important issue than the rivalry for power and supremacy that raged between popes and emperors. And though John of Salisbury and the medievalists did not solve this larger issue, neither have the secularists: Is the state, even the democratic state, to have absolute and complete authority, or must there be some competing principles of allegiance that will make it difficult, or impossible, for the state to become an all-absorbing Leviathan? The church can no longer, as in the Middle ages, play the part of a competing major source of loyalty and authority, but thus far no institution or idea is in sight that can be relied on to do the job. The democratic state—precisely because of its popular source of support—has by no means abolished the possibility of tyranny and repression . . . (*Great Political Thinkers, Plato to the Present*, 3rd ed., copyright 1951, © 1956, 1960; reprinted by permission of Holt, Rinehart and Winston, Inc.)

The Reformation.—The immediate effect of the Reformation was a great increase in the power of the state both in Catholic and in Protestant countries. Christianity in its fractured condition could offer no effective opposition to a strong ruler. Assuming the position of head of church and state, rulers now claimed divine right for their positions. (*See* King.) Both Luther and Calvin taught absolute obedience to rulers, even to tyrants, except in matters involving violation of God's law; resistance in any case should be passive. In Lutheran countries the churches in many cases reflected the trends of German nationalism and were to all intents and purposes arms of the state. In Calvin's Geneva the political order was subordinated to the ecclesiastical order; no pope of the middle ages had asserted the supremacy in theory and practice of the church with greater vigour than did Calvin. Some of the extreme sectarians of the Reformation proclaimed a doctrine of Christian anarchy, substituting the Bible alone as the law for all people.

In England Henry VIII broke the ties with Rome and assumed the headship of the Church of England. While the break and the assumption of leadership by the king were revolutionary, few revolutionary changes were made in ritual and doctrine. The reign of Henry's successor, the young Edward VI, saw more changes in the direction of Calvinism. Elizabeth I, however, stressed a middle course that was in no sense acceptable to the more Calvinistically inclined members of the Church of England, the Puritans, who sought to reform the established church still further along Calvinist lines. Their aim was not a separation of church and state but a reform of the established church. Under the Stuart kings certain groups within the Puritan ranks developed theories that proclaimed the independence of the church from the state. (*See* also Puritanism.)

In the 17th century there were few who believed that diversity of religious belief and a church unconnected with the civil power were possible in a unified state. Common religious standards were looked upon as a principal support of the political order. Nevertheless, the idea that religious dissent should be tolerated was growing, especially among the leaders of the new commercial classes. One might, however, still hold a belief in a state church along with an acceptance of toleration of religious dissent. That a state should be neutral in religion or not confess a definite faith was more novel as a point of view than toleration of religious dissent.

America.—Increasing persecution of the Puritan groups in England through the 17th century resulted in the settlements in New England. These settlers, whatever their early ideas on separation of church and state happened to be, did not provide for separation in the new colonies. In Plymouth and Massachusetts Bay rigid conformity to the church ideas of the settlers was enforced. In all the colonies, with the exception of Rhode Island, Pennsylvania and for a time Maryland, established churches were the rule, though laws regulating religious belief differed, as did the rigour of enforcement.

The 1st amendment to the United States constitution provided that congress could not establish a religion; it had been provided in the constitution, as first written, that no religious test could be required for holding public office under the national government. The 1st amendment was the result of agitation by four groups: the men such as Jefferson, Franklin, Madison and others who were affected by the ideas of the French Enlightenment; the leaders of established churches who feared that one church would be established to the exclusion of the others; those churchmen (particularly in New England) who wanted to protect already established churches from congressional action; and the Baptists, growing in number, who held to the separation idea as a principle of their creed. The word separation, however, does not appear in United States law.

The migration of the 1840s brought to America thousands of people whose tradition was Roman Catholic. Fears that the new immigrants would receive public funds for their separate educational facilities resulted in many states' adopting restrictive clauses in their constitutions against such a practice. The 20th century saw the 1st and 14th amendments to the constitution applied with considerable strictness by the courts in the field of education. These judicial decisions prohibited aid to private education or the introduction of any form of religious belief or teaching in public schools. Roman Catholics and not a few Protestants believe that the new interpretation of the constitution came to place a restriction on religion in favor of secularism and nonreligion. Others believe, however, that a constant watch must be kept on governmental action to make sure that no favour is shown to religion in any form.

General.—There exists no one set pattern throughout the world of the relation of church and state. In the western world, where the Judaic-Christian tradition is strong, the pattern runs all the way from establishment, as in England and the Scandinavian countries; through the Spanish arrangement, with close working relations between church and state and limited toleration for others; through simple recognition of the official primacy of one church without state support, as in Ireland; through the policy of benevolent neutrality on the part of the state with regard to all religions, as in the United States; to the declared "lay state" found in France. Where the overwhelming part of a population is of one religious belief, complete separation cannot exist, since the organs of government will always reflect the social conscience of the great mass of the people in some degree (as in the recognition of Sunday or in the use of prayers and religious exercises in public functions as in the United States). The natural and supernatural parts of men's activities will touch at some points and will be institutionalized according to the needs and traditions of different societies.

In the modern western world certain component parts of church-state relationship have come to be recognized. (1) The first of these is the primacy of the spiritual, as traditionally stated: God is to be obeyed rather than man, or man's conscience is to be followed. (2) The second is freedom of religious action where the common good is not endangered by such action; this means religious toleration on the part of the state with the accompanying privilege of public worship, preaching and publication. (3) The third might be called co-operation. On this point there will be differences of opinion, but in its most elemental form it means that no unnecessary political restrictions be placed upon religion or its institutions. It appears in its positive aspects in exempting churches from taxation or the clergy from military service. It signifies, too, no hostility on the part of the state to religion.

See GALLICANISM; ULTRAMONTANISM; *see* also references under "Church and State" in the Index volume.

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CHURCH ARMY, an organization of lay evangelists within the Anglican Church, was founded in the slums of London in 1882 by Wilson Carlile (*q.v.*). The society almost from the outset was concerned as much with social work and rehabilitation as with preaching.

At the conclusion of a two-year residential course of training students are commissioned as officers of the Church Army, the men being called captains and the women sisters. Some officers later undergo a further specialized course of training; *e.g.*, for moral welfare work. About 200 officers serve on the staff of parish churches in England as specialists in evangelism, while others have an itinerant ministry. Among the latter there are a number of children's missioners and about 40 officers living on mission caravans. In the summer, camps, house parties and beach missions are organized at seaside resorts. Several prisons are served by resident evangelists, and a prisoners' families department is operated from the headquarters in London.

The practical demonstration of Christian charity includes running about 70 homes and hostels, caring for old people, men and women on probation and discharged prisoners, young folk having to live away from home, unmarried mothers, poor families in need of holidays, etc. By 1939 over 900 houses and flats had been built by Church Army Housing, Ltd., and during 1945–60 more than 50 large houses were converted into 600 "Churchill" flatlets for elderly people. Other activities in England include youth clubs, centres for members of the armed forces, a visual aid department, printing press and secondhand clothing department.

There are autonomous societies in the United States, Canada, New Zealand and Australia, the latter including a few aborigines among its officers. West Indians are trained in London for service in Jamaica or England, and East Africans in Nairobi for a ministry within the areas of detribalization. English officers serve as missionaries in India, the West Indies, Kenya and in Tanganyika, where the Wilson Carlile school for blind boys is situated.

See A. E. Reffold, *Wilson Carlile and the Church Army* (1947).

(E. W. CA.)

CHURCH COMMISSIONERS, in the Church of England, are the successors to two corporations that have ceased to exist, Queen Anne's bounty and the Ecclesiastical commissioners. Under a number of acts of parliament and measures of the church assembly the Church commissioners, mainly through a board of governors, perform administrative and financial functions including pastoral reorganization and the management of funds which help to provide stipends, houses and pensions for the clergy of the Church of England and to contribute toward the cost of new church buildings.

In 1703 Queen Anne by letters patent, authorized by statute, established a corporation, the "Governors of the Bounty of Queen Anne for the Augmentation of the Maintenance of the Poor Clergy." To this corporation, first fruits (annates; *q.v.*) and tenths (decimae) of the annual profits, originally paid by the clergy to the papal exchequer and later appropriated to the crown by Henry VIII (1532 and 1534), or commuted sums in lieu, were payable until their abolition by the First Fruits and Tenths measure (1926). This income was devoted to the augmentation of poor livings, mainly by helping toward the cost of the upkeep of parsonage houses.

The Ecclesiastical commissioners were created by act of parliament in 1836 as the result of two royal commissions appointed in 1835. Subsequent legislation not only greatly extended their administrative powers but also had the effect of vesting in them a great deal of church property, some of it allocated to specified objects, but the remainder forming a large common fund out of which provision was to be made for the cure of souls in parishes where assistance was needed, a provision which in practice has been implemented largely by the augmentation of the stipends of the clergy, though its scope is in fact wider and grants have been made for church schools.

By the Church Commissioners measure, 1947, Queen Anne's bounty and the Ecclesiastical commissioners were amalgamated into one body called the Church commissioners, with all the rights, functions and funds of both bodies. The two archbishops and all the diocesan bishops are ex officio commissioners, as are also a large number of other persons, including the lord chancellor, the speaker of the house of commons, the lord chief justice and the lord mayor of London. The three treasurers of the Church commissioners, the first and third of whom are salaried officials, are known as Church Estates commissioners.

See P. B. Wilbraham, *The First Five Years* (1953). (E. G. MO.)

CHURCHILL, CHARLES (1731–1764), English poet, wrote lampoons and polemical satires in heroic couplets, and was the last writer to use the form consistently for this purpose with poetic distinction. Born in Vine street, Westminster, in Feb. 1731, Churchill was educated at Westminster school. Delayed in taking orders by an early and imprudent marriage, he was, however, ordained in 1756, and in 1758, on his father's death, succeeded him as curate of a Westminster parish. In 1761 or 1762 he became friends with John Wilkes (*q.v.*), and his collaboration with Wilkes thereafter earned him an honourable place in the history of parliamentary democracy and civil liberties. But he made his name independently in 1761, with *The Rosciad*, a satire on the London stage which named every prominent actor of the day unfavourably, except Garrick; the brilliant and immediate success of this poem brought fame and money to the bankrupt parson, and Churchill launched himself on the town. For he resembled Wilkes not only in energy and courage but also in profligate tastes, and by June 1762 he was a member of the Hell Fire club at Medmenham abbey and separated from his wife. He resigned his clerical position, and in 1763 published *The Prophecy of Famine*, the first of several political satires attacking the government; a quarrel with Hogarth (*q.v.*) produced Churchill's *Epistle to William Hogarth* in June 1763. He gave new cause for scandal this year by an elopement with Elizabeth Carr. In 1764, when Wilkes was outlawed and in France, Churchill defended him in *The Duellist*, and wrote *The Candidate* and other poems. He traveled to Boulogne to meet Wilkes, but fell ill and, broken by disease and dissipation, died on Nov. 4, 1764.

Churchill's writing, taken couplet by couplet, or even page by page, is brilliant and memorably pungent, but in his poems considered as wholes the lack of any consistent standpoint in the satirist is evident and damaging.

See his *Poetical Works*, ed. by Douglas Grant (1956); *see* also Kenneth Hopkins, *Portraits in Satire* (1958). (D. A. DE.)

CHURCHILL, LORD RANDOLPH HENRY SPENCER (1849–1895), English politician, who acquired great popularity and considerable influence for a brief period in the 1880s as a result of his vociferous campaign for "Tory democracy." The third son of John, 7th duke of Marlborough, by Frances, daughter of the 3rd marquess of Londonderry, he was born at Blenheim palace, Woodstock, Oxfordshire, on Feb. 13, 1849. He was educated at Eton and at Merton college, Oxford. In 1874 he was elected to parliament in the Conservative interest for Woodstock.

By 1878 he had begun to force himself on the public attention as a critic of the Conservative leadership and the practitioner of a brilliant type of satirical oratory. He did not emerge fully into prominence, however, until the parliament of 1880–85, when, in alliance with three other Tory backbenchers, Sir Henry Drummond Wolff, Sir John Gorst and Arthur Balfour, he formed what became known as the "fourth party." The object of this group was to preach a political gospel announced as "Tory democracy," and it received a considerable impetus from the sentiments aroused by the death of Disraeli (1881). Lord Randolph distinguished himself by the vigour and wit with which he assailed W. E. Gladstone's administration, and by independence toward the leaders of his own party. His campaign had two aims, to encourage the parliamentary opposition to attack the government with more vigour, and to convert Conservatism into a popular political movement. An excellent opportunity of pursuing the first aim was given by the case of Charles Bradlaugh, a convinced atheist who had been elected in 1880 and who claimed the right to make an affirmation of allegiance instead of taking the oath. When this was denied him, he came forward to take the oath, but again was debarred. Lord Randolph was able to pose as the champion of the church, the defense of which was the traditional preoccupation of Toryism, and, at the same time, to enjoy himself at the expense of Gladstone, whose piety and churchmanship did not prevent him from defending Bradlaugh's right to sit.

Lord Randolph had from the first been deeply interested in the Irish question and had had exceptional opportunities for studying it while acting as unofficial private secretary to his father, the viceroy from 1876 to 1880. Though wholeheartedly committed to the maintenance of the union, he had always contended that the troubles of Ireland largely arose from generations of mismanagement, and that more foresight and enlightenment would dispose of the need for coercive measures. Lawlessness in Ireland and the systematic obstructionism of the Irish M.P.'s (led by C. S. Parnell) at Westminster occupied much of the government's attention at this time, and led it to appeal for special powers in Ireland.

The majority of the Conservative party was inclined to accept the government's reasoning, but Lord Randolph and his friends looked with suspicion on the view that coercion was inevitable and could not reconcile themselves to a bipartisan policy. As the parliament drew to its close Lord Randolph's attitude had become more pronounced, and an agreement, whether formal or tacit remains obscure, had arisen between him and the Parnellites to the effect that the Conservatives would oppose coercion in return for Irish support at the general election. This understanding caused the Conservative leaders much distress. Subsequent events seemed to show that coercion was the only effective alternative to home rule; Lord Randolph's critics maintained that by saddling his party with this embarrassing commitment he had driven the Liberals to a home rule policy, and had therefore unwittingly frustrated one of the chief aims of Toryism.

Simultaneously with these activities in the house, Lord Randolph was trying to create a popular Conservative movement in the country, and it is in these activities that the chief permanent interest of his career lies. He was prominent among the founders of the Primrose league, a movement dedicated to the upholding of church, constitution and the traditional national virtues, and inspired by a desire to perpetuate Disraeli's memory. He also tried to secure real power for the representatives of the constituencies in the Conservative party's central organization, and to prevent the popular element in party organization from being a mere sham. This brought him into still more bitter conflict with the party leadership and more particularly with Lord Salisbury, whom he had hitherto admired as an exponent of aristocratic conservatism. When in 1884 Lord Randolph was elected chairman of the Central Union of Conservative Associations, victory seemed to be in sight, but Lord Salisbury, who in matters of party organization favoured government by consent rather than democracy, abhorred these moves, and the result was a party split.

As the general election of 1885 approached, the need for healing this split became paramount. Lord Randolph was now one of the most popular figures in the country and acknowledged as a brilliant parliamentarian. Lord Salisbury therefore readily responded to suggestions of mediation. Lord Randolph, having done much to create a popular Conservative organization, agreed to resign the chairmanship to make way for Sir Michael Hicks Beach, a candidate committed to neither side in the quarrel and one who could be trusted, in the absence of Lord Randolph, to control the new forces which had been unleashed. It was now necessary to listen to Lord Randolph when shaping the strategy of the party, and he was chiefly responsible for persuading the opposition to confine itself to detailed criticisms of Gladstone's Agricultural Workers' Enfranchisement bill in 1884, which led to its acceptance in an amended form. After the Tories were returned at the general election of 1885, Lord Randolph was put at the India office, where it was felt that his sphere of activity would be sufficiently circumscribed to make it possible to contain him safely in the government. There he distinguished himself by extraordinary industry and mastery of detail until the fall of the Conservatives in Jan. 1886. When the Conservatives returned to power in Aug. 1886 Lord Salisbury, with some apprehension, appointed him to the exchequer and to the leadership of the house of commons.

In these posts, Lord Randolph was entitled to be consulted on all matters of domestic policy, and, with a considerable following in the country, he soon made it clear that he proposed to control the government. Lord Salisbury tried in vain to make peace between Lord Randolph and his colleagues, and eventually fell back on a waiting policy, the essence of which was that the prime minister should efface himself until such time as the chancellor became unendurable. This point was reached when Lord Randolph presented to the cabinet his first budget, a brilliant piece of financial contrivance which, however, involved a cutting of the service estimates unacceptable to the service ministers and to the rest of the cabinet and constituted an implicit criticism of the whole conduct of foreign policy.

Lord Randolph offered his resignation (Dec. 20, 1886) and, to his infinite surprise, it was immediately accepted. The general expectation was that the withdrawal of this powerful minister would lead to a complete disruption of the government, but the support that Lord Randolph had built up in the country disintegrated with pathetic rapidity.

The last years of Lord Randolph's life were a period of almost unmitigated personal tragedy. He suffered from a crippling disease which killed him by inches and which long travels failed to arrest. He began to lose interest in politics and to devote much time to the turf but he continued to sit as a backbench Conservative until his death. Although his speeches were rare and sometimes almost incomprehensible, the house listened to him with respectful attention, his old adversary, Gladstone, always punctiliously attentive and seizing every opportunity to show him courtesy. He died in London on Jan. 24, 1895.

The judgment of posterity has been that Lord Randolph did not succeed in the effort to produce a new brand of popular conservatism, and that indeed he was concerned principally, though possibly unconsciously, with equipping the Conservative party to win mass support for what was in essence a specifically Radical policy of reform at home and peace abroad. His most indisputable gift was a power of oratory which did not spare personalities, but which was combined with a charming and generous disposition.

Lord Randolph Churchill married, in April 1874, Jennie, daughter of Leonard Jerome of New York, by whom he had two sons, Sir Winston Churchill being the elder.

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(T. E. U.)

CHURCHILL, WINSTON (1871–1947), U.S. author of historical novels, was born in St. Louis, Mo., Nov. 10, 1871. Graduated from the U.S. Naval academy in 1894 and having private means, he soon devoted himself to writing. His first novel, *The Celebrity*, appeared in 1898. His next, *Richard Carvel* (1899), a novel of Revolutionary Maryland in which the hero serves as a naval officer under John Paul Jones, sold nearly 1,000,000 copies. Then followed another great success, *The Crisis* (1901), a novel of the Civil War, in which the heroine is a descendant of Richard Carvel; and *The Crossing* (1904), which tells of Kentucky pioneers during the Revolution. These romantic tales of America's past were Churchill's most popular. His later work consisted chiefly of novels on political issues, such as *Coniston* (1906) and *Mr. Crewe's Career* (1908), or on religious or social problems, such as *The Inside of the Cup* (1913) and *A Far Country* (1915). In 1899 Churchill became a resident of Cornish, N.H., where he lived for almost 50 years. From 1903 to 1905, he served in the New Hampshire legislature, and in 1912 was a Progressive candidate for the governorship. He died on March 12, 1947, in Winter Park, Fla.

See C. C. Walcutt, *The Romantic Compromise in the Novels of Winston Churchill* (1951).

CHURCHILL, SIR WINSTON LEONARD SPENCER (1874–1965), British statesman, the great national leader during World War II, was born on Nov. 30, 1874, prematurely, at Blenheim palace, Oxfordshire. In his veins ran the blood of both the English-speaking peoples whose unity, in peace and in war, it was to be his constant purpose to foster. Through his father, Lord Randolph Churchill, he was directly descended from the 1st duke of Marlborough, while his mother, Jeanette Jerome, a noted beauty, was the daughter of a self-made New York businessman, Leonard W. Jerome.

After the conventional preparations of governesses and preparatory schools, the young Churchill entered Harrow, where his conspicuous lack of success at his studies seemingly justified his father's decision to enter him on an army career. In 1893 he entered the Royal Military college, Sandhurst, where he applied himself happily and seriously to his work, passing out (graduating) in 1894, 8th in a class of 150. In 1895, the year of his father's tragically early death, Churchill entered the 4th hussars. Initially the only prospect of action was in Cuba, where he spent a couple of months reporting the Cuban War of Independence for the *Daily Graphic* (London). In 1896 his regiment went to India where he saw service as both soldier and journalist with the Malakand field force (1897). Reprinted in *The Story of the Malakand Field Force* (1898), his dispatches attracted such wide attention as to launch him on the career of author which he intermittently pursued throughout his life. In 1898 he wrote *Savrola* (1900), a Ruritanian romance, and got himself attached to Sir Herbert Kitchener's Nile expeditionary force in the same dual role of soldier and correspondent. *The River War* (1899) brilliantly describes the campaign.

POLITICAL CAREER BEFORE 1939

The five years after Sandhurst saw Churchill's interests expand and mature, and in 1899 he resigned his commission and entered politics by fighting a by-election at Oldham as a Conservative. He lost, but found immediate solace in reporting the South African War for the *Morning Post* (London). In South Africa he won fame for his part in rescuing an ambushed armoured train and for his success in escaping from a Boer prison camp. Returning to Britain a popular hero, he won Oldham in the "khaki" election of 1900 and laid the foundations of the private income virtually indispensable to a rising politician by earning £10,000 on lecture tours in Great Britain and the United States.

A self-assurance redeemed from arrogance only by a kind of boyish charm made Churchill from the first a notable house of commons figure, but it was some time before he mastered parliamentary debate. He excelled in the set speech rather than in the impromptu; Lord Balfour said of him that he carried "heavy but not very mobile guns." In matter as in style he modeled himself on his father, as his admirable biography, *Lord Randolph Churchill* (1906; rev. ed., 1952), makes evident, and from the first he wore his Toryism with a difference, advocating a fair peace for the Boers and deploring high military expenditure.

Liberal Minister.—In 1904 Joseph Chamberlain's open advocacy of tariff reform brought Churchill to a parting of the ways. He joined the Liberal party and won renown for the shameless audacity of his attacks on Chamberlain and Arthur Balfour. He acquired a reputation for radicalism and displayed a liberalism which bore evident marks of the influence of two colleagues in particular, John Morley and David Lloyd George. In 1906, rejected by Oldham, he secured a notable victory in Manchester and began his ministerial career as undersecretary of state for the colonies in the new Liberal government. He soon gained credit for his able defense of the policy of conciliation and self-government in South Africa. Under H. H. Asquith in 1908, Churchill was made president of the board of trade. Defeated at Manchester in the ensuing by-election, he stood and won at Dundee. The same year he married Clementine Hozier; it was a marriage that provided a happy background for his turbulent career.

At the board of trade Churchill emerged as a social reformer. He put on the statute book the eight-hour bill for the mines launched by his predecessor, Lloyd George, and went on to check the evils of "sweating" by setting up trade boards, and to reduce unemployment by establishing labour exchanges. He was Lloyd George's ally in devising the provocative budget of 1909 and as president of the Budget league his oratorical broadsides at the house of lords were as lively and devastating as Lloyd George's own. Indeed Churchill, an alleged traitor to his class, earned the lion's share of Tory animosity. In 1910 Churchill became home secretary. He showed a keen interest in prison reform but was soon less happily involved in a wave of industrial unrest. His action in calling in the military to aid the police in the Welsh miners' strike in Tonypandy and in the dock and railway strikes lost him much of his radical following.

The Agadir crisis affected Churchill profoundly, and when Asquith transferred him to the admiralty in Oct. 1911 he went to work with a conviction of the urgent need to bring the navy to a pitch of instant readiness. His first task was the creation of a naval war staff; to assist him in this and other reforms he persuaded Adm. Sir John Fisher to interrupt his retirement and accept the chairmanship of the commission on oil supplies from which came the important decision to make the government a joint owner of the Anglo-Persian Oil company. Meanwhile Churchill's general political activities continued. He moved the second reading of the Irish Home Rule bill in 1912 and was its fierce champion in the bitter disputes that ensued; even so, through his friendship with F. E. Smith (afterward earl of Birkenhead) and Austen Chamberlain he was a principal figure in the abortive, behind-the-scenes negotiations for a coalition.

World War I.—War came as no surprise to Churchill. He had already held a test naval mobilization and had ordered the fleet not to disperse after the naval review in July 1914. In the cabinet he insisted on the need to resist Germany and on Aug. 2, on his own responsibility, ordered the naval mobilization which guaranteed complete readiness when war was declared. The conflict called out all Churchill's energies. In Oct. 1914, when Antwerp was falling, he characteristically rushed in person to organize its defense; resistance was prolonged for only five days but it enabled the Belgian army to escape and the channel ports to be saved. He recalled Fisher to be first sea lord but signs of strain appeared in 1915 when Churchill became an enthusiast for the Dardanelles expedition, of which Fisher disapproved. When the naval attack faltered and was called off by Adm. J. M. de Robeck on the spot, the admiralty war group and Asquith both supported De Robeck rather than Churchill. Churchill came under heavy political attack, largely inspired by Fisher, who resigned in protest against Churchill's conduct of the admiralty. Preoccupied with departmental affairs, he was quite unprepared for the storm that broke about his ears. In the maneuvers that produced the first coalition government Churchill had no part and the Conservatives, with the sole exception of Sir William Maxwell Aitken (soon Lord Beaverbrook), insisted on his being demoted from the admiralty to the duchy of Lancaster. There he was given special responsibility for the Gallipoli campaign without, however, any powers of direction. Reinforcements were too few and too late; the campaign failed; evacuation was ordered in the autumn.

In Nov. 1915 Churchill resigned from the government and returned to soldiering, seeing active service in France as lieutenant colonel of the 6th Royal Scots fusiliers. But though he entered with zest into the perils and excitements of the front line, his heart was still at Westminster. In June 1916 when his battalion was merged he did not seek another command but instead returned to parliament as a private member. He had no part in the intrigue which led to the Lloyd George coalition and it was not until 1917 that the Conservatives would consider his inclusion in the government. In March 1917 the publication of the Dardanelles commission report demonstrated that he was at least no more culpable than his colleagues for the fiasco. Meanwhile his contributions to debate, especially in the secret session on the battle of the Somme, made a notable impression on the house of commons.

In July 1917, despite Tory protests, Lloyd George appointed Churchill minister of munitions. In that post he was able to stimulate production of the tank, the decisive weapon of World War I, development of which he had largely inspired at the admiralty. Paradoxically, it was not until the war was over that Churchill returned to a service department. In Jan. 1919 he became secretary of war, charged with the difficult job of handling demobilization. On one front, the Russian, British troops were still fighting. Vehement in his denunciation of the Bolsheviks, Churchill made no secret of his belief that the Allies should support the White Russian armies. In May 1919 the Allied Supreme council agreed in somewhat ambiguous terms to help the White Russian commander, Adm. A. V. Kolchak, and also to withdraw their own troops. Churchill poured in supplies and organized a volunteer force of 8,000 to provide cover for British withdrawal. Evacuation was effected almost without loss. Churchill was widely attacked for his policy. Unrepentant, he was instrumental in having arms sent to the Poles in 1920 when they invaded the Ukraine; his reward was the bitter hostility of the British Labour movement.

In and Out of Office, 1921–29.—In 1921 Churchill moved to the colonial office, where his principal concern was with the mandated territories in the middle east. For the costly British army in Iraq he substituted the Royal Air Force as an agency of law and order and at a conference in Cairo, with T. E. Lawrence as his main adviser, arranged some settlement of Arab affairs. Churchill played only a minor role in the negotiation of the Irish treaty of 1921, but after its passage he was largely instrumental in preserving peace between the Irish Free State and Ulster and in strengthening the new Irish government. "Tell Winston," said Michael Collins, the Irish leader, "we could never have done anything without him."

When in 1922 the insurgent Turks threatened the peace of Europe, Churchill was foremost in urging a firm stand at Chanac (now Canakkale) on the Dardanelles. But the robust tone of his communiqué announcing the government's intentions, though it checked the Turks, also alarmed opinion in the dominions and at home and undoubtedly contributed to the collapse of the coalition. In the ensuing political debacle Churchill suffered severely; as a firm believer in a centre party as a bulwark against Socialism, he faced his Dundee constituents in 1922 as a "Lloyd George Liberal" who still wanted a coalition. Crippled by a sudden attack of appendicitis, he was not able to appear in public until two days before the election, and then only in a wheel chair. He was defeated by more than 10,000 votes. He thus found himself, as he said, all at once "without an office, without a seat, without a party and without an appendix."

Churchill found some solace in painting and writing. The years 1922–24 saw the completion of a war history which was also an autobiography, *The World Crisis*, six volumes (1923–31). It netted its author £20,000 with which he purchased Chartwell, his country house in Kent. When Stanley Baldwin appealed to the country in 1923 on the tariff issue Churchill offered himself to West Leicester as a free-trade candidate of the reunited Liberal party. He lost by 4,000 votes. In March 1924, deploring Asquith's decision to support the installation of a Labour government, he appeared in the new guise of "Independent Anti-Socialist" in a by-election in the Abbey division of Westminster. Again he was defeated, by the official Conservative candidate, but only by 43 votes, and his campaign was conspicuous for the wide support it won from prominent Conservative leaders. Six months later, at the general election, he was easily returned for the safe Conservative seat of Epping in Essex under the label "Constitutionalist." Baldwin offered him the chancellorship of the exchequer. Surprised, Churchill accepted; dumbfounded, the country interpreted it as a move to reabsorb into the party all the right-of-centre elements of the former coalition.

In the five years that followed, Churchill so far departed from his early radicalism as to appear, repeatedly, as the natural spokesman for the Tory die-hards. At the exchequer he was bored with economic issues and in his handling of financial questions displayed a rigid orthodoxy. His first move was to restore the gold standard, a disastrous measure, unsparingly exposed by John Maynard Keynes in *The Economic Consequences of Mr. Churchill* (1925), from which flowed deflation, unemployment, the miners' strike and so the general strike of 1926. Churchill had no remedy except the introduction in 1926 of an unsuccessful "economy" bill. He regarded the general strike solely as an attempt to hold the nation to ransom and he was foremost in the cabinet in resisting a negotiated settlement and insisting on a militant response. During the strike he published and edited the official newspaper, the *British Gazette*, with its propagandistic and frequently inflammatory tone. Churchill was obsessed in this period by the international menace of Communism, and it seemed in keeping that, while on holiday in Italy, he should praise Benito Mussolini's Fascist movement as having "rendered a service to the whole world."

Churchill's tenure of the exchequer was otherwise notable mainly for his abortive betting tax and for his 1928 schemes for the rerating of agriculture and industry. In 1929, when the government fell, Churchill would have liked a Tory-Liberal reunion, but Baldwin preferred to put Labour in power. Next year an open rift developed between them. On Baldwin's acceptance of the plan for Indian self-government, Churchill resigned from the shadow cabinet to become the leading spirit of the Indian Defence league. He fought the Government of India bill to the bitter end.

Political Wilderness.—Thus when in 1931 Baldwin led his party into Ramsay MacDonald's National government, Churchill's exclusion was a foregone conclusion. Though Churchill remained in the commons, he was exiled from power, largely distrusted by both major parties, thought to lack judgment and stability, regarded as a guerrilla fighter impatient of discipline, a clever man who liked to associate with clever men—Birkenhead, Beaverbrook, Lloyd George—and who despised the necessary humdrum associations and compromises of practical politics. Painful though this decade of political exile was for a man of spirit at the peak of his energies, the enforced withdrawal seems in fact to have had a maturing, strengthening effect upon him.

Churchill did not lack occupation. In addition to a supplementary volume of *The World Crisis*, an engagingly fresh, even ironic piece of autobiography, *My Early Life* (1930), appeared, to be followed two years later by *Thoughts and Adventures* (1932). But the great continuing enterprise of the decade was *Marlborough; His Life and Times*, four volumes (1933–38), begun as a refutation of the criticisms contained in Macaulay's *History*, but becoming, as it unrolled its massive length, an evocation of British leadership in a warring Europe by a Churchill entrusted with his country's destiny.

During the 1930s the growing menace of Hitler's Germany caused a steadily mounting anxiety in Churchill's mind. Before a supine government and a doubting opposition, Churchill, supported only by a small personal following, argued the seriousness of the German threat and the need to prevent the *Luftwaffe* from securing parity with the Royal Air Force. When Baldwin became prime minister in 1935 he persisted in excluding Churchill from office, although in offering him membership of the secret committee on air defense research he did enable him to work on some vital national problems. Churchill's ceaseless advocacy of British rearmament imparted no urgency to Baldwin's administration. They differed over the Abyssinian war, Churchill being initially cool to sanctions lest they drive Mussolini into Hitler's arms, but equally convinced that, once in, Great Britain should have seen the matter through. In the crisis preceding Edward VIII's abdication Churchill vainly sought to plead the king's cause, but struck no responsive national chord.

When Neville Chamberlain succeeded Baldwin the gulf between the Cassandralike Churchill and the Conservative leaders widened. Repeatedly the accuracy of Churchill's information on German rearmament plans and progress was confirmed by events; repeatedly his warnings were ignored. Only in Anthony Eden did Churchill feel any confidence; when Eden resigned as foreign secretary in Feb. 1938, "the dark waters of despair," in Churchill's words, overwhelmed him. As German pressure mounted on Czechoslovakia Churchill urged the government to effect a joint declaration of purpose by Great Britain, France and the U.S.S.R. When the Munich settlement was made Churchill laid bare its implications, insisting that it represented "a total and unmitigated defeat." In March 1939 Churchill and his group pressed for a national government and at last sentiment in the country, recognizing him as the nation's spokesman, began to agitate for his return to office. As long as peace lasted, Chamberlain ignored all such persuasions.

WORLD WAR II

On Sept. 3, 1939, Great Britain declared war on Germany; the same day Chamberlain appointed Churchill first lord of the admiralty. On Sept. 11 Churchill received a congratulatory note from Pres. Franklin D. Roosevelt and replied over the signature "Naval Person"; a memorable correspondence had begun. At once Churchill's restless energy began to be felt throughout the administration as his ministerial colleagues as well as his own department received the first of those pungent minutes which preserved the remotest corners of British wartime government from any hazard of lassitude or stagnancy. However, all his efforts failed to energize the torpid entente during the so-called phony war, before the German seizure of Norway in April 1940. The failure of the Narvik and Trondheim expeditions, dependent as they were on naval support, could not but evoke some memories of the Dardanelles and Gallipoli, so fateful in the previous war for Churchill's reputation. This time, however, the public had a better appreciation of the facts and when the government was censured in May it was at Chamberlain that the critics loosed their shafts.

Prime Minister.—On May 10, 1940, with the news of the German invasion of the Low Countries, Chamberlain resigned. He wanted Lord Halifax to succeed him, but when Halifax declined to serve, Chamberlain advised the king to call Churchill to be prime minister. That very evening Churchill received Labour and Liberal adherence to a coalition government under his premiership. He formed a war cabinet of five, with himself as minister of defense and leader of the house of commons, Chamberlain, Lord Halifax and the Socialists Clement Attlee and Arthur Greenwood. There were other appointments equally momentous, notably Ernest Bevin's as minister of labour. Offers were made to Lloyd George, but he declined them. The result was a real government of national unity in which Churchillian magnanimity secured the services of both old foes and old friends, and the nation closed ranks in face of the common peril. On May 13 Churchill faced the house of commons for the first time as prime minister. He warned members "I have nothing to offer but blood, toil, tears and sweat." He announced his policy: "to wage war, by sea, land, and air, with all our might and with all the strength that God can give us." He proclaimed one aim: "Victory—victory at all costs, victory in spite of all terror; victory, however long and hard the road may be." The commons gave him a unanimous vote of confidence.

War Policy and Aims.—Brought thus to the pinnacle of power through a series of trials which, however taxing, could be seen to constitute a lifelong preparation for the hour of supreme crisis, Churchill exuded confidence and inspired it in all around him. A few simple principles animated his policy throughout the years that followed. Hitler's Germany was the enemy; nothing should distract the entire British people from the task of effecting its defeat. Anyone who would share this burden was an acceptable ally, even a Communist. To save Great Britain from defeat the friendship of the United States was indispensable; for winning the war its active alliance was devoutly to be desired. Strategically, the war must be fought so as not to repeat for Great Britain the catastrophic bloodlettings of World War I. No shibboleths—of orthodox economics, social convention, class privilege and, least of all, military etiquette or tradition—should stand in the way of the nation's total prosecution of the war. The prime minister should delegate freely, but interfere continuously, regarding nothing as too large or too small for his attention. He should query, prod and prime his service chiefs but never go against their collective judgment. He should enjoy sweeping powers but never forget the parliament which conferred them, finding in the house of commons both an instrument of national leadership and a source of personal strength.

All this the nation soon learned for itself and, learning, took Churchill to its heart. On May 22, 1940, parliament within a day passed legislation placing all "persons, their services and their property at the disposal of His Majesty." After the evacuation of Dunkerque, Churchill warned parliament of the risk of invasion, in terms not of possible defeat but of confident defiance:

> . . . we shall not flag or fail. We shall go on to the end . . . whatever the cost may be, we shall fight on the beaches, we shall fight on the landing-grounds, we shall fight in the fields and in the streets, we shall fight in the hills; we shall never surrender, and even if, which I do not for a moment believe, this island or a large part of it were subjugated and starving, then our Empire beyond the seas, armed and guarded by the British Fleet, would carry on the struggle, until, in God's good time, the New World, with all its power and might, steps forth to the rescue and liberation of the Old.

Faced with the swift collapse of France, Churchill made repeated personal visits to the French government in an attempt to keep France in the war, culminating in the celebrated offer of Anglo-French union on June 16, 1940. When all this failed, Churchill warned the house of commons that the battle of Britain was about to begin.

> But if we fail, then the whole world, including the United States, including all that we have known and cared for, will sink into the abyss of a new Dark Age, made more sinister, and perhaps more protracted, by the lights of perverted science. Let us therefore brace ourselves to our duties, and so bear ourselves that, if the British Empire and its Commonwealth last for a thousand years, men will say, "This was their finest hour."

While the battle of Britain raged Churchill was everywhere, at fighter headquarters, inspecting coast defenses or the home guard, solicitously visiting victims of the "blitz," smoking his cigar, giving his "V" sign, broadcasting frank reports to the nation, laced with touches of grim Churchillian humour and splashed with Churchillian rhetoric. Utterly individualistic, he was also the perfect personification of the people he led.

Meanwhile, via transatlantic cable and telephone, the former "Naval Person" had developed a personal relationship with President Roosevelt which soon bore fruit in the exchange of U.S. destroyers for British bases and the concept of lend-lease or mutual aid. The former evoked from Churchill the prophecy that "the English-speaking democracies . . . will have to be somewhat mixed up together," a process "like the Mississippi, it just keeps rolling along." In Aug. 1941 Churchill administered a powerful impetus to this process by his first meeting with the president in Placentia bay, Nfd., the product of which was the Atlantic charter.

The "Grand Alliance."—When Hitler launched his sudden attack on the U.S.S.R., Churchill had a far-reaching decision to make. He announced it in a broadcast on June 22, 1941, in which he refused to "unsay" any word he had previously spoken against Communism but insisted that "the Russian danger is . . . our danger" and promised that "we shall give whatever help we can to Russia and the Russian people." He followed this with a personal message to Stalin, the first of many, for which, as he said, "... I received many rebuffs and only rarely a kind word." Nevertheless, from that time he constantly endeavoured to win Soviet trust and to construct a "grand alliance," incorporating the U.S. and the U.S.S.R. In Sept. 1941 he sent Lord Beaverbrook on a personal mission to the Soviet Union; in Dec. 1941, Anthony Eden. At the same time Mrs. Churchill headed a large and successful charitable appeal for "Aid to Russia."

The Japanese attack on Pearl Harbor (Dec. 1941) altered, in Churchill's eyes, the whole prospect of the war. "I knew," he wrote, "the United States was in the war . . . there was no more doubt about the end." He sailed immediately to Washington and there, as a guest in the White House, hammered out with Roosevelt a set of Anglo-American accords: the pooling of both countries' military and economic resources under a combined chiefs of staff; the establishment of unity of command in the southwestern Pacific (a precedent to be followed in all Anglo-American theatres of war); finally, agreement on the basic strategy that the defeat of Germany should have priority over the defeat of Japan. The grand alliance was now fully in being. Churchill's main concern for the next three and a half years was to foster it.

In this, the respect and affection between him and Roosevelt were of crucial importance. They alone enabled Churchill, in the face of relentless pressure from Stalin and ardent advocacy by the U.S. chiefs of staff, to secure the rejection of the plan for launching a second front in 1942. In Aug. 1942 Churchill himself flew to Moscow to advise Stalin of the Allied decision and to bear the brunt of his displeasure. At home, too, he came under fire in 1942: first in January after the reverses in Malaya and the far east, and later in June when Tobruk fell during his second visit to Washington. In each case the main argument of his critics was that Churchill was trying to do too much, particularly in acting as both prime minister and minister of defense. On neither occasion did his critics muster much support in the commons —3 in the opposition lobby in January and 25 in June. In Feb. 1942 there was some reconstruction of the cabinet, mainly to permit the retirement of Beaverbrook from the ministry of supply and the inclusion of Sir Stafford Cripps as leader of the house of commons. To some degree this reflected a "leftward" movement of the government, and although in November Cripps, at his own request, moved to aircraft production, his place in the cabinet was taken by Herbert Morrison and popular interest in social reform quickened. Indeed the publication of the Beveridge report on social insurance provoked from Churchill, as a Liberal redivivus, a broadcast endorsement in March 1943.

Military Successes and Political Problems.—The Allied landings in north Africa necessitated another meeting between Churchill and Roosevelt, this time in Casablanca in Jan. 1943. There Churchill argued for an early, full-scale attack on "the underbelly of the Axis" but won only a grudging acquiescence from the Americans. There, too, was evolved the "unconditional surrender" formula. Churchill paid the price for his intensive travel (including Tripoli, Turkey and Algeria) with an attack of pneumonia, for which, however, he only allowed the briefest of respites. In May he was in Washington again, arguing against persistent U.S. aversion to the "underbelly" strategy; in August at Quebec, working out the plans for "Overlord," the cross-channel assault. When he learned that the U.S. was planning a large-scale invasion of Burma in 1944 his fear that their joint resources would not be adequate for a successful "Overlord" revived. In Nov. 1943 at Cairo he urged on Roosevelt priority for further Mediterranean offensives, but at Teheran, in the first Big Three meeting (Nov.–Dec. 1943), he failed to retain Roosevelt's adherence to a completely united Anglo-American front. The president, though consulting in private with Stalin, refused to see Churchill alone; for all their friendship there was also an element of rivalry between the two western leaders which Stalin skilfully exploited. On the issue of Allied offensive drives into southern Europe Churchill was outvoted. Throughout the meetings Churchill had not been well and on his way home he came down again with pneumonia. Recovery was rapid but it was mid-Jan. 1944 before his convalescence was complete. By May he was proposing to watch the D-day assaults from a cruiser; only the king's personal plea dissuaded him.

With military successes came political problems. After the Quebec conference in Sept. 1944 Churchill flew to Moscow to try to conciliate the Soviets and the Poles and to obtain an agreed division of spheres of influence in the Balkans. He authorized British armed intervention in Greece to prevent a Communist take over, and at Christmas flew to Athens to effect a settlement. Much of what passed at the Yalta conference of Feb. 1945, including the far east settlement, concerned only Roosevelt and Stalin, and Churchill did not interfere. He fought to save the Poles but was forced to rely on Soviet promises which were soon broken. Warned by this experience, he urged the U.S. to allow the Allied forces to thrust into eastern Europe as far and as fast as possible, but he met with no response from Gen. Dwight D. Eisenhower or Gen. George C. Marshall. Churchill, who saw, as he said, an "iron curtain" descending on Europe, went to Potsdam in a worried mood. But in the final decisions of the conference he had no part; halfway through he had to return to England and tender his resignation to the king.

Electoral Defeat.—As early as 1944, with victory in prospect, party political stirrings and dissensions had begun to reappear, and by May 1945 all parties in the coalition wanted an early election. Churchill wished the coalition to continue until Japan was defeated, but he could not carry his colleagues with him. On June 15, 1945, parliament was dissolved and a lively election campaign followed. In this Churchill was more zestful than judicious, indulging, seemingly at Beaverbrook's suggestion, in extravagant prophecies of the appalling consequences of a Labour victory and identifying himself wholly with the Conservative cause. His campaign tours were a triumphal progress but it was the war leader, not the party leader, that the crowds cheered. They preferred Labour's careful, if sweeping, reform program to Churchill's flamboyance. On July 25 the last serviceman's vote was in and the world, to its astonishment, learned that Britain's architect of victory, although returned for Woodford in Essex, was out of office.

POSTWAR POLITICS

Leader of the Opposition.—For the next six years Churchill led the Conservative opposition, entering with relish into the rough and tumble of parliamentary warfare but confining his criticisms, mainly, to the domestic and imperial policies of Labour. In foreign policy, even when ostensibly criticizing the government, he was in fact often saying for it what it could not say for itself. Thus on March 5, 1946, at Fulton, Mo., he pleaded for Great Britain and the United States to unite as guardians of the peace and set out frankly the menace of Soviet policies. Less successfully, perhaps because less consistently, he emerged as an advocate of European union. At Zürich, Switz., on Sept. 19, 1946, he urged the formation of "a council of Europe," and followed it up by attending the first assembly of the council at Strasbourg in 1949. Churchill was highly critical of what he called Labour's imperial policy of "scuttle" and the granting of independence in India and Burma. He opposed the reduction of the house of lords' veto from two years to one and, of course, the successive measures of nationalization. Meanwhile, in private, he was at work on his great history, *The Second World War*, six volumes (1948–54).

The general election of Feb. 1950 afforded Churchill his long-awaited opportunity to seek again for a personal mandate. He abstained from the extravagances of 1945 and campaigned with his party rather than above it; even so his personality, his zest in combat and his oratory dominated the election. His Edinburgh speech of Feb. 15 in which, contemplating the horrors of an atomic armaments race, he called for "a parley at the summit," echoed round the world, a kind of obverse of the Fulton speech of four years before. The onslaught shook Labour, but left it still in office. What Churchill called "one more heave" was administered in Oct. 1951. Churchill again took the lead in the campaign with vigour. He pressed the government particularly hard on their handling of the Iranian oil-nationalization crisis and in return had to withstand charges of warmongering. The electorate returned the Conservatives with a majority of 26 over Labour and Churchill formed a government in which the more liberal Conservatives predominated, though the Liberal party itself declined Churchill's suggestion of office. Some notable Churchillians were included, among them Lord Cherwell, his former scientific adviser, as paymaster general. Anthony Eden was foreign secretary.

Prime Minister Again.—The domestic labours and battles of his administration were far from Churchill's main concern. Indeed critics sometimes complained of a lack of direction in these areas and of a certain slackness in the reins of government. Undoubtedly Churchill was getting older and reserving more and more of his energies for the great agonizing issues of foreign affairs, peace and war. One of his first acts was to visit Washington (and also Ottawa) in Jan. 1952 to repair what he regarded as the damage done to the "fraternal association" since 1945. The visit helped to check U.S. fears that the British would desert the Korean war, harmonized attitudes toward German rearmament and, distasteful though it was to Churchill, resulted in the acceptance of a U.S. naval commander in chief of the eastern Atlantic.

The year 1953, that of the coronation of Queen Elizabeth II (which drew out all his love of the historic and symbolic), was also in other respects a gratifying one to Churchill, bringing him the Nobel prize for literature and the Order of the Garter. On Eden's illness in April he took on the extra burden of the foreign office and, after Stalin's death (March 1953), planned a Bermuda meeting with Pres. Dwight D. Eisenhower to arrange summit talks. However, a sudden stroke wrecked these plans, although he effected a remarkable recovery by October and in 1954 was able to make another visit to Washington. When a crisis arose over forming a European defense community, Churchill and Eden solved it by the device of the Western European union. Churchill's 80th birthday on Nov. 30 was the occasion of a unique all-party ceremony of tribute and affection in Westminster hall. In 1955, "arming to parley," Churchill authorized work on a British H-bomb while still striving for a summit conference. However, age robbed him of this last triumph; on April 5, 1955, his resignation took place only a few weeks before his chosen successor, Sir Anthony Eden, announced plans for the four-power conference at Geneva.

Retirement and Death.—Although Churchill laid down the burdens of office amid the plaudits of the nation and the world, he remained in the commons to become "father" of the house and, in 1959, to win yet another election. He also published another major work, *A History of the English-Speaking Peoples*, four volumes (1956–58), and headed the trust to build and endow the new Churchill college at Cambridge university. In April 1963 Sir Winston was made an honorary U.S. citizen by act of congress. His death in London on Jan. 24, 1965, was followed by a state funeral, at which almost the whole world paid tribute. He was buried in Bladon Churchyard, Oxfordshire. *See* also references under "Churchill, Sir Winston Leonard Spencer" in the Index.

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CHURCHILL RIVER (MISSINIPI or ENGLISH), a river of northern Saskatchewan and Manitoba, Can., named after former Fort Churchill, which was established at its mouth in 1685. It rises in Methy lake, just east of the Alberta border at an altitude of 1,460 ft., and empties into Hudson bay. Its headwaters and tributaries draw water from eastern Alberta. Flowing for about 1,000 mi. easterly through Saskatchewan and through Manitoba in a northeasterly direction, it has a winding course, consisting of lake expansions, rapids and falls. The largest lakes on its course are Peter Pond lake, Churchill lake, Lac Ile-à-la-Crosse, Snake lake, Granville lake and Southern Indian lake. Among the tributaries of the Churchill, the Montreal river discharges the water of Montreal lake and Lac la Ronge, while the Reindeer river drains Reindeer lake and is one of two outlets of Wollaston lake. Between Frog and Methy portages (480 mi.) Churchill river formed part of the old *voyageur* route from Winnipeg to the Athabasca and Mackenzie rivers. At the mouth of the river on Hudson bay is a railway terminus and transatlantic harbour. The hydroelectric potential along the river has been developed only at Island falls in eastern Saskatchewan. (AN. KR.)

CHURCHING OF WOMEN, the Christian ceremony of thanksgiving on the part of mothers shortly after the birth of their children. Unlike the Mosaic ceremony (Lev. xii), it is not a rite of purification from uncleanness. In ancient times the ceremony was usual but not obligatory in England. In the Greek and Roman Catholic churches it is not obligatory but is encouraged. Custom differs, but the usual date of churching is the 40th day after confinement, in accordance with the biblical date of the presentment of the Virgin Mary and the Child Jesus at the Temple. It was formerly regarded as unlucky for a woman to leave her house after confinement until she went to be churched. It was not unusual for the churching service to be said in private houses.

In the *Rituale Romanum* (*titulus* vii, *c.* 3) the rite is called the Blessing of a Woman after Childbirth. The mother kneels at the church door (more commonly at the altar rail), holding a lighted candle. The priest sprinkles her with holy water and recites Psalm xxiii (xxiv). Then he leads her into the church, saying in Latin: "Enter into the temple of God, Adore the Son of Blessed Mary the Virgin, who has granted thee [the grace of] the birth of a child." The mother "kneels before the altar and prays, thanking God for the gifts given her"; and the priest utters a prayer for her temporal and external happiness and that of her child. Finally, he invokes upon her the abiding "peace and blessing" of the Trinity. The ceremony as performed in the Church of England is very similar, but the blessing and sprinkling with holy water are omitted.

CHURCH MUSIC. Christian church services, like the Jewish temple rites from which they derived, have always used music as a means of enhancing verbal communication and heightening the emotional effect of the liturgy. Words when sung or chanted enjoy greater carrying power both physically, as in the vast interior of an abbey or cathedral, and psychologically, since a melody may call to mind texts otherwise in danger of being forgotten. In chant, there is a division between what is sung by the priest and his assistants and what is sung by the congregation. In the former, elements of virtuosity hinting at professional execution are often found, whereas the latter must be relatively simple. Hence the difference between the chant for a Gradual, Alleluia or Offertory, and that for a hymn, a psalm or a canticle. These characteristics are generally true of the music of Eastern churches as well as of the Roman Catholic Church, whose music underwent continual revision with a view to standardization during the middle ages. Because of the widespread acceptance of Roman chant in its basic form and the prevailing differences in pronunciation and performance between one nation and another, this vast body of music was in fact prone to local deviations until a fairly late date.

Two branches of the Roman Church maintain to this day non-Roman types of chant that were originally connected with the localities concerned: the diocese of Milan, where the Ambrosian chant (*q.v.*) is still sung, and Toledo, the home of Mozarabic chant. Ambrosian chant was formerly held to be of earlier origin than Roman, but it is possible that part of it may be a later and more ornate form of certain common antecedents. Mozarabic chant was evolved by Christian communities in those parts of Spain under Arab domination before the 11th century. Only the plainsong (*q.v.*) of the Roman Church has influenced polyphonic music to any degree, the first written signs of the movement toward polyphony being almost contemporary with the vast extensions made to the chant of Mass and Office by means of trope, sequence (*qq.v.*) and liturgical drama. From the 10th century onward there gradually emerged also a vast number of hymns, of which only a small proportion are still sung, since the mortality rate of texts is greater than that of melodies.

The use of polyphony was from the earliest times restricted to major feasts, often including the patron saint of the cathedral or its dedication festival. Elaborate ecclesiastical rules determined the portions of the Mass or Office that might be set polyphonically, but these were often disregarded because of the sensuous appeal of the new art. Professional singers delighted in solo or duet virtuoso performances, accompanied by the organ or possibly by a group of instruments. By the end of the 12th century, the art of harmony had matured, especially in France where the early polyphonic tropes of Limoges had stimulated the later and more spectacular *organa* of Leonin and Perotin, both associated with the Parisian school of composers. Musicians of other nations studied in Paris, and brought to Spain, Italy, Germany and England some of the secrets of vocal polyphony, which were in due course modified.

The 14th century saw a proliferation of locally produced verbal tropes, and these were set to music by more or less trained practitioners of the art, often in a relatively simple homophonic manner. This may have been part of a trend away from the overdecorative compositions of the former age, although subtlety of an unusual kind persisted in French circles, where the old *ordo* or reiterated note group was expanded to form the new and complex isorhythm, a structural feature sometimes pervading all voice parts. Isorhythmic technique was applied to the motet (*q.v.*) as well as to sections of the Mass and is present in certain movements of the Mass by Guillaume de Machaut, one of several cyclic Masses written during the second half of the 14th century.

Church music during the later middle ages became progressively more direct in its method and expression, the former subtlety of rhythm being replaced by a strong feeling for tonality and a penchant for order and symmetry. Guillaume Dufay (*q.v.*) and his followers in France and the Netherlands, John Dunstable (*q.v.*) and Lionel Power in England, and many anonymous imitators throughout Europe brought a new freshness and force to liturgical music, written for princely chapels and court ceremonies rather than for abbey and cathedral services. Music had reached a pitch of perfection, and it could be properly interpreted only by the finest singers and players. Manuscripts containing liturgical polyphony used in monasteries frequently do not mention composers by name, for the *Opus Dei* was a matter for communal concern and not a vehicle for display. But in spite of attacks on its manner and content, church music survived to play a considerable part in the arts of the Renaissance. The techniques of the Netherlanders Jakob Obrecht and Jean d'Okeghem were taken over by the Henrician composers in England, and to some extent by Josquin Després, who brought clarity and lyricism to an art that had sometimes leaned toward the sombre. Cristóbal de Morales in Spain; his countryman Tomás Luis de Victoria, who lived for many years in Rome; Lassus, the international and prolific writer of church music in all forms; and later in the 16th century William Byrd and Palestrina—all helped to develop Renaissance church music to a high peak of expression.

This same period also saw the growth of liturgical organ music, used originally when and where there was no choir (*q.v.*) capable of singing polyphony. It was the organist who played harmonized settings of plainsong hymns, canticles and Masses, alternating his verses with the plainsong of choir or congregation, and in due course the organ was used to accompany singing as well as to alternate with it. The rise of the verse anthem in England and the baroque motet in Italy (*see* ANTHEM; MOTET) made demands on the organist's ability to improvise accompaniments. In Venice a splendid new concept of church music was due to Andrea and Giovanni Gabrieli and their followers, chief among them Monteverdi and Alessandro Grandi, who made dramatic use of spatial contrasts and opposing forces of strings, wind and voices. Eventually an anthem without an orchestra was unthinkable, and the music of Lully, Alessandro Scarlatti, Purcell and John Blow continued to stress instrumental participation.

Church music in Germany, from the time of the Reformation, had followed a clear-cut path. The chorale (*q.v.*), or hymn melody, was an all-important ingredient of motet and organ solo, and later in the 17th century it pervaded the cantata also. The music of Heinrich Schütz, Franz Tunder and Dietrich Buxtehude possessed a sweetness and gravity that slowly led music into a position of the greatest importance in church services. Bach's morning service at Leipzig went on for several hours, and music was used to accompany practically every part of the service except the sermon. This genuinely liturgical music marked a high point in Protestant church music, and in the history of church music as a whole (*see* HYMN). Anthems, motets and Masses continued to be written in all Christian countries of Europe and the new world, but with few exceptions they were routine works. The great composers of the day wrote music set to liturgical texts but often with the concert hall rather than the church in mind. The resounding Masses of the early Viennese masters, especially Haydn, who cheerfully used trumpets and drums in his scores, remained a local product that other countries and other churches could hardly hope to use.

The Masses of Beethoven, Schubert and Anton Bruckner, the motets of Rossini and Brahms, the organ music of César Franck and Max Reger, the requiems of Verdi and Berlioz—all belong to the extremely varied development of church music during the 19th century. One result of this revival was a series of attempts to write music in 16th-century style, and though much of this was no more than elegant pastiche it did serve to draw composers of church music away from the earlier romantic flamboyance. About the middle of the 20th century some of the more advanced composers contributed music for use in church. Roger Sessions, Benjamin Britten and Olivier Messiaen are among several distinguished composers who led the way in showing new paths for an art form of great antiquity.

See also CANTATA. (D. W. ST.)

CHURCH RATE, the name of a tax formerly levied in each parish in England and Ireland for the benefit of the parish church. Out of this rate were defrayed the expenses of carrying on divine service, repairing the church edifice and paying the salaries of the officials connected with it. The church rate was made by the churchwardens (*see* CHURCHWARDEN) together with the parishioners and was a personal charge imposed on the occupier of land or of a house in the parish. Though it was compulsory, much difficulty was found in collecting it. This was especially so in the case of Nonconformists, who had conscientious objections to supporting the established church; and in Ireland, where the population was preponderantly Roman Catholic, the grievance was specially felt and resented. The agitation against church rates led in 1868 to the passing of the Compulsory Church Rate Abolition act. In the 20th century the parochial church council may collect an entirely voluntary church rate, though it is doubtful whether this is ever done. But parliament has by various statutes imposed upon local authorities the obligation to reimburse parochial church councils out of the general rate for the cost of maintaining churchyards and disused burial grounds. (E. G. Mo.)

CHURCHWARDEN, in the Church of England, one of the lay guardians of a parish church. The office dates from the 14th century, but the original duties of the maintenance of the edifice and goods of the church, with the financial obligations involved, were transferred to the parochial councils in 1921. Duties that remain are the provision of necessaries for divine service, the allocation of seats and the keeping of order during divine service. The duty of the presentment of offenses against ecclesiastical law has lapsed since the 19th century. The wardens are officers of the bishop, though locally elected. By virtue of their office they become leading laymen in the parish and have a pastoral importance greater than their legal duties would suggest.

There are usually two churchwardens in a parish, but sometimes more, elected annually at Easter. They are nearly always chosen from the parochial electoral roll, which includes nonresident worshipers as well as resident members of the Church of England, but some other lay householders are also eligible. Canon law requires that the churchwardens be chosen by joint consent of the minister and parishioners, but if there is no agreement the minister is to choose one and the electors the other. There is a strong custom in many parishes for the second method, which is legally prescribed in new parishes. Each churchwarden subscribes before the ordinary a declaration that he will execute his office faithfully.

In other parts of the Anglican communion churchwardens are generally the parochial lay officers, and discharge much the same duties as do the English officials, but their financial responsibilities are often greater; their duties may be determined by canons or by diocesan regulations. In the Protestant Episcopal Church in the United States, as in some other provinces, the usual practice is for the parishes to elect both churchwardens.

See H. W. Cripps, *A Practical Treatise on the Law Relating to the Church and Clergy*, 8th ed. (1937); C. Drew, *Early Parochial Organisation in England* (1954). (C. R. F.)

CHURCHYARD, THOMAS (*c.* 1520–1604), English writer whose "aptness to take any theam" gave him contemporary fame as the author of occasional verse, pamphlets on his experience at the wars, pageants for the queen, historical and antiquarian works, all reflecting the varied aspects of his crowded career. Born at Shrewsbury, about 1520, he served in the household of Henry Howard, earl of Surrey, and then became a soldier of fortune. For 30 years he fought in almost every campaign in Scotland, Ireland, the Low Countries and France, in the service of the Holy Roman emperor Charles V, in the English force, or, finally, under the prince of Orange. On his return he repaired to court and was employed to devise pageants for the queen's progresses to Bristol in 1574 and Norwich in 1578, but a passage in his *Generall Rehearsall of Warres* (1579, with the running title *Churchyardes Choise*) offended Elizabeth I, and Churchyard fled to Scotland. He was restored to favour about 1584, and in 1593 received a small pension from the queen. He died in London in 1604, and was buried on April 4.

Churchyard's earliest work was *A Myrrour for Man* (about 1552), and he wrote prolifically for the rest of his life. *The Firste Part of Churchyardes Chippes* (1575) was followed by numerous "discourses," occasional verses, broadsides and tracts describing the wars in which he had fought. "The Legend of Shore's Wife," his most popular poem, was contributed to William Baldwin's *Mirror for Magistrates* (1563), and *The Worthiness of Wales* (1587) in prose and verse retains some antiquarian interest. Despite Thomas Nashe's declaration in his *Foure Letters Confuted* that Churchyard's "aged Muse . . . may well be grandmother to our grandiloquentest poets at this present," however, most of his works were forgotten even within his lifetime. His works have never been completely printed and copies are extremely rare.

Other extant works of Churchyard include: *The Thre First Bookes of Ovids De Tristibus, translated into English* (1572); *A Lamentable and Pitifull Description, of the Wofull Warres in Flaunders* (1578); *A Light Bondell of Livly Discourses Called Churchyardes Charge* (1580); and *Churchyards Challenge* (1593). For his biography *see* his "Tragicall Discourse of the Unhappy Man's life," in *Churchyardes Charge* and G. Chalmers (ed.), *Churchyard's Chips Concerning Scotland* (1817). *See* also *Churchyardes Chippes*, ed. by J. P. Collier (1870); *Worthiness of Wales*, pub. by the Spenser society (1876).

Bibliography.—H. W. Adnitt, *Thomas Churchyard 1520–1604* (1884); A. G. Chester, "Notes on the Bibliography of Churchyard," *Modern Language Notes*, vol. lii (1937); and C. S. Lewis, "The Sheepheard's Slumber," *Times Literary Supplement* (May 9, 1952).

CHURCHYARD, a piece of consecrated ground attached to a parochial church and used as a burial place. *See* Cemetery; Death (Legal Aspects).

CHURCH YEAR (Christian Year or Liturgical Year) represents the sanctifying of the seasons for the purposes of Christian worship. Though based on the weekly Lord's day, it is generally thought of in terms of the annual festivals. Its structure is formed by the six festivals of Christmas, Epiphany, Good Friday, Easter, Ascension and Pentecost or Whitsunday (*qq.v.*). The first five of these commemorate events in the earthly life of Jesus Christ; the last commemorates the descent of the Holy Spirit upon the apostles, which began the work of the church.

All holy days, including those kept in honour of the saints as well as those devoted to Christ, form part of the church year, but this article is confined to the development of the church year as a whole, in the Western and Eastern Orthodox churches, without discussing the individual festivals that either supplement the main structure or are inserted independently of it.

Origins.—The details of the early development of the church year are difficult to trace. Information about the celebration of an individual festival sometimes can be gleaned from casual references in the writings of the period, but conclusions about the whole church cannot be drawn from statements which may refer to only one locality. Similarly, evidence provided by surviving early sermons, calendars and lectionaries is almost always local. The early history of the church year thus often has to be pieced together from scattered, often ambiguous, contemporary information about individual festivals.

As the earliest members of the church were Jews as well as Christians, they naturally kept the Jewish liturgical year, with its ordered series of festivals and holy seasons (*see* Jewish Holidays). Of these the chief was the Passover, which Christian Jews undoubtedly associated not only with the deliverance of the Jews from Egypt but also with the deliverance of Jesus from death after his sacrifice on the cross. Similarly, Christian associations must have been present in the minds of Christians celebrating the Jewish festival of Pentecost. These two were the only festivals which the church carried over from its Jewish past. At the beginning of the 3rd century and possibly earlier the Pascha, as the Greeks translated the Hebrew Pesach (Passover), was not merely Easter but a unitive three-day festival in commemoration of both the death and the resurrection of Jesus. At the same period two events, the ascension, and the descent of the Holy Spirit, also were remembered together at Pentecost.

The Pascha and Pentecost were movable feasts, as Good Friday, Easter, Pentecost and Ascension still are; *i.e.*, they are not kept on a fixed day in the calendar but vary in date from year to year depending on the incidence of the first full moon after the vernal equinox (*see* further Calendar; Easter). Christmas and Epiphany, the other two festivals which form the structure of the church year, were not taken over from Judaism and are fixed to certain dates in the calendar. The older of them, Epiphany, on Jan. 6, is first known to have been kept in the 3rd century, though it may be older. It celebrated the manifestation (Gr. *epiphaneia*) of God to the world in Jesus Christ, a revelation shown especially in the nativity and the baptism of Jesus. Epiphany therefore, like the early Pascha and Pentecost, was a unitive festival, commemorating two events.

In the course of the 4th century, after the cessation of persecution and the acceptance of Christianity as a permitted religion in the Roman empire (313), three new festivals, Christmas, Good Friday and Ascension, were introduced. Each of these seems to have taken over the functions of one of the three existing unitive festivals (Epiphany, Pascha and Pentecost). Thus, the nativity was now celebrated at Christmas, the baptism at Epiphany, the passion on Good Friday, the resurrection at Easter, the ascension on Ascension day and the descent of the Holy Spirit at Pentecost.

The evolution of Good Friday and Easter out of the earlier Pascha took place at Jerusalem, probably in the third quarter of the 4th century. In the second quarter of the same century the birth of Christ was already being kept on Dec. 25 in Rome. Before the end of the century its relationship to and distinction from Epiphany had been worked out in the eastern half of the empire, notably in Constantinople, Cappadocia and Antioch. It was probably in this same area that Ascension became detached from Pentecost and kept on its own, 40 days after Easter.

This pattern of development however did not prevail immediately throughout the whole church. Time was required for the new ideas to spread and in some cases to overcome ecclesiastical conservatism. And in fact divergencies remained. Jerusalem apparently did not include the baptism in the early unitive Epiphany, and as late as the 6th century the separate celebration of Christmas had not been firmly established there. In Rome Epiphany, which became a kind of extension of Christmas, celebrated the adoration of the Magi, with the baptism remembered only in the octave, and this usage has become normative in the west. Nevertheless, by the end of the 4th century the basic pattern of the church year had been established, commemorating the major events of Christ's earthly life from the nativity to the ascension, followed by the descent of the Holy Spirit at Pentecost.

Jerusalem.—The impetus for the early development of the church year was provided by Jerusalem, the city where the passion, the crucifixion and the resurrection had actually taken place and with which the earthly presence of Jesus was intimately connected. It is common liturgical practice to read at a festival the biblical lection appropriate to the day concerned, but in Jerusalem alone it is possible throughout Holy Week and the season of Easter to choose lections that are suitable not only to the time but also to the place of the event commemorated. Most of the holy sites in the 4th century were provided with churches or chapels, some being imperial foundations; among these were the great basilica on Golgotha, the sanctuary of the cross also on Golgotha and the Anastasis ("Resurrection"), known in the west as the Holy Sepulchre. Jerusalem now became a centre for pilgrimage, and the local church took full advantage of its liturgical opportunities. Fortunately there is extant, though not complete, an account of Jerusalem practice near the end of the 4th century written by Etheria, a nun who went on pilgrimage from Galicia in western Spain to the holy places in Palestine and elsewhere. A summary of the information she gives about the Holy Week and Easter services in Jerusalem, with their hymns and biblical readings "appropriate to the day and to the place," will show the unique influence of the holy city on the liturgical development of this season, during which the bishop with his congregation followed step by step the movements of Christ as recorded in the Gospels.

On the Saturday evening before Holy Week the people went to Bethany, where in the sanctuary called the Lazarium the gospel, beginning "Six days before the Passover, Jesus came to Bethany" (John xii, 1), was read. In the evening of Palm Sunday the gospel of the triumphal entry into Jerusalem (Matt. xxi, 9) was read at the Mount of Olives, and the people, bearing branches of palms or olives in their hands, escorted the bishop, as Christ had once been escorted, with hymns and anthems, into the city, where a late evening service was then held in the Holy Sepulchre. Similarly on the Monday, Tuesday and Wednesday of Holy Week services with hymns and lections suitable to the day and the place were held. On Wednesday evening the lection, concerning Judas Iscariot's visit to the high priest to arrange the betrayal of Jesus, was accompanied by such loud exclamations of grief that no one present could refrain from tears. On Thursday afternoon all the people received communion at the sanctuary of the cross, and in the evening they went to the church on the Mount of Olives where there was a cave in which Christ had taught his disciples on that day. The night was spent in services and in a procession to Gethsemane, where the lection of the arrest of Jesus was again accompanied by tears and wailing. It began to grow light on Friday morning when the procession reached the sanctuary of the cross. Here the trial narratives from the Gospels were read. On their way home the people prayed at the column where Jesus was scourged, and after a brief rest returned to the sanctuary to adore the relic of the cross preserved there. Then from the sixth to the ninth hour they gathered in the open air outside the sanctuary to hear lections referring to the passion from the Psalms, the Prophets, the Gospels, the Acts and the Epistles, and to take part in appropriate hymns and prayers. The last lection was the account of the death of Jesus in John's Gospel. Then in the Holy Sepulchre the lection about the burial was read, and those who were able kept vigil there all night with hymns and anthems.

The paschal vigil proper—that is, the vigil of the Saturday night—took place in the great church, where the bishop brought those who had just been baptized in the Holy Sepulchre, and the Eucharist was celebrated. The people then moved to the Holy Sepulchre for the Easter lection and a second celebration of the Eucharist. After the evening service in the Holy Sepulchre the people went to the church on Mt. Zion, where the lection was that of the appearance of Jesus to his disciples on Easter day at that very spot (John xx, 19 ff.). Special services were held during Easter week, and on the Sunday after Easter the lection from the same chapter about the incredulity of Thomas was read at Zion.

Clearly this complex structure of Holy Week observances was new to Etheria. Since the middle of the previous century Holy Week had been kept throughout the church as a period of fasting and preparation for Easter, but there is no evidence elsewhere for the historical sense whereby the worshipers actually took part in the events of the eight days preceding the resurrection of Jesus Christ. It is from Jerusalem that the Palm Sunday procession and the Veneration of the Cross on Good Friday were later adopted throughout Christendom. No doubt the enthusiasm of returning pilgrims, such as Etheria, helped to spread the Jerusalem practices to other lands, where they might not have evolved of themselves without the presence of the holy sites.

The Jerusalem church had another contribution to make to the development of the liturgical year; this was in the order and cohesion that came from concentrating attention in an advancing movement from Epiphany to Pentecost. The aim was to make the life of Christ more real and contemporary to the worshipers by leading them realistically from place to place in the sacred narrative at the appropriate times, from the nativity at Bethlehem to the ascension on the Mount of Olives, and to the coming of the Holy Spirit to the disciples in the upper room at Zion. Although some modification was necessitated when these practices were transplanted elsewhere, the structure has remained; the life of Christ is manifested afresh to the church in every liturgical year, unobscured by later additions and complexities that periodically require reform.

Byzantine System.—The Orthodox Eastern Church regards the church year as beginning with Easter, the greatest of the festivals, commemorating the victory of Christ over sin and death. Lent, the period of fasting and prayer in preparation for Easter, thus comes at the end of the year, which concludes with the Easter vigil. Christmas and Epiphany, which always fall on Dec. 25 and Jan. 6 respectively, do not form part of this series; they are found in the Menaion, which contains the readings for each fixed holy day from Sept. 1 (the beginning of the Byzantine civil year) to Aug. 31, and corresponds to the western Proper of the Saints (*see* below).

The cycle of the Byzantine movable feasts depending on Easter was fixed by the 9th century. Those Sundays that have no special name are called after the subject of their gospel lection. The series is as follows:

Easter
Sunday of Thomas
Sunday of the myrrh-bearing woman
Sunday of the paralytic
Sunday of the Samaritan woman
Sunday of the blind man
Ascension day on the following Thursday
Sunday of the 1st ecumenical council
Pentecost
Trinity (kept the day after Pentecost)
A series of 17 Sundays of Matthew and 14 Sundays of Luke
Sunday of the publican and the Pharisee
Sunday of the prodigal son
Sunday of abstention from meat (*apocreo*)
Sunday of eating cheese (*tyrophagou*)
First to fifth Sundays in Lent (which begins the day after *tyrophagou*)
Palm Sunday
Holy Week, ending with Good Friday, Holy Saturday and the Easter vigil.

Though this series in its present form had not been fully developed by the late 4th century, the principle of it, whereby Easter stood at the beginning, was already present then. In this church year the conception of a sacred cycle moving from the nativity to the ascension and Pentecost is overshadowed by the idea that Easter, the greatest festival, is in a different category from Christmas and Epiphany. This conception of the church year is probably more primitive than that which arose in Jerusalem, for Christmas and Epiphany were introduced into the cycle of feasts later than Easter and Pentecost, which had Jewish antecedents.

It is not easy to trace this church year beginning with Easter back to its original area. It seems however that it was shared by Antioch and Constantinople in the 4th century. The so-called Apostolic Constitutions, which reflect the usage of the Antiochene church at the end of that century, include instructions about the keeping of fasts and festivals; the order in which they are mentioned is: Holy Week, Easter, Ascension, Pentecost, Christmas, Epiphany. Here, although Christmas and Epiphany are put in the same series as Easter, and Easter is not right at the beginning, the structure obviously is more similar to the Byzantine system than to the Jerusalem one. A further point of similarity between the Byzantine and Antiochene year is the prominence given to Saturday (*Sabbaton*), the Jewish Sabbath, which remains a liturgical day in the Orthodox Eastern calendar; Saturday, like Sunday, has its special lections, and fasting is forbidden on Saturday as on Sunday.

Western System.—It was the Jerusalem system, with its cycle from the Nativity to Pentecost, that was taken over by the Western Church and later underwent modifications and additions. In the Roman missal the Proper of the Time (*i.e.*, the temporal cycle) runs as follows:

Four Sundays in Advent, the first of which is the Sunday nearer Nov. 30
Christmas day (Dec. 25)
St. Stephen's day (Dec. 26)
St. John the apostle's day (Dec. 27)
Holy Innocents' day (Dec. 28)
Sunday within the octave of Christmas
St. Thomas à Becket's day (Dec. 29)
St. Silvester's day (Dec. 31)
Octave of Christmas (Jan. 1)
Sunday before Epiphany
Epiphany (Jan. 6)
Six Sundays after Epiphany
Septuagesima Sunday
Sexagesima Sunday
Quinquagesima Sunday
Ash Wednesday (the first day of Lent, three days after Quinquagesima)
Six Sundays in Lent, the fifth of which is Passion Sunday, inaugurating Passiontide, and the sixth Palm Sunday
Holy Week
Easter day
Five Sundays after Easter
Ascension day on the following Thursday
Sunday after Ascension day
Pentecost
Twenty-four Sundays after Pentecost, of which the first is Trinity Sunday followed by Corpus Christi on the next Thursday.

(If Easter is early there are fewer Sundays after Epiphany, if Easter is late there are fewer Sundays after Pentecost.)

The developments to note are the addition of the two seasons of Advent and Septuagesima and the inclusion of the saints' days after Christmas, all other saints' days being in the Proper of the Saints.

Advent is a penitential season of preparation for the first coming of Christ in humility at Christmas and for his second coming in glory at the end of the world. It was an early innovation introduced perhaps as early as the 5th century in Gaul. At first, however, Advent was placed at the end of the calendar, not at the beginning where it now stands. There is a parallel here with the Byzantine liturgical conservatism whereby Christmas and Epiphany, though they find a place in the system, do not dislodge Easter from its position at the head of the year, and the preparatory season of Lent is calendrically divorced from Easter to which it is directed. In the west, however, logic prevailed, and the season of Advent was transferred in about the 7th or 8th century to its present position where it begins the church year. It may be pointed out that the Proper of the Saints begins at the same time, with the vigil of St. Andrew on Nov. 29, whereas in the Byzantine system, as mentioned above, it starts in September quite separately from the movable year's commencement at Easter.

The season of Septuagesima—that is, the two and a half weeks before Lent which include the Sundays called Septuagesima, Sexagesima and Quinquagesima—is a kind of anticipation of Lent and forms a parallel to the two weeks running from the Monday before *apocreo* to the Sunday of *tyrophagou* in the Byzantine system. This season was introduced in the 6th century by Pope Gregory I, who was familiar with Byzantine custom. The names of the Sundays—Septuagesima ("70th"), Sexagesima ("60th") and Quinquagesima ("50th")—are only approximations; the next Sunday, Quadragesima ("40th"), from which these three are numbered in reverse order, really does fall on the 40th day (not 40th Sunday) before Good Friday.

The inclusion of five saints' days (during the octave of Christmas) in the Proper of the Time, not in the Proper of the Saints, is a curious feature. Three of these are saints of the early church who were connected closely with Christ: St. Stephen was the first martyr, St. John was "the disciple whom Jesus loved," and the Holy Innocents suffered for Christ as involuntary martyrs shortly after his birth. The first two of these feast days have been celebrated since at least the 4th century and the third since the 5th century. St. Thomas à Becket was martyred on Dec. 29, 1170, and there is no clear reason why his name should figure in the Proper of the Time instead of in the Proper of the Saints. St. Silvester, remembered on the last day of the civil year, was pope during the rule of Constantine I, who gave peace to the church and founded many churches in Jerusalem, Rome and Constantinople.

Proper of the Saints (Western Church).—The other saints' days form a separate list, which includes also the festivals of Christ unconnected with the main cycle of the church year; for instance, the Transfiguration (Aug. 6) and the Exaltation of the Cross (Sept. 14). Local commemoration at the tomb of a martyr on the day of his martyrdom, practised since the second half of the 2nd century, was extended to other places as the fame of the martyr grew, and after persecution ceased holy persons who had not been martyred were similarly remembered annually on the appropriate day (*see* SAINT). Saints' days, being mostly unconnected with each other, do not form a cycle which can be discussed as a whole. Three, however, depend on the date of Christmas: the Annunciation (*q.v.*) of the Blessed Virgin Mary (March 25, nine months before Christmas), the nativity of John the Baptist (June 24, six months before Christmas; *cf.* Luke i, 26) and the Purification of the Blessed Virgin Mary (Feb. 2, 40 days after Christmas; *see* CANDLEMAS). The remaining festivals of the Blessed Virgin, including the Assumption (*q.v.;* Aug. 15), are not linked chronologically with any event in the life of Christ.

The increase in number and importance of saints' days at various times has threatened to obscure the cycle of the church year, and prunings periodically have had to be made. Saints' days are transferred if in any year they fall on the same day as a major festival; the Annunciation, for instance, is transferred if it occurs in Holy Week or on Easter day. There is indeed a tendency to avoid placing a saint's day in the period of penitence covered by Lent, which accounts for the relatively fewer feast days in February, March and April.

Reformed Churches.—None of those churches which underwent the Reformation retained the church year in its full traditional form.

Lutherans preserved the main structure, though with minor variations in different countries, but the Proper of the Saints was greatly curtailed. Their chief innovations are the transference of the Transfiguration from Aug. 6 to the last Sunday after Epiphany and the eschatological interpretation given to the last three of the Sundays after Trinity (these Sundays, as in Anglican churches, being named after Trinity instead of after Pentecost). Each Sunday and holy day has an introit, collect, epistle, gradual and gospel.

In the Church of England the Proper of the Seasons was retained, with a collect, epistle and gospel for each Sunday and for the following holy days: Christmas, the Circumcision, Epiphany, Ash Wednesday, each day in Holy Week, Easter Monday and Tuesday, Ascension day, Whit-Monday and Whit-Tuesday. The calendar in the Book of Common Prayer contains about 80 saints' days, of which only those commemorating New Testament saints or events in their lives have special collects, epistles and gospels. Some of the prayer books used by other churches in the Anglican communion have increased the number of saints' days and propers for them.

Presbyterians were more radical in their attitude. They tended to retain only the major festivals, though in Scotland even these were rejected. There has been a tendency however in the 20th century to reinstate some of the rejected festivals and holy seasons.

Some of the radical decisions evoked by the Puritan movement and the ensuing conflicts in Great Britain did not directly affect the Reformed churches on the continent. These retained the great festivals of the church year and also seasons such as Lent. Special days such as Ascension and All Saints also continued to be observed. The system of Sunday epistles and gospels, conforming to the seasons of the year, was not abolished though it fell into disuse in some of these churches. It enjoyed a general revival in the 20th century.

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CHURL. The word ceorl in Old English law denoted the free peasant who formed the basis of Anglo-Saxon society. Originally he paid various dues directly to the king, owed suit of court and in time of war was required to serve in the fyrd, the national levy. But ceorls had insufficient resources easily to survive misfortune, and although a document of the early 11th century shows that some ceorls prospered and even attained the rank of thegn, the class as a whole suffered a steady depression. As early as the 7th century ceorls were paying to lords dues originally owed direct to the king; if provided with a homestead and stock as well as with land, they also gave labour services. By the reign of King Alfred (871–899) a ceorl was equated with a Danish freedman. Ceorls retained their wergild of 200*s.* (one-sixth that of a thegn) until the system became obsolescent by the early 12th century, and their obligation to attend local courts proclaimed them freemen. But after the Norman conquest disaster or intermarriage brought many into the great class of unfree villeins. The word churl, perhaps because it long existed only in a spoken vernacular and denoted a depressed and subject peasant, had acquired its pejorative sense by the 14th century and was so used by Chaucer.

See also Serfdom; Villeinage.

CHURN: *see* Dairy Industry; Butter.

CHURRIGUERA, JOSÉ (1665–1725), Spanish architect, called the Spanish Michelangelo because he combined his art with sculpture and painting, was born on March 21, 1665, at Madrid. Under Philip V, he was the foremost Spanish architect, designing the Royal Academy of Fine Arts, church façades and altars in Madrid, and the entire town of Nuevo Baztán (1709–13). His altars show baroque genius for grandiose, theatrical effects, both sculptural and pictorial. They are complex, rhythmically harmonious in vibration and movement and profusely decorated with statues. His altar at San Esteban, Salamanca (1693–96), over 90 ft. high, has six huge twisted and garlanded columns, set at different depths in a concave-convex plan. He died on March 2, 1725, at Madrid.

The name churrigueresque is given to the phase of Spanish baroque architecture lasting from about 1650 to 1740 and characterized by the use of the spiral column and lavish decoration. However, the style was not created by Churriguera, and he was conservative in his use of it.

See A. García y Bellido, "Estudios del barroco español," in *Archivo español de arte y arqueologia,* vol. v, pp. 21–86 (1929).

CHURUBUSCO, a suburb of Mexico City on the river of the same name. Pop. (1950) 1,392. It contains a massive stone convent constructed by the Franciscans in 1768 on the site of an Aztec temple. It was there that Mexican forces under Gen. A. L. de Santa Anna and United States forces under Gen. Winfield Scott met in a brisk battle on Aug. 20, 1847, following the brief skirmish known as the battle of Contreras (*q.v.*). Pressing on after the victory at Contreras, Gen. William J. Worth's division suddenly encountered stout resistance at the bridgehead and convent at Churubusco. A spirited assault by the U.S. forces overcame the stubborn Mexican resistance after a three-hour carnage which left hundreds on both sides dead, wounded or prisoners. Among the prisoners taken by the Americans were members of the San Patricio battalion, U.S. deserters fighting for Mexico, many of whom were subsequently hanged by General Scott. The following day, Aug. 21, 1847, Santa Anna and Scott opened peace negotiations which soon broke down.

Churubusco was in precolonial times a town of considerable importance, called Huitzilipocho by the Aztecs. (R. B. McCk.)

CHUSAN: *see* Chou-shan-ch'un-tao.

CHUVASH AUTONOMOUS SOVIET SOCIALIST REPUBLIC, in the Russian Soviet Federated Socialist Republic, U.S.S.R., lies on the right bank of the middle Volga, between Gorki and Kazan. Pop. (1959) 1,097,859. Area 7,066 sq.mi. It is drained by tributaries of the Volga, notably the Sura in the west of the republic, the Bolshoi Tsivil and Maly Tsivil in the centre and the Kubnya in the east. Most of the area consists of the so-called Chuvash plateau—low, gently rolling hills, much cut up by ravines—which forms the extreme northern end of the Volga upland and drops gradually to the terraces and flood plain of the Volga. In the west, along the Sura, are extensive sands of old alluvial origin. The boundary between the forest and forest-steppe natural zones crosses the republic. The Sura sands are densely forested with pine. In the north are areas of mixed and deciduous forests, with oak, on gray forest earths. Much of the original forest cover has been removed by overcutting. In the east and southeast are patches of black earth soils, almost all of which are under the plow. Along the Volga and Sura are flood plain meadows. A small part of the republic lies across the Volga on the left bank opposite Cheboksary. The climate is continental, with an annual range of about 60° F. and long, cold winters. Rainfall is low: 15–18 in. a year.

The republic was first formed as an autonomous *oblast* in 1920, becoming an autonomous republic in April 1925 and from 1929 to 1936 formed part of Gorki *krai.* In 1959 about 75% of the population were Chuvash, the remainder being mostly Russians, Mari (Cheremis), Mordvins and Tatars. The Chuvash are a Turkic people, related to the Bulgars who originally inhabited the middle Volga area. In 1959 the Chuvash numbered 1,470,000 in the U.S.S.R. as a whole. They were already a settled, agricultural people when their domain was overrun by the Russians in the 16th century and there was never any considerable Russian colonization of the area. Most of the present Russian population is concentrated in the towns. Urban population in 1959 numbered 267,789, or 24% of the total. The administrative centre, Cheboksary (*q.v.*) has 83,000 inhabitants. Of the other towns the most important are Alatyr, Kanash and Shumerlya. Over-all population density—155 per square mile—is well above the average; even counting rural population alone, the density is 117 per square mile. As such a density indicates, the republic is predominantly agricultural, almost half of its area being arable land. Nearly two-thirds of the sown area is under grain crops, with rye easily the most important, followed by oats and spring wheat. Hemp, potatoes and vegetables, especially peas, are important and small quantities of flax and *markhorka* tobacco are grown. Along the Volga, fruit-growing is important. Animal husbandry, including cattle, pigs and sheep, is well developed and the acreage under maize (corn) and other fodder crops has been greatly increased. The numbers of livestock per 100 ac. of agricultural land are far above the average for the central regions of European Russia. Dairy produce and meat are supplied to the large urban areas of the Moscow district and Gorki. Poultry and honey are other agricultural products of the republic.

Industry, which scarcely existed before the Revolution, has shown considerable development, particularly since World War II. The timber industry is one of the most important, and sawmilling and timber-processing are carried on in most of the towns. Cheboksary, which is also a river port, produces textiles, alcohol and leather goods, and is the site of a Chuvash regional museum. Alatyr (pop. [1956 est.] 34,700), a centre of the grain-growing area, has locomotive and automobile works. Shumerlya, which developed during the 1930s, produces furniture, veneers, flooring and tannin from the local oaks. Mariinski Posad (with shipbuilding) and Kozlovka are the chief timber centres on the Volga. Prefabricated houses, sleepers (railroad ties), pit-props and matchwood are produced. Food-processing and textile and leather manufacture are widespread. A chemical industry has developed at Vurnary, based on wood chemicals and local supplies of phosphorites from Buinsk. Shale oil from Buinsk and Ibresi and peat from the Volga flood plain are the only local fuels, but a large hydroelectric plant was constructed after 1960 on the Volga above Cheboksary. Cheboksary and Alatyr have thermal power stations.

Communications in the Chuvash republic are good. In addition to the Volga, the main Moscow–Kazan–Trans-Siberian railway traverses the area, with branches from Kanash north to Cheboksary and south to Saransk and Penza. Motor roads link Cheboksary to Gorki, Kazan and Ulyanovsk, and the republic has a well-developed road network. (R. A. F.)

CHŪZENJI-KO, Japanese lake within Nikkō National park, Tochigi prefecture, north central Honshū, at 1,271 m. (4,170 ft.) elevation, is a noted resort, famous for its shrines. Volcanic Mt. Nantai, 2,484 m. (8,150 ft.), towers above its northern shore, with lesser elevations around most of its irregular coast line (23.3 kms. [14.4 mi.]). Fed by small rivers in the west and northwest, Chūzenji-ko is deepest in the east, about 170 m. (558 ft.). Its waters occupy a structural depression that has been deepened further by a lava obstruction at its eastern end, from which emerges the Daiya river, its sole outlet. The splendid scenery, temples and hot springs, boating and fishing attract scores of tourists in summer and autumn. (J. D. Ee.)

CIALDINI, ENRICO, Duca di Gaeta (1813–1892), Italian soldier and statesman who made his name in the wars of the Risorgimento, was born at Castelvetro in Modena on Aug. 10, 1813, the son of a civil engineer. Having taken part in the insurrection in Modena in 1831, he fled to France and then went to Spain to fight the Carlists. Returning to Italy in 1848, he commanded a regiment at the battle of Novara. He commanded one of the Sardinian brigades in the Crimean War. In the Italian war of 1859 he organized the alpine brigade and led the 4th division at Palestro; in that of 1860–61 he led the Sardinians into the papal states, won the battle of Castelfidardo, took Ancona, conducted the successful siege of Gaeta (for which he received his ducal title) and reduced Messina and the last Bourbon resistance. Sent to oppose the Garibaldian expedition of 1862, he won the battle of Aspromonte. King's lieutenant at Naples (1862–66) and a senator from 1864, he resumed command of an army corps in the Italo-Austrian war of 1866, but dissensions between him and Gen. A. La Marmora led to the defeat at Custozza. In Oct. 1867 and in Dec. 1869 he was invited to form a cabinet, but failed. In Aug. 1870 he advocated Italian intervention on the French side in the Franco-German War. From 1876 to 1882 he was Italian ambassador in Paris, but had to resign when the Italian foreign minister P. S. Mancini published a dispatch of his complaining that the former French premier W. H. Waddington had treated him with arrogance. Cialdini died at Leghorn on Sept. 8, 1892.

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CIAMICIAN, GIACOMO LUIGI (1857–1922), Italian chemist whose most important researches were in organic chemistry. He was born at Trieste on Aug. 22, 1857. Educated at Trieste and Vienna, he took his doctorate in 1880 at the University of Giessen. He became assistant to Stanislao Cannizzaro (*q.v.*) and later reader in the Institute of General Chemistry of the University of Rome. In 1887 he was appointed professor of general chemistry in the University of Padua. In 1889 he accepted the chair of chemistry at the University of Bologna and retained this post until his death on Jan. 2, 1922. From 1910 to 1922 he was a member of the Italian senate, concerning himself mainly with education and the chemical industry.

Ciamician stressed the application of organic to biological chemistry. An investigation of the compounds in animal tar led him early in his career to important researches on pyrrole. A monograph, *Il Pirralo e i suoi derivati* (1888), gained the royal prize of the Accademia dei Lincei. Ciamician was also a pioneer in the chemistry of vegetable products. At first he worked on organic compounds of vegetable origin and later became interested in the chemistry of the substances in the living plant and their biological significance. The essential oil of celery was the subject of an important early investigation; later he inoculated plants and seeds with alkaloids and their constituents. His researches on the chemical action of light are noteworthy. Ciamician's later researches were on the theory of electrolytic dissociation, on solvates, on the nature of chemical affinity and on the valency of atoms. He published about 170 papers and delivered lectures before the German and French chemical societies and the International Congress of Applied Chemistry at New York city in 1912. A street in Trieste was named for him.

CIANO, GALEAZZO, Conte di Cortellazzo (1903–1944), Italian Fascist statesman, foreign minister from 1936 to 1943, in the Fascist government of his father-in-law Benito Mussolini, was born at Leghorn on March 18, 1903. His father, the conte Costanzo Ciano, distinguished himself in the Italian submarine attack on Pola in World War I, and the young Galeazzo took part with him in the Fascist march on Rome in 1922.

After studying law at Rome university and working briefly in journalism, Ciano entered the Italian diplomatic service and held posts in Rio de Janeiro, in Peking, at the Vatican, and, as consul general, at Shanghai. In 1930 he married Mussolini's eldest child, Edda. He became minister of propaganda in 1934. An enthusiastic aviator, he led a bomber squadron in the war against Ethiopia. On his return to Rome he was made foreign minister (June 1936).

Ciano vigorously advocated Italian intervention in the Spanish Civil War, the invasion of Albania and the Axis pact with Nazi Germany. Subsequently, however, his enthusiasm for Germany waned, and his diary records the humiliation that he felt at the Germans' arrogance toward their ally. Even so, he swayed the vacillating Mussolini into entering World War II on the German side after the collapse of France in June 1940.

After successive Axis defeats in 1942 Ciano joined those members of the Fascist party who wanted a separate peace with the Allies. Mussolini, suspicious of his loyalty, relieved him of his post as foreign minister in Feb. 1943. Ciano was then appointed ambassador to the Vatican. During the historic session of the Fascist grand council on July 24, 1943, he was among those who forced Mussolini's resignation. Having disappeared from Rome while Marshal Pietro Badoglio's government was preparing charges of peculation against him (Ciano's private fortune was immense), he was captured in hiding in northern Italy by partisans of his father-in-law and the Germans in Oct. 1943. Brought to trial on a charge of treason he was found guilty and executed at Verona on Jan. 11, 1944.

Ciano's diaries from 1939 to 1943 were published in English in 1946. His *L'Europa verso la catastrofe* (a collection of diplomatic papers) also appeared in English in 1948.

CIBBER, CAIUS GABRIEL (1630–1700), Danish sculptor and the father of the actor and dramatist Colley Cibber (*q.v.*), was born at Flensburg, the son of the king's cabinetmaker. He was sent to Italy at the royal expense, but before 1660 he was in England working as foreman to John Stone (1620–67). His earliest important work was the large relief showing "Charles II Succouring the City of London After the Great Fire" on the monument near London bridge (1674). A few years later he made the famous statues of "Raving Madness" and "Melancholy Madness" for the gate of Bedlam hospital (now Guildhall museum) and in 1677 a fine tomb at Withyham, Sussex, for the Sackville family.

Between 1688 and 1691 he was working at Chatsworth, Derbyshire, where he made the figures of Apollo and Pallas on the staircase, those of Faith and Justice in the chapel and much garden sculpture. He was employed by Sir Christopher Wren to carve the pediment on the east park front of Hampton court and some of the architectural detail at St. Paul's cathedral, though he died in London before his work on the latter was completed. His work, which shows the influence of Holland as well as of Italy, is competent though somewhat provincial. All of his known works are in England, and his reputation in his own day was good. (M. D. Wy.)

CIBBER, COLLEY (1671–1757), English actor, dramatist and poet laureate, born in London on Nov. 6, 1671, was the son of the Danish sculptor Caius Gabriel Cibber (*q.v.*) and Jane Colley, who claimed descent from William of Wykeham, founder of Winchester college. Cibber attended the free school at Grantham, Lincolnshire, where he distinguished himself as a fluent writer, but he failed of election to Winchester college in spite of his claim to be of "founder's kin." In 1688 he "met the revolution" by serving with a company of volunteers raised by the duke of Devonshire to aid William of Orange. He attached himself as an actor to Thomas Betterton's (*q.v.*) company at Drury Lane in 1690.

Marrying in 1693, and finding his earnings as a minor actor inadequate for the support of a growing family, Cibber wrote a play for the purpose of providing himself with a satisfactory role. This play, *Love's Lost Shift* (1696), became a landmark in the history of the theatre; it is generally considered the first sentimental comedy, a form of drama that dominated the stage until it was challenged nearly a century later by Goldsmith and Sheridan. The play's immediate effect, however, was to establish Cibber as an important playwright and as one of the leading actors in London. "For a young fellow," declared Lord Dorset, "to show himself such an actor and such a writer in one day was something extraordinary." The dramatist William Congreve, with perhaps less enthusiasm, also acknowledged the play's success; and Sir John Vanbrugh honoured it with a sequel, *The Relapse* (1696), in which the character Sir Novelty Fashion reappears as Lord Foppington. Two years later Cibber was included among the dramatists castigated in Jeremy Collier's *True View of the Immorality and Profaneness of the English Stage*. In 1700 Cibber produced his famous adaptation of *Richard III*, which, though it was frequently condemned as a travesty on Shakespeare, held the stage as the preferred acting version until the original was restored by Henry Irving in 1871. In 1702 Cibber produced *She Would and She Would Not* and in 1704 *The Careless Husband*, designed especially for Anne Oldfield.

At this time Cibber entered upon a series of complex intrigues in order to attain a position in management. In 1706 he left Drury Lane for the Haymarket, where he produced *The Double Gallant* (1707), returning to Drury Lane in 1708 as a shareholder. By 1710, with Robert Wilks and Thomas Doggett, he acquired control of the patent. Thus was formed the famous "triumvirate" of actor-managers, under which (Doggett was later replaced by Barton Booth) the theatre prospered as it never had before. After the death of Queen Anne and the rise of Whig dominance, Sir Richard Steele, then prominent in Whig politics, joined the managers in obtaining a new patent. Cibber demonstrated his gratitude to the Whigs by producing the *Nonjuror* (1717), freely adapted from Molière's *Tartuffe*. This play provoked the animosity of all anti-Whig factions, but it brought Cibber a generous gift from the king and doubtlessly led later to his appointment as poet laureate. In 1728 he completed *The Provoked Husband*, a play left unfinished by Vanbrugh at his death in 1726. Mrs. Oldfield, Cibber's leading actress, died in 1730, the year he became laureate, her loss being followed in 1733 by that of Wilks, his first partner in management. The next year Cibber sold his share of the patent and announced his retirement, but he did not make his final appearance until, at the age of 74, he played in his own adaptation of Shakespeare's *King John* (Feb. 15, 1745).

In 1740 he published *The Apology for the Life of Colley Cibber, Comedian*, upon which a contemporary wit remarked that Cibber had "lived his life in order to apologize for it." But Horace Walpole pronounced it "worthy of immortality," and Swift sat up all night to read it. Apart from its general interest, it contains the best account of the theatre in Cibber's day and an excellent study of the art of acting as it was practised by his great contemporaries.

In the edition of 1743 Cibber was substituted for Lewis Theobald as the hero of Pope's *Dunciad*, an act of meaningless spleen on the part of Pope that did his own poem great harm and resulted in the undeserved depreciation of Cibber's reputation. Cibber had been subject to attack throughout his career, especially in the political journals and pamphlets of the day. Samuel Johnson was contemptuous of him, as he was of all actors, and expressed his contempt with characteristic bluntness. Henry Fielding, anti-Whig always, attacked Cibber frequently, especially in *Joseph Andrews* and in the *Historical Register for 1736*, a comedy in which Cibber appears as Ground Ivy. But these and other attacks Cibber always met with irritating indifference. "The only way I knew how to stop authors of this stamp," he explained, "was to become insignificant." He had adopted the same attitude toward Pope's stinging attack in his *Epistle to Dr. Arbuthnot* (1735). Pope's antagonism began as early as 1717, following the production of the *Nonjuror*, though Cibber explains it as having originated in a trivial altercation over a farce, *Three Hours After Marriage* (also 1717), written by John Gay with the co-operation of Pope and Arbuthnot. Whatever the cause, Cibber did not break his silence until he learned that Pope was revising the *Dunciad* and was elevating him to the place of doubtful eminence as the hero of the satire. To this he responded with *A Letter From Mr. Cibber to Mr. Pope, inquiring into the motives that might induce him in his satirical works to be so frequently fond of Mr. Cibber's name* (1742). The next year he wrote *A Second Letter. . . .* When the promised revision appeared, with an insulting preface by Warburton, Cibber published *Another Occasional Letter. . . .* (1744). Pope's death following the publication of the third letter brought the controversy to an end. Altogether Cibber had the better of the argument. He scored heavily against the splenetic but sensitive poet, causing him, according to Johnson, to writhe in anguish. Also, by the substitution of the sprightly comedian for the pedantic Theobald, much of the satire lost its point.

Cibber's faults were many, but they certainly did not include dullness. He had written and adapted nearly 30 plays, some of them very good. He was a great theatrical manager. "He was," says Hazlitt, "a man of wit and pleasantry in conversation, a diverting mimic, an excellent actor, an admirable critic, and one of the best comic writers of his age."

Cibber died on Dec. 11, 1757, and was buried in the old Danish church, east London.

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CIBBER, THEOPHILUS (1703–1758), English actor and playwright, son of Colley Cibber (*q.v.*), was born on Nov. 26, 1703. His first appearance on the stage was in 1721. In 1731 and 1732 he acted for his father as manager of Drury Lane, serving also as actor-manager of the Haymarket in 1734. He was a capable actor, his best role being Pistol in *Henry IV*, but his plays are worthless. There is perhaps no contemporary reference to Cibber that does not set him down as a scoundrel. He traded dishonestly on his father's name, engaged in blackmail, in shameless plagiarism and in scandalous lawsuits to obtain money. He died in a shipwreck while on his way to play in Dublin at the Theatre Royal. (M. Rs.)

CIBORIUM, in ecclesiastical usage, is (1) a chalice-shaped, covered, metal cup in which the sacramental bread for the Eucharist is reserved; and (2) a baldachin (*q.v.*).

CICADA, the common name for medium- to large-sized homopterous insects of the family Cicadidae, order Hemiptera, having two pair of membranous wings, prominent compound eyes, three simple eyes (ocelli) and fore femora spined below. Male cicadas produce very loud noises by vibrating paired dorso-lateral membranes (timbals) located at the base of the abdomen. In some species the "song" is musical, but most North American cicadas produce rhythmical ticks, buzzes or whines. Paired hearing organs (tympana) are located ventrally at the base of the abdomen in both males and females, and both sexes possess large tracheal air sacs. Females are not known to "sing." Eggs are usually laid in woody tissues, and hatching nymphs burrow into the ground, where they feed on the juices sucked from roots of perennial plants. Nymphs usually undergo five molts during the several year period required for all species to reach adulthood. Both adults and nymphs imbibe copious amounts of plant fluids and eliminate much liquid.

Cicadas are not ordinarily considered pests. Over 2,000 species are known, only one of which occurs in southern England, while 180 species are known in the United States and Canada. Most species are tropical. They range in size from ¾ in. to several inches in length, and occur in deserts, grasslands and forests.

THOMAS E. MOORE

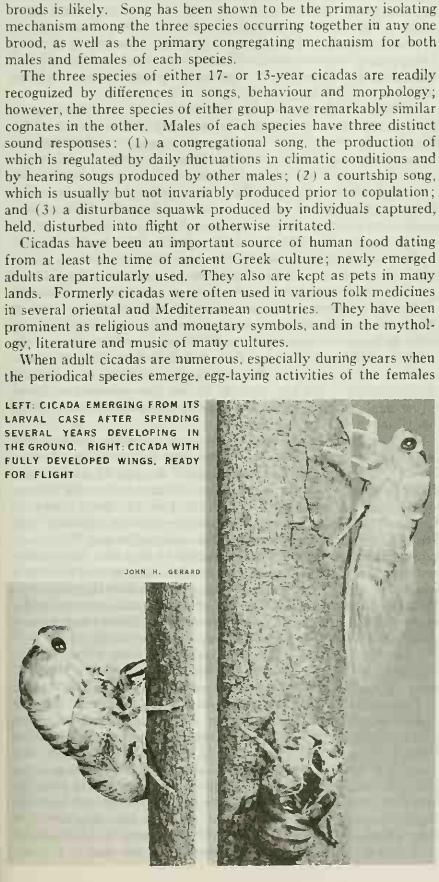
DORSAL VIEW OF ADULT MALE CICADA (OKANAGANA CANADENSIS)

Besides the dog-day cicadas (*Tibicen* species and others) that appear yearly in midsummer, there are periodic cicadas. These smaller *Magicicada* species, with reddish eyes and wing veins instead of the green and black of dog-day cicadas, are among the most fascinating and best known cicadas. There are three northern North American species of 17-year cicadas (often erroneously called 17-year "locusts") and three southern species of 13-year cicadas found from Oklahoma eastward. These species occur in very large numbers in chronologically and geographically isolated broods, always intimately associated with oak woods, but contact between 13- and 17-year broods is likely. Song has been shown to be the primary isolating mechanism among the three species occurring together in any one brood, as well as the primary congregating mechanism for both males and females of each species.

The three species of either 17- or 13-year cicadas are readily recognized by differences in songs, behaviour and morphology; however, the three species of either group have remarkably similar cognates in the other. Males of each species have three distinct sound responses: (1) a congregational song, the production of which is regulated by daily fluctuations in climatic conditions and by hearing songs produced by other males; (2) a courtship song, which is usually but not invariably produced prior to copulation; and (3) a disturbance squawk produced by individuals captured, held, disturbed into flight or otherwise irritated.

Cicadas have been an important source of human food dating from at least the time of ancient Greek culture; newly emerged adults are particularly used. They also are kept as pets in many lands. Formerly cicadas were often used in various folk medicines in several oriental and Mediterranean countries. They have been prominent as religious and monetary symbols, and in the mythology, literature and music of many cultures.

When adult cicadas are numerous, especially during years when the periodical species emerge, egg-laying activities of the females may cause some damage to young saplings. *See* also HEMIPTERA; INSECT.



LEFT: CICADA EMERGING FROM ITS LARVAL CASE AFTER SPENDING SEVERAL YEARS DEVELOPING IN THE GROUND. RIGHT: CICADA WITH FULLY DEVELOPED WINGS, READY FOR FLIGHT

JOHN H. GERARD

See J. G. Myers, *Insect Singers; a Natural History of the Cicadas* (1929); R. D. Alexander and T. E. Moore, *Ohio J. Sci. 58*, 2:107–127 (1958). (T. E. M.)

CICELY (*Myrrhis odorata*), family Umbelliferae (*q.v.*), a perennial herb with a leafy hollow stem two to three feet high, much-divided leaves, whitish beneath, a large sheathing base and terminal umbels of small white flowers, of which only the outer ones are fertile. The fruit is dark brown, long (three-fourths to one inch), narrow and beaked. The plant is a native of central and southern Europe, and is found in parts of England and Scotland in pastures, usually near houses. It has aromatic and stimulant properties and was once used as a potherb.

CICERO, MARCUS TULLIUS (106–43 B.C.), Roman statesman, barrister, scholar and writer, who in vain upheld republican principles in the civil struggles which destroyed the republic of Rome, who as an orator ranks in greatness with Demosthenes and Edmund Burke, and whose correspondence illuminates the political, social, literary and economic life of the late republic. He was the son of a Roman knight and came, like Gaius Marius, from Arpinum (Arpino). Admirably educated in Rome and in Greece, he did military service in 89 under Pompeius Strabo (the father of Pompey), and first appeared in the courts defending Quinctius in 81. His brilliant defense in 80 or early 79 of Sextus Roscius (*Pro Roscio Amerino*) established his reputation at the bar, and he started his public career as quaestor in western Sicily (at Lilybaeum) in 75. His skill as a barrister was confirmed in 70 by his unorthodox prosecution of Gaius Verres (governor of Sicily, 73–71 B.C.) for extortion; restricting himself to a short speech, he relied on the evidence of witnesses to secure a condemnation.

As praetor in 66 he made his first important political speech when, against Q. Catulus and leading *optimates* (the conservative element in the senate), he spoke (*Pro lege Manilia* or *De imperio Gnaei Pompei*) in favour of conferring on Pompey the command against Mithradates. His relationship with Pompey, whose hatred of M. Licinius Crassus he shared, was to be the focal point of his career in politics (*see* POMPEIUS). His election as consul for 63 was achieved through a swing of optimate votes in his favour.

Consulship 63.—In the first of his consular speeches he opposed the agrarian bill of Servilius Rullus in the interest of the absent Pompey; but his chief concern, the harder because he mistrusted his colleague Gaius Antonius, was to discover the revolutionary intentions of Catiline (*q.v.*) who, defeated in 64, stood again at the consular elections in 63 (over which Cicero presided, wearing armour beneath his toga). Catiline was unsuccessful, and now planned revolution—armed uprisings in Italy and arson in Rome. Cicero had difficulty in persuading the senate of the danger. The "last decree" (*senatus consultum ultimum*), something like a proclamation of martial law, was passed on Oct. 22; on Nov. 8, after escaping an attempt at assassination, Cicero delivered the first speech against Catiline in the senate, and Catiline left Rome that night. Evidence incriminating the conspirators in Rome was secured on the night of Dec. 2–3 through Gallic envoys (Allobroges) who were arrested leaving Rome, and on Dec. 5, after a senatorial debate when Cato spoke for execution and Caesar against, they were executed on Cicero's responsibility (Antonius being out of Rome). Cicero, announcing their death to the crowd with the single word, *vixerunt* ("they are dead"), received a tremendous ovation from all classes, the inspiration of his subsequent appeal in politics to *concordia ordinum*, "concord between the classes." He was hailed by Catulus as "father of his country." This was the climax of his career.

In his exposure of the conspiracy he acted admirably, as even his critics agreed (*e.g.* M. Junius Brutus, who called him *optimus consul*, and Sallust in the *Conspiracy of Catiline*), but though he never regretted the execution of the conspirators, its legality was doubtful. Its authority was the "last decree," but this administrative enactment, first employed in 121, which contravened the fundamental right of a Roman citizen to trial before execution, had never been approved by the *populares* (such as Caesar), and had indeed been challenged with Caesar's encouragement in summer 63 when Gaius Rabirius, whom Cicero defended, was tried for murder.

Combination of Pompey, Caesar and Crassus, and Cicero's Exile.—Cicero declined Caesar's invitation to join the political alliance of Caesar, Crassus and Pompey at the end of 60, and also Caesar's offer in 59 of a place on his staff in Gaul. When P. Clodius, whom Cicero had antagonized by speaking and giving evidence against him when he was tried for profaning the mysteries of the Bona Dea early in 61, became tribune in 58, Cicero was in danger, and in March, disappointed by Pompey's refusal to help him, Caesar still being in the neighbourhood, he fled from Rome, and on the following day Clodius carried a bill forbidding the execution of a Roman citizen without trial. Clodius then carried a second law, of doubtful legality, declaring Cicero an exile. Through his gangsters he destroyed Cicero's house on the Palatine, bought in 62 from Crassus for 3,500,000 sesterces, and his villas at Tusculum and Formiae. The Palatine site was consecrated to be a shrine of Liberty.

Cicero went first to Thessalonica, and then to Illyricum. In 57, thanks to the activity of, particularly, Pompey, the consul Lentulus Spinther and the tribunes T. Annius Milo and Publius Sestius, he was recalled on Aug. 4. Cicero landed at Brundisium (Brindisi) on that day, and traveled, warmly acclaimed, to Rome, where he arrived a month later. His precipitate departure from Rome, which he had previously deplored, he now represented as an act of altruistic heroism.

Alignment of Cicero with Pompey, Caesar and Crassus.—In winter 57–56 he sought to recover his standing in politics, but his hope of estranging Pompey from Caesar was frustrated when Pompey renewed his compact with Caesar and Crassus at Luca in April 56. Cicero now agreed, under pressure exerted through Pompey, to align himself with Pompey, Caesar and Crassus in politics, and committed himself in writing to this effect (the "palinode"). The speech *De provinciis consularibus* marked his change of front. Though obliged to accept a number of distasteful briefs (in particular the defense of P. Vatinius, Caesarian tribune of 59, and A. Gabinius, the unfriendly consul of 58), he abandoned public life for scholarship, and in the next few years completed the *De oratore* (55) and *De republica* (started in 54, finished in 52), and started the *De legibus* (52). In 52 he was delighted when Milo killed Clodius, but failed disastrously in his defense of Milo (later written up for publication, the *Pro Milone*).

In 51 he was forced, as a consequence of Pompey's provincial law of 52, to govern the province of Cilicia for a year, with a strong subordinate staff which included his brother Quintus and Gaius Pomptinus, both ex-praetors and experienced soldiers. The threat of Parthian aggression did not materialize, but some brigands were suppressed on Mount Amanus. The senate granted a *supplicatio* (a period of public thanksgiving), and Cicero hoped for a triumph on his return to Rome. He certainly governed Cilicia with conspicuous integrity.

Civil War 49–45.—He was back in the neighbourhood of Rome when Caesar invaded Italy in Jan. 49. Cicero met Pompey outside Rome on Jan. 17 and accepted a commission to supervise recruiting in Campania. He did not leave Italy with Pompey on March 17. His indecision, testified by his correspondence, was not discreditable, though his criticism of Pompey's strategy was inexpert. Caesar would have welcomed his co-operation, and in an interview with him on March 28 Cicero showed great courage in stating his own terms—his intention of proposing in the senate that Caesar should not pursue the war against Pompey any further—though they were terms which Caesar could not possibly accept. He sailed from Gaeta to join Pompey on June 7; in 48 he left Pompey's camp for Dyrrachium because of illness; refused the command of the republican forces after Pompey's defeat at Pharsalus; and returned to Italy in Oct. 48, after receiving a guarantee of safety from Caesar. He disapproved utterly of Caesar's dictatorship; yet he realized that in the succession of battles (which continued until 45) he would have been one of the first victims of Caesar's enemies, had they triumphed. This was his second period of intensive literary production, works of this period including the *Brutus*, *Paradoxa*, *Orator* in 46, *De finibus* (45), *Tusculanae disputationes*, *De natura deorum* and *De officiis*, finished after Caesar's murder, in 44.

Death of Caesar; Cicero's Attacks on Antony.—Cicero was not involved in the conspiracy to kill Caesar on March 15, 44, and was not in the senate when he was killed. On March 17 he spoke in the senate in favour of a general amnesty, but after this returned to his philosophical writing, and planned to visit his son, then a student at Athens. He returned to Rome at the end of August, however, and his 14 Philippic orations, so called in imitation of Demosthenes' speeches against Philip II of Macedonia, the first delivered on Sept. 2, 44, the last on April 21, 43, survive to record his vigorous re-entry into politics. His policy was to make every possible use of Caesar's adopted son Octavian, whose mature intelligence he badly underestimated, and to drive the senate, against its own powerful inclination toward compromise, to declare war on Antony in Cisalpine Gaul. No letters survive to show how Octavian deceived Cicero in the interval between the defeat of Antony in Cisalpine Gaul on April 14 and his march on Rome to secure the consulship in August. It was in May that Octavian learned of Cicero's unfortunate remark that "the young man should be given praise, distinctions—and then the *coup de grâce*"—*Laudandum adulescentem, ornandum, tollendum*. The triumvirate of Octavian, Antony and Lepidus was formed at the end of October. The proscriptions followed. Cicero, proscribed, was caught and killed near Caieta on Dec. 7. His head and hands were displayed on the *rostra* at Rome.

Political Judgment.—In politics Cicero constantly exaggerated the shortcomings of his opponents and the virtues of his friends. As a "new man" he was never accepted by the dominant circle of *optimates*, and he attributed his own political misfortunes after 63 partly to the jealousy, partly to the spineless unconcern of complacent *optimates*. The close political association with Pompey for which he longed was never achieved. He was more ready than Cato to compromise from motives of expediency but, though he came to admit in the *De republica* that republican government required the presence of a powerful individual—a *gubernator* or *moderator*, an idealized Pompey perhaps—to ensure its stability, he showed little appreciation of the intrinsic weaknesses of Roman republican administration (the failure of legislation to check bribery, the absence of machinery for enforcing law and order in Rome, the powerlessness of the government to control the armies). His appeal in 63 and later to the concepts of *concordia ordinum* and *consensus Italiae* and his eloquent but unconvincing demonstration in the *Pro Sestio* in 56 that there was no fundamental incompatibility between *optimates* and *populares* did not touch the fringe of the real problems.

Cicero's marriage to Terentia, a woman of wealth and breeding, in 80, produced, probably in 79, a daughter Tullia, and in 65, a son Marcus. He divorced Terentia in late 47 or early 46, and married Publilia, a girl of 15, for her money. Tullia, to whom he was devoted, married three times, and died in Feb. 45. Soon afterward Cicero divorced his second wife. His brother and nephew were killed in the proscriptions of 43; his unattractive son Marcus escaped, fought at Philippi, was reconciled to Octavian, and became consul in 30. Though barristers were forbidden by law to receive more than a token fee, Cicero's money was made at the bar (often through legacies of grateful clients). He was extravagant, especially in the number of his villas, and continually in difficulty over money.

Cicero's Letters.—From Cicero's correspondence between 67 and July 43 B.C. over 900 letters survive, and of the 835 written by Cicero himself, 416 (the first written in 67, the last in Nov. 44) were to his friend, financial adviser and publisher, the knight T. Pomponius Atticus, and 419 to one or other of some 94 different friends, acquaintances and relatives. There are 92 letters written to Cicero by 31 different correspondents (who include Caesar, Cato, Pompey, Mark Antony and M. Brutus) and 20 which were exchanged between third parties (including dispatches of generals to the Roman government). There are far more letters from the late than from the early part of the period (nearly 400 from the three years 45–43 B.C., including 26 of the 31 surviving letters of the correspondence with Brutus). There are only 30 letters earlier than 60 B.C. (inclusive), none of them from the year of Cicero's consulship. Of the 27 letters to his brother Quintus, two were written when Quintus governed Asia in 59, two when Cicero was in exile in 58 and 18 when Quintus was on Pompey's staff in Sardinia in 57–56 or on Caesar's staff in Gaul in 54.

The number, large as it is, obviously constitutes only a small portion of the letters which Cicero wrote and received. Many letters which were current in antiquity have not survived, for instance the vainglorious account of the suppression of Catiline's conspiracy, mentioned in the *Pro Sulla* and *Pro Plancio*, which Cicero sent to Pompey at the end of 63; Pompey hardly as much as acknowledged it and Cicero was mocked about it in public later. Many letters were evidently suppressed for political reasons after Cicero's death. That is why nothing survives of the letters written by Atticus, of Cicero's correspondence with Octavian in 44–43 or of his letters to Atticus later than Nov. 44.

There are four collections of the letters: to Atticus (*Ad Atticum*) in 16 books; to his friends (*Ad familiares*) in 16 books; to Brutus; and, in three books, to his brother (*Ad Quintum fratrem*). His most unguarded and self-revelatory letters were to Atticus and Quintus. In his letters to Atticus he constantly resorted to Greek quotations and tags for the *mot juste*.

The idea of publishing some of his letters was entertained by Cicero in 45, and in July 44 his freedman Tiro had collected about 70 which were to form the basis of the publication. These doubtless included specimens of elaborate fine writing like the invitation to L. Lucceius in 56 to write a monograph on Cicero's consulship, which Cicero himself thought a particularly good letter. But the publication did not take place in Cicero's lifetime and in the event it included much of a trivial nature, for instance the 81 letters of personal recommendation, mostly to provincial governors on behalf of friends, which constitute *Ad familiares* xiii.

The letters *Ad familiares* were collected and published by Tiro, grouped generally, but not with complete uniformity, according to the person of the correspondent. The letters to Atticus—"in eleven volumes"—were first mentioned by Cornelius Nepos in his *Life of Atticus* (first edition, 35 or 34 B.C.) as a repository of valuable information on contemporary history, as yet unpublished. The earliest quotation from a letter to Atticus is (*c.* A.D. 63–65) by Seneca and, since the scholarly Asconius in those of his admirable commentaries on Cicero's speeches which survive (written *c.* A.D. 54–57) never used the evidence of Cicero's letters to Atticus, they were generally held to have been published under Nero, until in 1947 J. Carcopino suggested that writers earlier than Asconius, even Horace in book ii of his *Satires*, used information derived from Cicero's letters to Atticus as well as to his friends. He claimed that both publications, carried out in 34–33 B.C., were the work of Atticus, M. Agrippa (his son-in-law), Tiro and Cicero's son Marcus, a part of Octavian's propaganda campaign against Antony before Actium, with the object of discrediting not merely Antony but republicanism and its protagonists, in particular Cicero himself. No part of this theory has won acceptance, apart from the suggestion that the silence of Asconius is not conclusive. It is possible that the letters to Atticus were published at that date, but not for the motive which Carcopino suggests, Octavian's sanction being given rather as a belated act of repentance for his part in Cicero's murder.

The letters constitute a primary historical source such as exists for no other part of the ancient world. They often enable events to be dated with a precision which would not otherwise be possible, and they have been used, though with no very great success, to discredit the accuracy of Caesar's commentaries on the civil war. Cicero's personal character has been assailed most unfairly on the basis particularly of his extravagant despair in exile and his (understandable) indecision in the early months of 49. On the other hand his reporting of events, naturally enough, is not objective, and he was capable after an interval of misremembering or misrepresenting past events so as to enhance his own credit. (J. P. V. D. B.)

Cicero as a Poet.—Cicero is a minor but by no means negligible figure in the history of Latin poetry. His best-known poems (which survive only in fragments) were the epics *De consulatu suo* (*On His Consulship*) and *De temporibus suis* (*On His Life and Times*). These were criticized in antiquity by Quintilian and others for their self-praise, and one line was assailed, for instance by Juvenal in the *Tenth Satire*, for sound and sense: *o fortunatam natam me consule Romam*, "O happy state of Rome to date your birthday from my consulate." Some lines from his *Marius*, describing an eagle seizing a snake, have power. Cicero's verse is technically important; he refined the hexameter, using words of two or three syllables at the end, to ensure coincidence of the natural word accent with the *ictus* or beat of the metre, and applying rhetoric to his treatment of poetry; he is one of those who made possible the achievement of Virgil. Unsympathetic toward contemporary Alexandrian movements, his work nonetheless influenced individual contemporaries, perhaps Catullus and also Lucretius. Fragments of his translations from Aratus, Homer and the Greek dramatists also survive.

Cicero as an Orator.—Cicero made his reputation as an orator alike in politics and in the law courts, where he preferred appearing for the defense (though his prosecution of Verres is perhaps his most famous case) and generally spoke last because of his emotive powers. Unfortunately not all his cases were as morally sound as the attack on Verres. In his day Roman orators were divided between "Asians" with a rich, florid, grandiose style, of which Q. Hortensius was the chief exponent, and the direct simplicity of the "Atticists" such as Caesar and Brutus. Cicero refused to attach himself to any school. He was trained by Molon of Rhodes, whose own tendencies were eclectic, and he believed that an orator should command and blend a variety of styles. He made a close study of the rhythms which were likely to appeal to an audience, especially in the closing cadences of a sentence or phrase (*clausulae*). The Polish scholar T. Zielinski examined 17,902 of these, and showed that Cicero preferred to end his sentences with the rhythms –⏑–/–⏓ (*esse conversos*) –⏑–/–⏑⏓ (*voce consentiunt*) –⏑–/–⏑–⏓ (*publicae molientem*) with their variants –––/–⏑⏓ (*admirandum dies*) and –––/–⏑–⏓ (*conscripti paenitebit*). These were called "genuine" (V or *verae*). Others possible (L or *licitae*) were modifications of these, of which the most important was the familiar –⏑⏑⏑/–⏓ (*esse videatur*) which is prominent in *Pro lege Manilia*. Between them these account for 86% of the *clausulae*. Cicero's rhetoric was a complex art-form, and the ears of the audience were keenly attuned to these effects. He himself tells us in *Orator* (214) that he heard Carbo win thunderous applause for an effective double-trochee *clausula*—"temeritas fīlĭī cōmprŏbāvĭt"—and says that the whole effect would have been spoiled by "comprobavit filii temeritas." Of the speeches, 58 have survived, some in an incomplete form; it is estimated that about 48 have been lost. Some of the speeches were revised for publication; the most notable is *Pro Milone*. Cicero's original speech was unsuccessful, and he rewrote it and sent it to Milo in exile at Massilia (Marseilles) who had the wit and grace to say that if the revised version had been given he would never have sampled the excellent local fish. It is in any event unlikely that procedure in a Roman court permitted the sort of continuous address which the published speeches represent, and we know that Cicero relied to some extent on improvisation. Nonetheless, we need not suppose that the versions we have are radically altered from the originals.

Cicero in *Brutus* (322) implicitly gives his own picture of his own equipment as an orator—a thorough knowledge of literature, a grounding in philosophy, legal expertise, a storehouse of history, the capacity to tie up an opponent and reduce the jury to laughter, the ability to lay down general principles applicable to the particular case, entertaining digressions, the power of rousing the emotions of anger or pity, the faculty of directing his intellect to the point immediately essential. This is not unjust. It is the *humanitas* of the speeches which turns them from an ephemeral tour de force into a lasting possession. This may be seen supremely in *Pro Archia*—"Studies of this kind" (literature and philosophy) "are the food of the young, the diversion of the old, an adornment to success, a refuge for consolation in adversity, a private delight without being a public disadvantage, our constant companions at night, abroad or in the country." His humour is at its best in his bantering of the Stoics in *Pro Murena* (61 *et seq.*) in order to discredit Cato, who was among the prosecutors: at its most biting when he is attacking Clodia in *Pro Caelio*. His capacity for arousing anger may be well seen in the staccato opening sentences of the first speech against Catiline; for arousing pity in the last page of *Pro Milone;* his technique in winning a case against the evidence is exemplified by *Pro Cluentio*, a speech in an inordinately complex murder trial; Cicero later boasted of "throwing dust in the jurymen's eyes."

Ancient critics stressed his forcefulness and fullness. These qualities are well described by the anonymous work, formerly attributed to Longinus, *On the Sublime*, contrasting his diffuseness with the terseness of Demosthenes: "Cicero, like a spreading conflagration, ranges and rolls far and wide; his inner fire is abundant and unextinguishable; he applies it in varying intensity at different points, and keeps it fed with relays of fuel." His fullness revolutionized the writing of Latin; he is the real creator of the "periodic" style in which phrase is balanced against phrase, and subordinate clauses woven into a complex but seldom obscure whole. His style formed the style of Renaissance Europe. The critic Quintilian, an ardent Ciceronian, declared that his name was synonymous with oratory and the historian Livy that a second Cicero would be needed to praise him adequately.

Cicero made a significant contribution to literary theory. His early *De inventione* is slight, but between 55 and 46 B.C. he gave an important survey of oratorical principle and practice, notably in *De oratore*, *Brutus* and *Orator*. In his broad, spacious, artistic treatment he invokes classical principles. The aim of oratory is threefold—*docere, delectare, movere;* it must be instructive, attractive and emotive. For the first the orator needs a well-stored mind; for the second a sense of balance between the exoticism of the "Asians" and the starkness of the "Atticists"; for the third a sound understanding of psychology. Great oratory comes from a combination of *ingenium, exercitatio* and *studium,* natural capacity, training and a sound liberal education.

Cicero as a Philosopher.—In his younger days Cicero studied under the Epicurean Phaedrus (*c.* 140–70 B.C.), the Stoic Diodotus (d. *c.* 60 B.C.) and the Academic Philo of Larissa (*c.* 160–80 B.C.), and thus had a thorough grounding in three of the four main schools of philosophy. Epicureanism he rejected, though his friend Atticus remained an adherent. During his travels in the east in 79–77 he came to a high admiration for Antiochus of Ascalon (*q.v.*), an Academic with leanings to Stoicism, and the great Stoic Poseidonius (*q.v.*). Cicero called himself an Academic, but this applied chiefly to his theory of knowledge, in which he preferred to be guided by probability rather than to allege certainty; he justified in this way contradictions in his own works. In ethics he was much more inclined to dogmatism, and was more attracted by the Stoics, but for his authority he looked behind the Stoics to Socrates. Similarly, he approved of the Stoic account of the order and constancy of nature, but corrected their excesses by reference to Plato and Aristotle. In religion he was an agnostic most of his life, but had religious experiences of some profundity during an early visit to Eleusis, and at the death of his daughter in 45; he usually writes as a theist, but the only religious exaltation in his writings is to be found in the *Somnium Scipionis* (*Scipio's Dream*) at the end of *De republica* with its sublime vision of a future life.

Cicero did not write seriously on philosophy before about 54, a period of uneasy political truce, when he seems to have begun *De republica,* following it with *De legibus* (begun in 52). These were an attempt to interpret Roman history in terms of Greek political theory. Cicero rejected democracy, oligarchy and monarchy (the best of the three) in favour of a mixed constitution, such as he imagined Rome to possess. An interesting feature of his theory is the presence of a *moderator* or *rector*, a philosophical autocrat, which was later used to buttress the position of the emperor.

The bulk of his philosophical writings belong to the period between Feb. 45 and Nov. 44. His output was astonishing: to those works listed below must be added the lost *De consolatione*, called out by his daughter's death; *Hortensius*, an exhortation to the study of philosophy, which proved an instrument in St. Augustine's conversion; and *De gloria*. Most important are the difficult *Academica* (*Academic Philosophy*) which defends suspense of judgment: *De finibus* or *The Supreme Good* (Is it pleasure, virtue, or something more complex?); *Tusculanae Disputationes* or *Table-talks at Tusculum* (Is death an evil? Is pain an evil? Can a wise man suffer distress? Mental perturbation? Is virtue sufficient for blessedness?); *De natura deorum; De officiis* (*Moral Obligation*). Cicero, except in the last book of *De officiis*, lays no claim to originality in these works. Writing to Atticus, he says of them "apographa sunt; . . . verba tantum adfero quibus abundo." ("They are transcripts; I simply supply words, and I've plenty of those.") His aim was to provide Rome with a kind of philosophic encyclopaedia. He derived his material from Stoic, Academic, Epicurean and Peripatetic sources. Much work has been done in identifying these. Some are obvious: *De amicitia* comes from Theophrastus (*q.v.*) and the first two books of *De officiis* from Panaetius (*q.v.*). The form he used was the dialogue, but his models were Heracleides Ponticus (*q.v.*) and Aristotle rather than Plato. His general method may be seen in *De finibus* where first the Epicurean view, and next the Stoic view are expounded and criticized, and the last book gives an account of the views held in common by Academics and Peripatetics. Cicero's importance in the history of philosophy is as a transmitter of Greek thought. In the course of this he gave Rome and therefore Europe its philosophical vocabulary. We owe to Cicero words such as *quality, individual, vacuum, moral, property, induction, element, definition, difference, notion, comprehension, infinity, appetite* and many others; in *Academica 2, 17–22* he gives a fascinating account of the difficulties which confronted him. In this way he has molded our ways of thinking, and in a century during which some have sought to compass philosophy within the bounds of linguistics it is well not to underestimate him. He was once valued, and is still worth reading, for his content. Petrarch said: "You could sometimes fancy that it is not a pagan philosopher but a Christian apostle who is speaking." Today we are more inclined to echo Voltaire's "We honour Cicero, who taught us how to think." The highest tribute came from his great adversary Julius Caesar: "It is better to have extended the frontiers of the mind than to have pushed back the boundaries of empire" (Pliny, *Naturalis Historia*, 7, 31). *See* also references under "Cicero, Marcus Tullius" in the Index volume.

Works.—Speeches: *Pro Quinctio* (81), *Pro Roscio Amerino* (80 or early 79), *Pro Roscio Comoedo* (77?), *In Caecilium divinatio, In Verrem actio* i, *actio* ii, 1–5 (70), *Pro Tullio, Pro Fonteio, Pro Caecina* (69), *Pro lege Manilia, Pro Cluentio* (66), *Contra Rullum* i–iii, *Pro Rabirio, In Catilinam* i–iv, *Pro Murena* (63), *Pro Sulla, Pro Archia* (62), *Pro Flacco* (59), *Post reditum ad Quirites* and *Post reditum in senatu, De domo sua* (57), *De haruspicum responso, Pro Sestio, In Vatinium, Pro Caelio, De provinciis consularibus, Pro Balbo* (56), *In Pisonem* (55), *Pro Plancio, Pro Rabirio Postumo* (54), *Pro Milone* (52), *Pro Marcello, Pro Ligorio* (46), *Pro rege Deiotaro* (45), *Philippicae* i–xiv (44–43). Critical: *De inventione* (84), *De oratore* i–iii (55), *Oratoriae portitiones* (54?), *De optimo genere oratorum* (52), *De republica* i–vi (51; completed 52), *Brutus, Paradoxa Stoicorum, Orator* (46), *Academica* i–ii, *De finibus* i–v, *Tusculanae disputationes* i–v, *De natura deorum* i–iii, *De divinatione* i–ii, *De fato, De senectute, De amicitia, De officiis* i–iii, *Topica* (45–44), *De legibus* (begun in 52 but published posthumously). Letters: *Ad Atticum* i–xvi, *Ad familiares* i–xvi, *Ad Quintum fratrem* i–iii, *Ad Brutum* i–ii.

(Jo. Fe.)

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(J. P. V. D. B.; Jo. FE.)

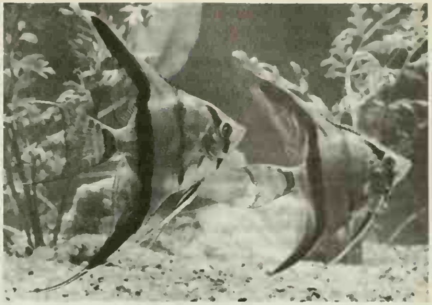
CICERO, a city of Cook county, Ill., U.S., adjoins Chicago on the west. The population was 69,130 in 1960. (For comparative population figures *see* table in ILLINOIS: *Population.*) Although settlers had appeared in the 1830s, there were only ten families when the township was organized (1857). The town was incorporated in 1867, and a city charter was granted in 1869. Growth on this rich, but swampy, land was slow until just after the American Civil War, when land speculators and farmers entered the region. Portus Weare, a Chicago grain merchant, opened the Morton Park division and built a 20-room house. Economic growth continued, but Cicero lost territorially to Chicago and by the formation (1901) of Berwyn and Oak Park. Cicero is an important manufacturing centre drawing on adjacent towns for labour. Manufactures include a variety of steel, brass and copper products. Early settlers came from England, Germany, Ireland and eastern United States (Cicero was named for Cicero, N.Y.), but southern and eastern Europeans later became predominant.

In the 1920s Al ("Scarface") Capone made Cicero the headquarters of his speak-easies and gambling enterprises. (M. Ws.)

CICHLID. The perchlike fishes of the family Cichlidae include specimens used for pond culture and food as well as for the aquarium. They are all relatively small (rarely over 12 in.), deep-bodied species found in lakes, rivers and brackish lagoons of Central and South America, Africa, Syria, Madagascar and India. They are scientifically characterized by having a single nostril on each side (rather than two on each side) and the lower pharyngeal bones coalesced or united by suture. Their geographical distribution was formerly considered to favour the idea of the connection between South America and Africa, but their importance in this regard is discounted by the fact that many species enter brackish water and some the sea, and by the possibility that earlier oceanic populations are now extinct. The presence of cichlids in Madagascar, where none of the true fresh-water African families is represented, indicates that their dispersal has been accomplished through saline waters.

The American species number about 250, the African 400; none of the genera is common to the two continents. The Indian *Etroplus* is an isolated genus, related only to *Paretroplus* of Madagascar, in which island three genera are endemic, the two others being related to African genera. Among the African cichlids an extraordinary diversity and specialization is attained in the great lakes: Lake Tanganyika has about 100 species, nearly all of which belong to genera found nowhere else; Lake Nyasa has nearly as many endemic species, some of which have evolved on parallel lines to those of Tanganyika. The lake-dwelling genera, which differ from each other especially in modifications of the mouth and teeth, make use of every kind of animal and vegetable food available in the lakes.

Many cichlids are beautifully coloured and are favourite aquarium fishes. *Cichlasoma cyanoguttatum* of Mexico, covered with bright blue spots, is one of the really handsome species. The fresh-water angelfish, *Pterophyllum scalare,* and a few related species, of the Amazon have the body very deep and strongly compressed and the dorsal and anal fins high. The South American discus or pompadour fish, *Symphysodon discus,* is another cichlid popular with aquariists (*see* AQUARIUM: *Aquariums in the Home*). One of the African mouthbreeders, *Tilapia mossambica,* which reaches a length of 18 in., is an important food fish, being cultivated in fish ponds in many tropical areas (*see* FISH CULTURE: *Tropical Pond Culture*).


BY COURTESY OF NEW YORK ZOOLOGICAL SOCIETY

FRESH-WATER ANGELFISH (PTEROPHYLLUM SCALARE), A CICHLID POPULAR IN AQUARIUMS

In many old-world cichlids the female fish keeps the eggs in her mouth until they hatch, and for a time swims with her brood, opening her mouth for the little fishes to swim in when danger threatens. In other species the eggs are laid in a hollow scooped out by the male; both parents guard the nest until the eggs hatch, at which time the mother may take the young into her mouth.

(C. HU.)

CICOGNARA, LEOPOLDO, CONTE (1767–1834), Italian critic and art historian, was born at Ferrara on Nov. 17, 1767. A residence of several years at Rome, devoted to the study of the antiquities and galleries, was followed by visits to Naples and Sicily. He then visited Florence, Milan, Bologna and Venice, acquiring an extensive knowledge of their art treasures and buildings. In 1795 he took up his abode at Modena, and was for 12 years engaged in politics, becoming minister plenipotentiary of the Cisalpine republic at Turin. Napoleon decorated him with the iron crown; and in 1808 he was made president of the Academy of Fine Arts at Venice.

In 1808 appeared his treatise *Del bello,* dialogues on the beautiful, a formulation of ideas of the neoclassic school. This was followed (1813–18) by his *Storia della scultura dal suo risorgimento in Italia al secolo di Napoleone*. The book was designed to complete the works of J. J. Winckelmann and J. Seroux d'Agincourt, and is illustrated with 180 plates in outline. His *Fabbriche più cospicue di Venezia,* two superb folios containing about 150 plates, was published (1815–20) under the auspices of Francis I of Austria. Charged by the Venetians with the presentation of their gifts to the empress Caroline at Vienna, Cicognara added to the offering an illustrated catalogue of the objects it comprised; this book, *Omaggio delle Provincie Venete alla maestà di Carolina Augusta,* has since become of great value to the bibliophile. In 1821 he published at Pisa a *catalogue raisonné*, rich in bibliographical lore, of his fine library, the result of 30 years of loving labour, which in 1824 was purchased by Pope Leo XII and added to the Vatican library. Cicognara's work in the academy at Venice led to the foundation of a gallery for the reception of Venetian pictures. He died in Venice on March 5, 1834.

CICONIIDAE, the ornithological name for the stork family of birds, a group of short-necked but long-legged waders. *See* ADJUTANT BIRD; JABIRU; STORK.

CID, THE (Arabic *sid*, "lord"), is the popular sobriquet by which RODRIGO DÍAZ DE VIVAR (*c.* 1043–1099), most famous of medieval Spanish captains, has been known in Spain since his own day. It is frequently linked with another sobriquet, of Romance origin, *Campeador,* "winner of battles." There is a substantial heroic history of Rodrigo Díaz, in both poetry and prose, originating in the 12th century, but this is of more concern to the student of literature than to the historian (*see* SPANISH LITERATURE). There are, however, some acceptable historical sources from which his biography may be established. These include some contemporary documents, the *Historia Roderici* (a very nearly contemporary private Latin chronicle of his life) and a detailed narrative of his conquest of Valencia written by Ibn Alkama, an Arab historian living in the city at the time.

Rodrigo Díaz was born at Vivar, near Burgos, about 1043, his father, Diego Laínez, being a member of the Castilian minor nobility. He was brought up at the court of Ferdinand I by the latter's eldest son, Sancho. Details of his early career are uncertain, but he seems to have distinguished himself in Ferdinand's later campaigns and, when Sancho succeeded to the Castilian throne (1065), the young Cid was appointed to the high military office of standard-bearer. His successful generalship during Sancho's reign established his military reputation.

The Cid had taken a prominent part in the campaign which enabled Sancho to seize the throne of León from his younger brother, Alfonso. His position was, therefore, of some difficulty when Sancho was killed at the siege of Zamora (1072) and Alfonso returned from exile to become king of both León and Castile. Nevertheless, he remained at Alfonso's court for nearly a decade and, in 1074, even married the king's own niece, Jimena, daughter of the count of Oviedo. In 1079 the Cid was with the army of Alfonso's tributary, al-Mutamid (al-Motamid) of Seville, when al-Mutamid defeated an invasion by Abdullah of Granada. Alfonso's favourite, Count García Ordoñez, happened to be on the Granadine side and was captured by the Cid. This affair renewed Alfonso's dormant suspicions of him, and when it was followed, in 1081, by an unauthorized incursion on a large scale into the Moorish kingdom of Toledo, over which Alfonso had established a protectorate, the Cid was ordered into exile.

He now removed himself to the Moorish kingdom of Saragossa, whose kings he served for a number of years, leading successful campaigns on their behalf against the count of Barcelona (1082) and Sancho Ramírez of Aragon (1084). He also became chief political adviser to his Moorish employers (who regarded him highly) and acquired that familiarity with Islamic politics, law and customs which was to prove invaluable for his later career.

A temporary reconciliation with Alfonso in 1083 had soon broken down, but the king's difficulties in meeting the invasion of Spain by the Almoravids led him to readmit the Cid to his favour in 1087. The Cid's interest were by this time wholly concentrated on eastern Spanish affairs, and he turned his attention to the task of securing Alfonso's suzerainty over the extensive Moorish kingdom of Valencia. In 1089 he extracted a written assurance from Alfonso that any lands won by him from the Moors would belong to himself and his heirs in perpetuity. When, later in the same year, he was again banished, he proceeded with the subjugation of Valencia more or less as a private venture.

The conquest of Valencia by the Cid was an extremely complicated affair: it began in 1089, when he made its king, al-Kadir, his tributary; entered its second stage in 1092, when al-Kadir was murdered by the cadi Ibn Yehhaf; and ended in June 1094, when the city capitulated to the Cid's troops after a prolonged siege. During these proceedings, the Cid relied on his talent for political intrigue almost as much as on military force, playing off against each other both the rival groups within the city and his own rivals for its control outside it—Alfonso himself, the Almoravids and the king of Saragossa. Several months after the surrender the Cid broke the terms of the capitulation that he had made with Ibn Yehhaf and executed him in a brutal manner; motives of cupidity and vengeance were responsible, at least in part, for this act. Determined Almoravid attempts to recover the city were defeated by the Cid at the battles of Cuarte (1094) and of Bairén (1097). The semiroyal status that the former knight from Vivar had by now achieved was shown when, soon afterward, his daughters Cristina and María married the Navarrese prince Ramiro and Ramón Berenguer III, count of Barcelona, respectively.

The Cid died in Valencia on July 10, 1099. Three years later his wife, Jimena, had to give up the city, as it was impossible to hold it indefinitely against the Almoravids. The Cid's body was removed to the monastery of San Pedro de Cardeña, near Burgos, where the monks gradually made it the centre of an elaborate cult which sought to portray the Cid as a near saint.

The task of evaluating the Cid's career historically is a delicate one because of his status as a national hero. It is clear from all sources that he was a remarkably successful field commander, consistently achieving brilliant victories over superior enemy forces by boldness in action balanced, however, by cunning and careful preparation. There is little evidence of any religious motive behind his career, particularly before the coming of the Almoravids. The force which drove him seems to have been the pursuit of power and wealth. In these respects his attitude was entirely typical of that of other Christian Spaniards in pre-Almoravid Spain. The truth behind his quarrels with Alfonso VI is uncertain, but it would be rash to absolve the Cid of all blame by attributing responsibility to that exceptionally able monarch. The deeds of the Cid cannot be said to have made any great material contribution to Spanish history: he did not take part in Alfonso's most critical campaigns; his greatest achievement, the conquest of Valencia, proved ephemeral.

Nevertheless the Cid's life fired the popular imagination as that of no other medieval Spaniard was able to do. This was the result not only of his invincibility in the field but also of the fact that, after his career as a courtier had been ruined, he had continued to win fame, riches and rank solely by the exercise of his sword and his intelligence despite the king's disapproval and the active opposition of the great magnates.

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CIDER is the name applied in most European countries to the expressed juice of apples that has undergone fermentation. In North America, the freshly expressed juice that has not been subjected to any permanent preservative treatment is generally called sweet cider, while that permitted to undergo some natural fermentation is designated as hard cider. The expressed juice of apples that has been treated by some method to prevent spoilage while in hermetically sealed cans or bottles is marketed as apple juice in most countries, although U.S. consumers often refer to it as cider.

Apple juice or cider is relatively low in content of protein, fat, ascorbic acid and vitamin A and contains a moderate amount of carbohydrates. However, about 75% of the carbohydrates consists of sugars that are readily assimilated by man. Ascorbic acid (vitamin C) content varies with varieties and the extent to which oxidation takes place during processing. It is easily added, however, and much of the juice produced in America contains ascorbic acid comparable in amount to that present in citrus juices. The pomace is considered equal to silage as a feed for cows and sheep.

Cider as an Alcoholic Beverage.—Many varieties of apples are grown in several European countries especially for use in the manufacture of an alcoholic beverage of fine quality. France has the largest acreage of such cider apple orchards, particularly in Normandy and Brittany. England has an extensive acreage, in the western and southwestern counties and in other scattered localities. Germany, Switzerland and Spain also produce substantial quantities. Some fermented cider is produced in Canada from varieties grown chiefly for table use; manufacture in the United States has not attained commercial importance.

Cider making in Europe prior to the 20th century was confined to the farms on which the fruit was grown and most of the indifferent product was consumed locally. The development of better manufacturing techniques led to a marked improvement in the quality of the cider and the establishment of many cider factories.

Cider manufactured in France must be produced by the fermentation of the juice of fresh apples or a mixture of apples and pears and must conform to specific standards for the different kinds, designated by different names. English cider has been extremely variable because of a lack of legal standards other than those requiring apple juice to be the basis of the beverage and regulations pertaining to metallic contamination.

However, because of the nature of the raw material, there is much variability even in the beverage produced under the most restrictive regulations. Sugar content of freshly expressed juice commonly ranges from 6% to 20%, acid content from 0.1% to 1.25%, and tannin content from 0.05% to 0.75%. Fermentation is related to varying nitrogen content of the juice. According to the nature of the juice, therefore, the finished product may be sweet or dry, strongly or lightly alcoholic, highly acid or low in acidity; astringency and degree of bitterness may also vary. Distinctive local characteristics result from environmental conditions such as soil and climate. Individual makers, however, aim at definite standards by blending the local varieties to suit the tastes of their consumers.

In making cider, the apples may be ground by being fed from a hopper to a revolving drum or cylinder in which are fixed toothed knives that project about $\frac{1}{16}$ in. above the surface of the drum. The fruit is thus grated to a fine pulp or pomace. Another method is to pass the apples through a hammer mill. In either case the pomace is fed onto the bed of a press where it is built up into "cheeses," consisting of a series of layers, each wrapped in strong, open-meshed cloths. These cheeses or layers of pulp are separated from their neighbours by slatted wooden racks to facilitate drainage of the juice. Power-driven hydraulic presses are used to express the juice.

The extracted juice is conveyed directly into fermenting vats or casks. If the fermented cider is to be sweet, the juice must be filtered at an early stage to make possible the retention of the desired percentage of unfermented sugar. If a dry cider is desired, fermentation must proceed until all or most of the sugar is converted to alcohol. Natural fermentation resulting from the wild yeasts present on the apples is the usual practice but some makers pasteurize the fresh juice and then add pure cultures of selected yeasts. Filtration, which is usually done within three months after grinding, may be accomplished by forcing the turbid juice under pressure through a thick layer of paper pulp or other fibrous material. Some makers centrifuge the juice prior to filtration. Flavour is improved by aging for a few months, or even two or three years, after filtration. Some cider is carbonated at the time it is bottled; some is conditioned by the champagne process, in which fermentation takes place under pressure, in tightly closed glass containers.

Sweet Cider or Apple Juice.—Prior to 1930 sweet cider was made on many farms in the United States from surplus or offgrade apples and sold in bulk or in large bottles or jugs during the autumn months. No treatment to prevent fermentation was provided other than occasional addition of sodium benzoate. Limited quantities are still made in this way but the development of various manufacturing techniques made possible the commercial production of a pasteurized juice, packed in hermetically sealed containers for all-year consumption, which now supplies most of the market demand in North America. This product is generally designated as apple juice although a few packers label it as cider. It is made from apples that do not meet specifications for fresh fruit marketing because of superficial blemishes, poor colour, or small size. Few of the market varieties make a satisfactory juice when used singly. Most packers blend two to four varieties for each batch of juice. In the manufacture of sweet cider the apples are washed thoroughly, passed over grading belts where fruits showing decay or insect infestation are removed, and ground with a grater or a hammer mill; the pulp is then built up into cheeses and the juice expressed as described for making alcoholic cider. The yield of juice is 7 to 8.5 U.S. gallons or 6 to 7 imperial gallons per 100 lb. of fruit.

Europeans prefer a juice that is mellowed by holding it for a few months in large tanks under pressure supplied by introducing carbon dioxide into the tanks. Americans generally prefer the flavour of freshly pressed juice.

The usual processing procedure for making a clear juice is to clarify and filter the juice, flash pasteurize it, fill the juice into enamel-lined cans, close the cans and cool immediately. If an unclarified or cloudy juice is to be packed, the apples are often sprayed with ascorbic acid when they are ground to prevent darkening of the juice by oxidation and to reduce the amount of sedimentation in the finished product. A juice intermediate between the clear and unclarified product may be made by passing previously screened juice through a centrifuge. This process is continuous and eliminates the need for tanks.

It is very difficult to filter freshly pressed juice unless one of the following clarifying treatments precedes filtration: (1) add gelatin and tannin to produce a flocculent precipitate; (2) clarify with an enzyme preparation; (3) flash heat to 180° F. and cool immediately; or (4) flash heat and cool and add bentonite. Filters that use a filtering medium such as diatomaceous earth are generally preferred. Cold sterilization accomplished by forcing the juice through special pads to remove yeasts and bacteria has not proved practical in North America but has been used successfully in some European areas.

Flash pasteurization is accomplished by pumping a thin layer or film of juice between plates or through tubes that are heated by steam or hot water. The juice is heated to 170° to 190° F. in a few seconds and this hot juice is filled directly into cans or bottles. The containers are closed immediately, inverted to bring the hot juice in contact with the cover or closure, and are then cooled under water sprays or in running water.

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CIENFUEGOS, a city in Las Villas province and one of the chief ports of Cuba, about 140 mi. E.S.E. of Havana on the south coast of the island. Pop. (1953) 57,991 (1961 mun. est.) 107,526. It is located on a broad, level peninsula opposite the narrow entrance of a fine, sheltered bay of Jagua (Bahía de Cienfuegos) and is built on a rectangular pattern with wide streets, numerous parks and promenades and attractive buildings.

The city serves as the trading centre for the fertile lands of southern Las Villas province and has become one of the most prosperous and modern cities of Cuba. Its port handles the exportation of raw sugar and molasses from about 15 sugar mills. In addition to large quantities of sugar cane, the hinterland produces significant amounts of coffee, tobacco, henequen, rice and fruit. Livestock are also raised. The main industries in the city are coffee-processing and tobacco-manufacturing plants, distilleries and fish canneries. Nearby at Central Soledad is a botanical garden established by Harvard university for research in tropical agriculture. Cienfuegos is well served by railways, highways and airways. It served as an international airlines centre until Camagüey became important.

Bahia de Cienfuegos was visited by Columbus in 1494 but attracted no permanent settlement until 1738; the fortress Castillo de Jagua was erected 1740–45 at the entrance of the bay as a protection against pirates. The city was actually founded in 1819 as Fernandina de Jagua by Luis d'Clouet, a French colonel from Louisiana. The first nucleus of population consisted of 46 colonists from Bordeaux, France, as part of a colonization scheme; by 1824 there were 1,238 inhabitants. Though destroyed by a storm in 1825 it was rebuilt and renamed Cienfuegos in honour of José Cienfuegos, who participated in its founding. (D. R. D.)

CIESZYN (Ger. TESCHEN; Czech. TESIN), a Polish town in the Katowice *wojewodztwa* (district), lies on the Polish-Czechoslovak frontier. Pop. (1960) 23,000. The town is picturesquely situated in the Cieszyn foothills on the Olza river (a tributary of the Oder), at the edge of the Moravian Gate which divide the Carpathians from the Sudetenland. The eastern (and older) part of the town, on the right bank of the Olza, belongs to Poland; the newer part, on the left bank, to Czechoslovakia. Cieszyn was one of the oldest Silesian castles defending the approach to the Moravian Gate. In 1282 it was the capital of an independent principality, whose ruler acknowledged vassalship in 1291 to the king of Bohemia. Like Bohemia, it came under the rule of the Habsburgs. (*See* TESCHEN for the history of the duchy and region.) In 1939 Cieszyn was occupied by German forces. Metal and electrotechnical industries have been developed in Cieszyn. There are also plants for the manufacture of watches, chemicals, wood products, paper and food products. The local people have preserved one of Poland's finest regional costumes and their own dialect.

(K. M. WI.)

CIEZA DE LEÓN, PEDRO DE (*c.* 1518–1560), Spanish soldier and chronicler of Peru, was probably born in Seville, or possibly in Llerena (Extremadura). He sailed for the Indies as a young man and was in Cartagena in 1534. He went with Alonso de Heredia to Darién in 1535 and in 1538 accompanied Juan Vadillo on his perilous journey up the Cauca valley in Colombia. When Vadillo was deserted by his men Cieza de León joined Jorge de Robledo's expedition and defended him when he was tried in Panamá. Afterward he served with Sebastián de Belalcázar in Colombia and was rewarded with an estate. He was ordered to go to Peru in 1545 but instead joined Jorge de Robledo's forces again, being obliged to hide when Robledo was captured and beheaded. In 1547 he arrived in Peru to help Pedro de la Gasca assert royal authority over Gonzalo Pizarro and his rebellious followers. He returned to Spain in 1550, after traveling in the mining region of Peru and visiting Cuzco to obtain details of the Incas.

From 1541 onward, Cieza de León kept a careful diary and, because of this, Pedro de la Gasca made him his official chronicler and gave him access to state papers. The result was his monumental and accurately observed *Crónica del Peru*. Part i, geographical and anthropological, was published in Seville in 1553. Part ii, giving a firsthand account of the Inca civilization, remained in manuscript in the Escorial library until 1880. Part iii, dealing with the conquest of Peru, has been lost. Part iv, on the civil wars of the conquerors, is incomplete. Three of the projected five books, on the wars of Las Salinas, Chupas and Quito, were published in 1877. These works are among the principal sources of information about the prehistory of the Andean area and the early history of Peru. The English translations by Sir Clements R. Markham (1864, 1883, 1913, 1918, 1923) should be used cautiously. (J. C. J. M.)

CIGAR. Columbus and the conquistadors who followed him in Cuba, Mexico, Central America and Brazil found the Indians smoking a primitive form of cigar—a long, thick bundle of twisted tobacco leaves, wrapped in a dried palm or maize leaf. The Spanish word *cigarro*, from which cigar is derived, probably was an adaptation of *sik'ar*, the Mayan term for smoking. By 1600 the cigar had been introduced into Spain, where it was a symbol of conspicuous wealth for two centuries before it was widely used in other European countries.

United States.—In New England, as in Latin America, the cigar was among the forms of tobacco used by the Indians and adopted by the newcomers. Within a few years after the settlement of Connecticut in 1633 the colonists had obtained the seed of the Cuban tobacco plant. The fragrance of the Havana leaf could not be reproduced in alien soil, but the transplanted product made a blander smoke than the indigenous one. In the mid-18th century many storekeepers took barrels of homemade cigars in trade. These they usually sent to coastal towns to be peddled to sailors, or sold at low prices to inns, which set up cigar barrels from which patrons were invited to help themselves.

In 1762 Israel Putnam, later a Revolutionary general, served with the British forces in the occupation of Havana, and returned to Connecticut with a large supply of Havana cigars. Putnam's adventures had already made him a celebrity, and his example enhanced the prestige of the cigar. Before the Revolution enough of a market for cigars had developed to warrant the establishment of factories in Connecticut, New York and Pennsylvania. One of the Pennsylvania factories was in Conestoga, famed also for the Conestoga wagon. Its product, a long, thin cigar, became known as the "stogie." Later this term was applied at random to low-priced cigars.

In the early years of the 19th century the term "twofer" was coined for cigars selling at two for a cent, and cigars containing some Havana tobacco sold for a cent apiece. Even at these prices, cigar smoking ranked as an expensive taste in the pre-Civil War era, which was largely one of a barter economy. However, the popularity of the cigar grew steadily. A Currier and Ives print of 1876 depicts a cigar-smoking Uncle Sam.

The cigar faced formidable competition from the cigarette after 1880, when the Bonsack cigarette-manufacturing machine began cutting the cost of the light smoke. Cigar-making machines were slower in development; the first of these was in operation in Newark, N.J., in 1919.

"Twofer" came to signify two for 25 cents, for a cigar made of domestic wrapper and binder, with a blend of domestic and Havana filler. This priced medium-grade cigars out of the market for many smokers, and led to a classic remark by Thomas R. Marshall, vice-president in the Woodrow Wilson administration. After hearing a senator discourse at length on the needs of the country, Marshall offered his own diagnosis: "What this country needs is a really good five-cent cigar." The cigar industry was unable to produce a five-cent cigar that was widely acceptable to consumers until the early 1950s, when the "homogenized tobacco leaf" was developed. This product, used for binders, consists of leaf that has been pulverized and formed into thin sheets—a process that eliminates the previous wastage of about 30% of the binder leaf and effects a saving that can be passed on in the form of lower price or a better grade of leaf. By the 1960s, the production of five-cent cigars constituted about 40% of total unit cigar volume.

Composition.—A cigar consists of three parts: filler, binder and wrapper. The filler is the inner core which forms the body and shape of the cigar. The binder is the leaf in which the filler is wrapped to form what is known as the cigar bunch. The wrapper is the outer covering of the cigar consisting of a ribbon of leaf rolled spirally around the cigar bunch. Wrapper leaf must be strong, elastic and silky in texture and of even colour, in addition to possessing good flavour and burning properties. It is the most expensive leaf of all.

Sources of Supply of Cigar Leaf.—The most celebrated tobacco-growing area in the world is the Vuelta Abajo region in the province of Pinar del Río in western Cuba, where most of the wrapper leaf for Havana cigars is produced. Cuba produces wrapper, binder and filler leaf; other well-known cigar-leaf-growing districts in the island are Partidos, southwest of Havana, which produces a wrapper called Candela used extensively in the American market, and Remedios, also known as Vuelta Arriba, in the centre of the island. Cuban wrapper leaf is used on Jamaican cigars. In addition to Cuba, the principal sources of supply of cigar leaf are, for wrappers, Sumatra, North Borneo, Connecticut and Florida in the United States, and Italy; for binders, Sumatra, Java, and Wisconsin, U.S.; for filler, Sumatra, Java, Brazil, Jamaica, the Philippines, and Pennsylvania, U.S.

Manufacture.—The correct maturing and blending of the leaves are of prime importance and can be achieved only if sorting and grading at the tobacco farms are accurate and consistent. The manufacturer has to decide how long each grade of leaf will take to finish maturing in bond or factory and to ensure that each cigar contains the right amount of each grade in it.

First the leaves must be "stemmed" (*i.e.*, the midrib must be removed) and this cannot be done until they have been softened by moisture. Then the tobacco—wrapper, binder and filler—must be brought to the hand-maker or to the making-machine in the right blend and in the right condition and fed into the cigars in the right proportions. The classic method of hand-rolling is by knife and board with no other aids. The filler for handmaking is "long"; *i.e.*, it consists of whole sections of leaves laid longitudinally to form the "bunch." The filler for machine-making can be "long" or "short" according to the type of machine employed. "Short" filler consists of particles of leaf not laid in any particular direction. With "short"-filler machines it is possible to achieve an evenly blended and even-drawing cigar. In many factories semi-mechanical aids to handmaking are used; *e.g.*, molds in which to hold up the bunch before wrapping and "aprons" with which to roll the binder around the bunch. At a rough approximation a good hand-maker will make about 100–150 large cigars or more smaller ones in a day. The average machine will make about 12–15 cigars a minute.

The wrapper is applied spirally and, since each leaf has two halves, left and right, the spiral will run left-handed or right-handed. If the wrong hand of leaf is used, the veins will run across the cigar instead of lengthways or the wrong side of the wrapper will show.

Colour Classification.—The main colour classifications of cigars are: claro (CCC), light; colorado-claro (CC), medium; colorado (C), dark; colorado-maduro (CM), very dark; and maduro (M), exceptionally dark. The last two are seldom seen in the United States or the United Kingdom. Although the colour of the wrapper is no indication of the strength of a cigar, considerable care is exercised in the matching of colour. Good-quality cigars may be sorted into as many as 20 different shades to ensure that all cigars in a box have a uniform appearance.

Size and Shape Descriptions.—These appear after the brand name: *e.g.*, La Corona corona denotes a corona shape and size cigar of the La Corona brand. (Corona, as a size and shape description, is in universal use and is not restricted to the La Corona brand.) The following are some of the descriptions used: Corona, a straight-shape cigar with rounded top (the end placed in the mouth) about 5½ in. long; petit corona or corona chica, about 5 in. long; très petit corona, about 4¼ in. long; half a corona, about 3¾ in. long; Lonsdale, same shape as a corona, about 6½ in. long; ideales, a slender torpedo-shaped cigar, tapered at the lighting end, about 6½ in. long; bouquet, a small torpedo-shaped cigar; Londres, a straight cigar, about 4¾ in. long. A panatela is a longish, thin cigar open at both ends, usually about 5 in. in length with a straight shape but sometimes possessing a "shoulder" (*i.e.*, slightly drawn in) at the mouth end. Originally it had a finished top that had to be cut off before smoking. A cheroot is a thin cigar open at both ends, usually thicker and stubbier than a panatela, and sometimes slightly tapered. A whiff in Britain is a small cigar open at both ends, about 3½ in. in length.

Conditions of Storage.—Cigars should be kept in a fairly dry and warm (not hot) atmosphere, care being taken to maintain constant conditions. The temperature should be from 64° to 67° F., with a relative humidity of about 53%–57%.

Great Britain and Europe.—The cigar was slow in spreading from Spain to other European countries. American sailors helped make it known in Hamburg and Rome, where it was being manufactured on a small scale in the late 1780s. Veterans of the 1814 campaign against Napoleon's forces in Spain brought the cigar to Britain, but it was an expensive luxury. The introduction in 1823 of an import duty on manufactured tobacco products three times as high as that on unmanufactured tobacco made them even more expensive. By 1827 cigar smoking was sufficiently prevalent in London to attract the attention of the cartoonist. Several British cigar manufacturers exhibited at the Great Exhibition of 1851 and in the second half of the 19th century other British firms took up manufacture. F. W. Fairholt, writing in 1859, reported that the taste for cigars, which 30 years earlier were quite an aristocratic luxury, had greatly increased and that prices ranged from the "Penny Pickwick," named after Charles Dickens' celebrated hero, to a shilling or more for a really fine cigar. But any further expansion in the popularity of cigars in Britain was cut short by the advent of the Virginia cigarette in the last quarter of the 19th century. From the outset, the British public liked the mild Virginian flavour, and the invention of the high-speed cigarette-making machine enabled cigarettes to be produced far more cheaply than the cheapest cigar. The very high rate of tobacco duty also contributed to the low level of cigar consumption in the U.K., since the effect of the duty is more apparent on a single cigar than on a cigarette or a pipe of tobacco.

Imported Havana and Jamaican cigars have a high reputation among connoisseurs, but many discriminating cigar smokers appreciate the fine quality of the best British cigars, made in the U.K. of Havana leaf, which are much lower in price. Owing to wartime restrictions and dollar stringency, imports of Havana cigars into Britain were suspended during World War II and were only resumed in 1952 on a limited scale. During this period the market in the U.K. for high-class Jamaican cigars was developed and, by the time imports of Havana cigars were resumed, the Jamaican cigar had established a place for itself, although at a level of sales lower than immediately after the war. Jamaican cigars are generally considered in the U.K. to be slightly milder in flavour than Havanas and, since less duty is paid on them, they are less expensive. Most of the cigars smoked in Britain, however, are manufactured in the U.K. In the early 1960s about one-fifth of the cigars sold in the U.K. were imported, compared with one-third in 1938.

During World War II sales of cigars in the U.K. fell to under 1,000,000 lb. a year and it was not until 1958 that they again reached the 1938 figure. A notable development in the postwar years was the rise in popularity of small-size cigars of the miniature and whiff type, which accounted for about 80% of the total U.K. cigar consumption in the early 1960s. The small cigar was chiefly responsible for making cigar smoking a year-round pleasure, instead of being confined mainly to the Christmas season and special occasions.

In Europe the domestic cigar is a good deal cheaper than in Great Britain because of the lower import duties on leaf tobacco. The Dutch, who are big manufacturers of cigars—using mostly Indonesian and Brazilian leaf—began exporting cigars and whiffs on a significant scale to the U.K. in the early 1950s. These cigars and whiffs, which are sold at prices near to those of comparable British brands, are very mild and obtained some popularity. Germany also is a cigar-smoking nation and has a big domestic production, using mostly East Indian and some domestic-grown leaf; German manufacture barely meets home consumption. Another big cigar-smoking country is Denmark. The basis of most European cigar brands is East Indian, Brazilian and some Havana leaf. *See* Tobacco; Cigarette.

See Fernando Ortiz, *Cuban Counterpoint* (1947); Robert K. Heimann, *Tobacco and Americans* (1960). (A. H. Ma.; X.)

CIGARETTE. The term cigarette, denoting a paper-wrapped roll of finely cut tobacco, is an adaptation of the Spanish *cigarro*. Its original meaning was "little cigar," but cigarette tobacco is usually of a different type, milder than that of the cigar (*q.v.*).

The Aztecs had a primitive cigarette, in the form of tobacco stuffed into a hollow reed or cane tube. Other natives of Mexico, Central America and parts of South America crushed tobacco leaves and rolled the shreds in corn husk or other vegetable wrappers. However, it was the cigar rather than the prototype of the cigarette that the conquistadors borrowed from the Indians and brought to Spain as a luxury of the wealthy class. Paper-wrapped cigarettes were improvised early in the 16th century by the beggars of Seville, who picked up discarded cigar butts, shredded them and rolled them in scraps of paper. These poor man's smokes were known as *papeletes* or *cigarillos*. It was not until late in the 18th century that they acquired respectability. Spreading then to Italy and Portugal, they were carried by Portuguese traders to the Levant and Russia. The French and British troops fighting each other on Spanish soil in the Napoleonic campaign of 1814 became familiar with the light smokes, as well as with cigars. It was in France that they acquired the name of cigarettes.

A cigarette factory powered by steam was set up in Havana in 1853. In 1854 a commentator on the social scene in New York, R. T. Trall, complained that some of the fashionable ladies were "aping the silly ways of some pseudo-accomplished foreigners, in smoking tobacco through a weaker and more feminine article, which has been most delicately denominated cigarette." However, the widespread use of the cigarette in the English-speaking world dates from the end of the Crimean War, which introduced the British soldiery to Turkish cigarettes. A cigarette factory was established in London in 1856, using Latakia tobacco. Curiously, although British taste switched later to straight Virginia cigarettes, the American public developed a preference for a blend including some Turkish tobacco.

United States.—Early manufacture in the U.S. was entirely by hand, either in factories or by the smoker (the "roll-your-own" method). The paper was often any type available, but later it was imported from France, where linen was reworked for this purpose. Equipment in early factories was extremely simple. Essentially the process consisted of hand-rolling on a table followed by pasting and hand-packaging. In 1883 girls working in these factories earned a maximum of $9 for rolling 15,000 to 18,000 cigarettes per week. The tobacco was reduced to granules or flakes by hand-crushing or beating.

A shredding or cutting machine was patented in 1860 by W. H. Pease, but was not widely used for many years. A crude cigarette-manufacturing machine was exhibited at the Philadelphia Centennial exposition in 1876. In 1880 James A. Bonsack patented a cigarette machine with several basic features. The prepared tobacco was fed onto a continuous strip of paper that entered a forming tube. In the tube the paper formed a cylinder, passing a pasting brush before being closed. A rotary cutting knife was activated by differential gears to permit intermittent action, and cut the cigarette into the proper length. In 1884 a printing attachment was added. Each of these crude machines did the work of about 50 hand-rollers, making nearly 100,000 cigarettes per day, and reduced the cost of manufacture from 80 to 30 cents per 1,000. Production increased from 500,000,000 cigarettes in 1880 to 1,000,000,000 in 1885 and 4,000,000,000 in 1895.

Consumer preference for tobacco products thereafter shifted enormously. Plug or chewing tobacco and snuff were dominant in 1850, while pipe smoking reached its peak in the next half century. Cigars continued in unchallenged favour until 1920, when their consumption was equaled by cigarettes. Cigarette consumption reached half of total tobacco consumption by 1938 and three-fourths by 1950. In 1960, 80% of the money spent on tobacco in the U.S. was used to purchase cigarettes.

The composition of the American cigarette changed several times. Turkish cigarettes, composed wholly of tobacco imported from the orient, were favoured first, but their popularity was soon shared by Virginia types, using tobacco from the Carolinas and Virginia. With the outbreak of World War I the supply of oriental tobacco to the United States was virtually cut off, and the supply of flue-cured tobacco became inadequate. The American blend, which then appeared, contained Burley and Maryland tobaccos in addition to flue-cured and Turkish, and continued thereafter with no marked changes.

Mechanization entered the cigarette industry to a marked degree in the first half of the 20th century. Tobacco from the farm may have the midribs removed by a stemming machine; this constitutes so-called green stemming. After drying, packing in hogsheads and aging up to three years, the tobacco is moistened and stemmed if this was not previously done. With certain classes of tobacco a thresher can be used for the same purpose. Blowers are used to remove dust and foreign matter.

A series of treatments alternately using moist and dry heat is used for domestic tobacco. Blending of all types in the proper proportions is done in revolving drums. This is followed by a storage known as bulking to ensure equal distribution of moisture. Cutting is done by machines equipped with self-sharpening rotary blades that shred the tobacco into strips only a few hundredths of an inch wide. After several days' storage, the blended mixture is made into cigarettes.

In general, four classes of tobacco are used in American blend cigarettes. Flue-cured or bright, the largest component, is grown in Virginia, North Carolina, South Carolina, Georgia and Florida. A high sugar and low nicotine content is desirable in bright tobacco. Burley, an air-cured class, second in importance, is grown in Kentucky, Tennessee, Ohio, Indiana, Missouri, Virginia, West Virginia, North Carolina and limited areas in other states. In the cigarette, Burley counteracts the acid smoke of bright to produce a neutral reaction. Maryland, also an air-cured type, has limited use to improve burning properties and aid aroma.

Turkish tobacco, imported into the U.S. mainly from Turkey and Greece, but also from Syria, Yugoslavia and Italy, is classed as aromatic tobacco but is also desirable because of its low nicotine content and mild taste. A modest quantity of aromatic tobacco is grown in the mountainous parts of North Carolina.

Standard machines produce 1,200 cigarettes a minute. Packaging machines, working twice as fast, wrap 20 cigarettes at a time in paper-backed foil, paper label and cellophane. Refinements in cigarette-making machinery resulted in notable increases in speed of operation. Uniformity was improved, for example, by microfeed controls, in which twin beams of nucleonic particles compare the density of the cigarette rod with a standard. The current thus generated and amplified finally regulates the feed mechanism automatically. Filter-tip attachments insert a double-length filter plug between two cigarettes, detach the tipping material and cut the assembly in two.

While packages of 20 cigarettes wrapped in paper, foil and cellophane are the most common unit, sliding boxes of 20s, "flat 50s" and tins of 50 are available. Cartons of 10 packages are packed in cases of 50 cartons for shipment. All of the packing is done by automatic machines.

Dependence of the U.S. industry on France for cigarette paper was no longer necessary after the early 1930s. Linen paper of the highest purity, made from flax straw, supplied the demand for cigarette papers. (O. E. S.)

Production of cigarettes in the U.S. increased about 600% between 1915 and 1930; a rise of about 110% occurred during and after World War II. A decline in domestic sales occurred in 1953 and 1954, following publication of research reports, accepted by some medical authorities and disputed by others, that linked cigarette smoking with lung cancer. The upward trend in sales was resumed in 1955, and by the early 1960s total production reached almost 500,000,000,000 units. Filter-tip cigarettes, which accounted for only 1.4% of production in 1952, had risen to above 50% of production in the early 1960s.

Great Britain.—Popular taste in the United Kingdom favours the Virginia cigarette. Sweetening ingredients are not permitted in cigarettes sold in the United Kingdom. Joseph Baker, cigar merchant and tobacconist, of Cheapside, London, writing in 1845, referred to the cigarette (which he described as "a pinch of Maryland placed within a square slip of paper") as rarely being used in the United Kingdom, save by foreign visitors, though the Spanish paper necessary for the purpose might be had at most tobacconists. The first cigarettes that came on the market were of the Turkish or oriental type. Virginia cigarettes were introduced around 1870 and soon ousted the oriental type in popular favour. The latter still retained a certain social cachet up to World War I but by the beginning of the 20th century the Virginia cigarette was already well in the ascendancy. Virginia tobacco grown in the U.S. is the principal tobacco used in cigarette manufacture in the United Kingdom, but large quantities of similar-type tobacco imported from the Federation of Rhodesia and Nyasaland, Canada and India are also used. The description "Virginia tobacco" is commonly used in many countries as applying to flue-cured tobacco leaf wherever grown.

Originally all cigarettes, including those produced in factories, were hand made. It is generally accepted that Robert Peacock Gloag became the first to manufacture cigarettes in England for sale when he opened a factory at Walworth, London, in 1856. The early cigarettes he produced, made by hand, were extremely crude and, in order to prevent the tobacco from escaping, the ends were turned in. The tobacco used was Latakia dust, the paper yellow tissue and there was a cane mouthpiece, in the Russian style. The cigarettes were put up in bundles of ten, to be retailed at 6*d.* In the 1860s–1870s Polish and Russian cigarette makers were employed by London tobacconists. The first Virginia cigarettes were hand made but by that time hand-making was of high standard.

The advent of the cigarette-making machine played a major part in the popularization of the cigarette and the development of the cigarette trade. In 1883 W. D. and H. O. Wills, who had been manufacturing cigarettes since 1871, bought the English patent in the Bonsack machine, the first really efficient cigarette-making machine to be invented, and put it into production. As a result they were able to make considerable reductions in their cigarette prices. The cheapness of cigarettes, combined with their convenience, made a wide appeal to the public, and sales mounted.

In the British manufacturing process the leaf first must be moistened to make it pliable for stemming (*i.e.*, removing the stalk or midrib). The next process is to cut the leaf into fine shreds. The cut tobacco is then conditioned, usually in large rotary drums, where it is first subjected to heat to remove excess moisture and then cooled. Handmade cigarettes are relatively rare, but for smokers who wish to make their own, various "roll-your-own" devices are on the market. In factory production, cigarette-making machines can produce from 1,000 to 1,500 or more cigarettes per minute, according to the size and type of cigarette. The cigarette paper is put up in bobbins of definite width and is fed into a narrow trough at the side of the machine. The name of the brand is imprinted on the paper at regular intervals so that it will appear on each finished cigarette. The shredded tobacco or "rag" falls upon or is drawn by suction onto the paper, which moves into a funnel-shape tube, passing a device that gums the edges, the paper then being automatically folded over the tobacco, thus forming a continuous length that is then cut into cigarettes by a revolving knife.

In the United Kingdom the type of package widely used is known as a hull and slide carton, usually containing 10 or 20 cigarettes. The cigarettes are automatically packed by machinery by which they are counted, wrapped in foil and tissue and placed in a cardboard slide. The slide is then inserted into a hull of cardboard. The machines are also capable of placing an insert in the package if necessary. The hinged lid, or "flip top," carton has also become popular. The packages of many brands of cigarettes in the U.K. are wrapped in moisture-proof transparent film in order to protect them from the varied conditions of humidity prevalent in the British Isles.

At the beginning of the 20th century four-fifths of the tobacco consumed in the U.K. was used in pipe tobaccos and only about one-eighth in cigarettes. By 1914 cigarettes were fast catching up with pipe tobaccos and by the end of World War I they had overtaken them. Afterward cigarettes rapidly went ahead and by the 1960s accounted for well over four-fifths of the total U.K. tobacco consumption.

In the early 1960s approximately 240,000,000 lb. of tobacco were used annually in cigarettes for home consumption, compared with 155,000,000 lb. in 1938 and 13,000,000 lb. in 1901. The increase in smoking by women contributed to the rise in cigarette consumption. The prejudice against smoking by women was first broken in World War I but it was not until the late 1920s and the 1930s that smoking by women started to become at all general in the United Kingdom. Even by 1939 consumption of cigarettes by women accounted for only about an eighth of the total consumption of cigarettes in the U.K. By the 1960s the proportion had risen to nearly one-third, and over two-fifths of the female population aged 15 and over were smokers.

There are two main popular classes of cigarettes, the medium size and the smaller size.

In the 1950s there was a considerable rise in popularity of tipped cigarettes; *i.e.*, cigarettes tipped with some material other than tobacco. These are not a modern innovation: there were tipped cigarettes on the market in the 19th century but up to World War II their sales were extremely small. In 1949 the leading United Kingdom manufacturers introduced new tipped brands with the object of producing more cigarettes from the then limited supplies of leaf tobacco and also of offsetting to some extent the effect of the enormous increase in the tobacco duty by providing cheaper cigarettes for smokers of limited means. Since in the United Kingdom the duty is assessed on the weight of the leaf tobacco used, it is possible to sell tipped brands at lower prices than untipped brands of corresponding size, as less tobacco is used in the tipped cigarettes. The British smoker is conservative and it was some time before tipped cigarettes became at all popular, but undoubtedly the main factor in their increased popularity was their lower price. This is borne out by the fact that the most popular tipped brands are in the medium size and smaller size classes of cigarettes. King-size or long-size tipped brands, which mostly sell at the same retail price as the medium-size untipped cigarettes, had only a limited success in the U.K. and at the end of 1959 they accounted for just over 1½% of total cigarette sales in the country. The pattern of the cigarette trade in the United Kingdom in the early 1960s was therefore very different from that in the United States and some other countries, where tipped cigarettes accounted for half or more of the cigarette trade and king-size cigarettes had achieved considerable success.

The effect of the duty on prices of cigarettes in the United Kingdom is shown by the fact that in 1960 the duty paid to the government on a packet of untipped cigarettes accounted for nearly three-quarters of the retail price. (A. H. Ma.; X.)

Europe.—Development of the cigarette industry in France, Belgium and other western European countries is quite comparable to that in the United States and Great Britain. The mechanization of the industry is aided by the use of different machines developed in several countries, notably Sweden and Switzerland. Average cigarette consumption in European countries usually ranges from one-third to two-thirds the U.S. usage. *See* also Tobacco.

(O. E. S.)

CIGNANI, CARLO, Conte (1628–1719), Italian painter who carried on the Bolognese baroque tradition in his use of ample, generalized forms, fluently turning poses, deep colours and blended contrasts of light and shadow, was born at Bologna on May 15, 1628, and trained there chiefly under Francesco Albani. In sentiment his work was characteristic of a tradition that derived its elements in the first place from Correggio, but Cignani was influenced also by Correggio directly, and his masterpiece, the "Assumption of the Virgin" in the cupola of Forli cathedral, was closely based on Correggio's cupola in Parma cathedral. He executed numerous altarpieces, mythological scenes and several fresco decorations (*e.g.*, in the ducal palace, Parma). He died at Forli on Sept. 6, 1719.

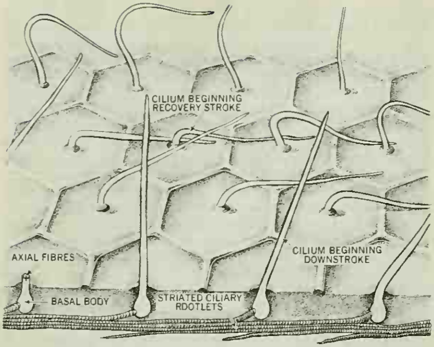
His son Felice Cignani (1660–1724) and nephew Paolo Cignani (1709–64) were also painters. (M. W. L. K.)

CIGOLI, LODOVICO CARDI DA (1559–1613), Italian painter, architect and poet whose work reflected the many crosscurrents in Italian art between the decline of Michelangelesque mannerism and the beginnings of the baroque, was born at Cigoli, Tuscany, on Sept. 21, 1559. He worked both in Florence and in Rome and trained under Alessandro Allori and Santi di Tito. There are few consistent characteristics in his earlier work beyond some north Italian strength of colour and lighting. He was an innovator in sentiment rather than in style and, like Federigo Barocci, foreshadowed baroque emotions. From 1595 onward he began to reflect the new realistic tendencies. These qualities are well illustrated in his "Ecce Homo" (*c.* 1607; Pitti palace, Florence). His architecture (*e.g.*, the court of the Palazzo Nonfinito, Florence, 1604) shows Palladian elements. He died in Rome, June 8, 1613. (M. W. L. K.)

CILEA, FRANCESCO (1866–1950), Italian composer whose operas are distinguished by their melodic charm. He was born at Palmi, Calabria, on July 26, 1866, and while studying at the Naples conservatory produced an opera, *Gina*, which secured him a commission from Edoardo Sonzogno, the publisher. In 1897 appeared his first important work, *L'Arlesiana*, based on Alphonse Daudet's drama. *Adriana Lecouvreur* followed in 1902. Cilea held several teaching appointments, among them the directorship of the Naples conservatory (1916–35). Besides his operas he composed some chamber music. He died at Varazze, near Genoa, on Nov. 20, 1950.

See E. Moschino, *Sulle opere di Francesco Cilea* (1932). (Dy. H.)

CILIA are microscopic filamentous projections of the living protoplasm of cells. They are capable of thrashing or undulating and propelling the cell to which they are attached through the surrounding watery medium, or of causing water currents to sweep by the cell. They are generally shorter, thinner and more numerous than related organelles called flagella (*see* Flagellum). Cilia and flagella, however, have the same basic structure (*see* below).


CILIUM BEGINNING RECOVERY STROKE
AXIAL FIBRES
CILIUM BEGINNING DOWNSTROKE
BASAL BODY
STRIATED CILIARY ROOTLETS

CILIARY APPARATUS OF THE PROTOZOAN PARAMECIUM IN VARIOUS PHASES OF PENDULAR MOTION

Cilia are found on the surface of certain protozoa (ciliates), on the sperm of some plants and on the cells of certain surfaces (ciliated epithelia) in multicellular animals.

Functions.—With the curious exception of two large groups of invertebrate animals, the roundworms (nematodes) and the crustacean arthropods, all animals depend on the movement of cilia or flagella for the performance of certain vital functions. The motility of these organelles provides the power for the locomotion of many unicellular algae and protozoa and for many multicellular animals such as rotifers, sea gooseberries and many aquatic larvae. The spermatozoa of most animals are propelled by flagellar movement and may thereby reach and fertilize an egg. Sedentary animals often depend on ciliated surfaces for the creation of water currents to bring in food and to provide for respiration; such is the function of the ciliated gills of clams and of sea squirts.

In some animals ciliated surfaces are very important in the movement of internal fluids and small particles. For example, cilia circulate the cerebrospinal fluid within the ventricles of the brain and spinal cord, and surfaces such as the lining of the air passages (lungs, windpipes, nasal cavities) are efficiently cleansed by the action of cilia sweeping away small particles of dust, bacteria, etc., that become lodged in the thin layer of surface moisture.

Food is carried through the digestive tracts of snails and clams entirely by the motion of cilia. Ciliary action is also responsible for transporting eggs in mammals from the ovary through the oviducts.

In addition to providing various types of motion, cilia may have a sensory function. The retinal rods of the eyes of mammals are ciliary derivatives, and some cilia are responsive to touch (thigmotactic); when stimulated, they will cease beating.

Structure and Mechanism.—Cilia are distinguished from other filamentous projections by their motility and by the presence of axial fibres within the shaft. Studies of cilia and flagella with the electron microscope have shown that all these filaments contain two central longitudinal fibres surrounded by a cylinder of nine peripheral longitudinal fibres. The bundle of fibres is enclosed by a thin membranous sheath which is continuous at the base of a cilium with the outermost membrane of the cell. The central fibres usually end at the level of the cell surface, but the nine peripheral fibres continue into the cell to form a basal body variously known as a basal granule, kinetosome or blepharoplast. Often additional fibres arise from the basal body and extend into the cell. These fibres, which are often striated, are called ciliary rootlets.

Cilia appear capable of movement only when connected to their respective basal granules. None of the other cellular organelles are directly necessary for motility since isolation of fragments of cytoplasm containing cilia attached to basal granules does not interrupt the ciliary movement. The ciliary rootlets are presumed to function in the co-ordination of the phase of beating between cilia or groups of cilia. By techniques of microdissection, it has been possible to sever the ciliary rootlets which interconnect certain groups of cilia in the protozoan *Euplotes;* the groups of cilia continued to beat, but not in the normal co-ordinated fashion.

The movement of a particular cilium may be of four types: (1) pendular movement, in which the shaft bends only at the base during the effective stroke, but bends from base to tip on the recovery stroke, all movement being in one plane; (2) circular movement, in which the shaft remains straight and the tip describes a circle; (3) undulatory movement, in which consecutive waves of bending pass in a plane outward from the base; and (4) gyratory movement, in which the whole filament is thrown into a gyre or rotating spiral. Intergrades and combinations of these simplified movements occur. In general, cilia proper show the first two movements and flagella the last two.

The mechanism of ciliary movement is unknown. Two points, however, are clear: the power for the movement of the cilium or flagellum is generated throughout the length of the filament (that is, they are not passively moved by some pull arising from within the cell body), and the bending must be caused by an active shortening of some element on one side of the filament. Ciliary movement can be envisaged as a contraction, initiated at one side of the base (producing bending toward that side) and subsequent progression of the contraction to the other side of the cilium and toward the tip (producing straightening and undulation). Ciliary contraction has been likened to the contraction of muscle fibres; indeed, there are some physiological and biochemical similarities between both of these contractile structures, such as the presence of the enzyme adenosine triphosphatase, important in the release of biological energy.

See also references under "Cilia" in the Index volume.

(F. M. C.)

CILIATA, one of the classes of the phylum Protozoa (*q.v.*) characterized by the permanent possession of cilia (*q.v.*) or organelles derived from these (membranelles, etc.), which serve as locomotory and food-catching devices. They are among the most highly differentiated protozoans; free agents, sessile types and parasites occur in this class.

CILICIA, a district of Asia Minor comprising approximately the Seyhan and Itchel *iller* of Turkey. It is bounded to the north and west by the Taurus range, to the east by the Anti-Taurus, and to the south by the Mediterranean. It is geographically divided into two contrasting regions, defined by the Romans as *campestris* and *aspera* ("the plain" and "the rugged"). The northern frontier of Cilicia Campestris is formidable, with one major pass, the Cilician Gates (Gulek Bogazi) through which runs the main road from Anatolia toward Syria and Iraq. In the southeast corner of the plain, it passes through the less impressive Amanian Gates, guarded by the foothills of Mt. Amanus and the slopes of Misis Dag. Westward lies the rich Aleian plain, formed of alluvium brought down from the Taurus by the Cydnus (Tarsus Irmagi) and the Sarus (Seyhan); to the northeast is a slightly higher plain, watered by the Pyramus (Ceyhan), with occasional limestone outcrops, many of them still crowned by medieval fortresses.

West of the Aleian plain, the natural entrance to Cilicia Aspera is at Lamos (Lamas), where the rocky spurs of the Taurus reach down to the Mediterranean. Communications are difficult except near the coast and up the valley of the Calycadnus (Goksu Nehri). Further, apart from the small fertile plain at its mouth and a few pockets of earth amid the rocks, there is barely any agricultural land. In Roman times, aqueducts carried water to the coast and to some interior settlements. Pines were grown for shipbuilding, and olives planted on terraces by the seashore, but the ancient harbours of Elaeusa and Corycus, from which timber and oil were exported, are now silted up. Game is still plentiful and the sea and rivers abound with fish. *Cilicies,* the goat-hair cloth used in antiquity for tent-making is still woven.

History.—Under the Hittite empire, Eastern Cilicia (Kizzuwatna) was at first independent, but was later reduced to vassalage. At the turn of the first and second millenniums, myth suggests and archaeology confirms the arrival of Mycenaean settlers near the mouth of the Pyramus; these were reinforced along the coast during the Greek colonization period, and Celenderis in Cilicia Aspera was actually a member of the Delian league. Under the Persians, the district enjoyed semiautonomous status under native kings called by the common title of Syennisis, and in 333 B.C. Alexander marched through the Gates unopposed. After his death, the Seleucids occupied Cilicia, and founded, among other cities, Seleucia (Silifke) on the Calycadnus, later renowned for its culture and learning. In 102 B.C., the Romans made Cilicia a province though Cilicia Aspera remained infested by pirates until Pompey defeated them at Coracesium (67 B.C.). Within a century and a half, by the absorption of the client territories of Castabala and Elaeusa and the foundation of Augusta, Neronias and Flaviopolis, Rome completed the urbanization of Cilicia Campestris, while old cities like Tarsus on the Cydnus, Adana on the Sarus, and Mallos, Mopsuestia, Anazarbus and Hieropolis Castabala on the Pyramus flourished the more.

Evangelized by St. Paul himself, Cilicia is rich in early Christian monuments, especially in Cilicia Aspera, where, of the many monasteries founded, the 5th-century example at Alahan northeast of Mut (Claudiopolis), is outstanding. Cilicia produced many saints and one famous heretic, Theodore of Mopsuestia (*q.v.*). From the 7th century until 964, when Nicephorus Phocas reconquered it for Byzantium, Muslim Arabs occupied Cilicia Campestris.

In 1080 the Armenians who fled southwestward before the Seljuks established in the Taurus a principality, later destined under Leo II (1187–1219) surnamed the Great, to become a kingdom comprising Cilicia Campestris and the coastlands of Aspera (*see* ARMENIA). It fell in 1375 to the Egyptian Mamelukes. In 1515 Ottoman Turks occupied the plain, having mastered Cilicia Aspera during the preceding century.

In 1833 the Egyptian Mohammed Ali Pasha occupied Cilicia as far west as the Gates, but was forced to evacuate it seven years later. After World War I, part of Cilicia was awarded to France by the treaty of Sèvres, but in the face of stubborn Turkish resistance, during which some of the medieval fortresses were reoccupied by Nationalist troops, France in 1921 abandoned its claims.

In modern times, with the building of new roads and the consequent expansion of the cotton and citrus industries, Cilicia is one of the most prosperous territories of the Turkish republic.

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CILLI, ULRICH, COUNT OF (*c.* 1406–1456), German magnate, the position of whose family domains (on the southeastern frontier of the Holy Roman empire) served to make him a power in imperial and Hungarian affairs. The son of Frederick II of Cilli (Celje, now in Slovenia), he was married in 1432 to Catherine, daughter of the great despot of Serbia, George Brankovich. When the emperor Sigismund made him and his father princes of the empire (1436), the Habsburgs felt their status in Styria to be prejudiced and began a dispute with the Cillis that went on, intermittently, till 1443, when the Cillis acknowledged Habsburg suzerainty. Even so, meanwhile, the Habsburg German king Albert II made Ulrich regent of Bohemia in 1438, and Ulrich helped to secure the coronation of Albert's posthumous son Ladislas as László V of Hungary in 1440. Intervention in Hungary proper, together with attempts to assert themselves in Bosnia (from 1443) and in Croatia, led to conflict between the Cillis and the Hungarian statesman János Hunyadi (*q.v.*). Successful in 1446, Hunyadi had to come to terms with them after he fell into Brankovich's hands (1448). Having forced the emperor Frederick III to surrender László V to his guardianship in 1452, Ulrich became the virtual ruler of Hungary in 1453, when Hunyadi resigned the governorship. He was made king's lieutenant by László V in 1456, but on Nov. 8 he was murdered in Belgrade by János' son László Hunyadi. The male line of the Cillis died with him (his father had died in 1454).

CIMA, GIOVANNI BATTISTA (CIMA DA CONEGLIANO) (*c.* 1459–1517?), Italian painter of the Venetian school whose style was marked by a freshness of observation of nature, and airy, luminous colour and design, was probably a pupil of Bartolomeo Montagna, and was later influenced by Giovanni Bellini. He was born at Conegliano on the southern slopes of the Alps. His earliest dated picture is the altarpiece of 1489 in the Museo Civico of Vicenza. He was then 30 years old and his style was fully developed and altered very little during the course of his long life. In 1492 he settled in Venice and in that year was commissioned to paint an altarpiece for the cathedral of Conegliano which is still in its original place.

Most of his important works are in Venice; there are also pictures by him at Bologna, Modena and Parma and in many of the great galleries in Europe.

See B. Berenson, *Venetian Painters of the Renaissance* (1903).

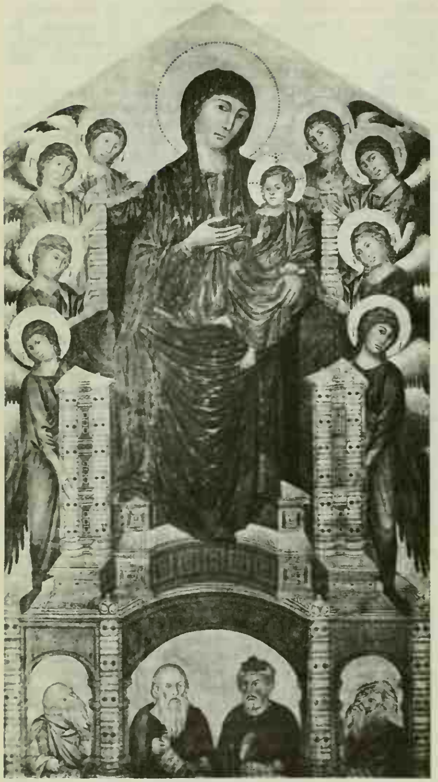
CIMABUE, GIOVANNI (CENNI DI PEPO) (1240?–after 1302?), Italian painter and mosaicist who provided a link between the Byzantine pictorial style and the early Italian Renaissance, was born probably at Florence. To a great extent he worked in the Byzantine tradition of design and coloration, but invested his solemn, monumental forms with a new mass and volume, and planned his large decorative schemes (such as the frescoes in the upper basilica of San Francesco at Assisi) with a quality of stylistic unity and aptness to their architectural setting which was unprecedented in Italian painting. Although very few facts are known about Cimabue's life, his fame among his contemporaries is attested to by the famous lines from Dante's *Divine Comedy* (*Purg.* xi, 94–96):

> Credette Cimabue nella pintura
> Tener lo campo; ed ora ha Giotto il grido,
> Si che la fama di colui' oscura.

("Cimabue thought to hold the field in painting, and now Giotto has the cry, so that the fame of him is obscured.") Cimabue's principal precursor in Tuscan painting was Coppo di Marcovaldo, and his most noteworthy immediate successor was Giotto.

Although there is no documentary evidence that a single picture attributed to Cimabue was painted by him, it is generally agreed that, despite their poor state of preservation, the frescoes at Assisi (*c.* 1277–81) most attest to his genius. Some of these scenes from the New Testament possess an unsurpassed power of tragic expressiveness and are designed with a sense of unity and consistency in spatial composition which was unequaled in his time. Many of the frescoes were probably executed by Cimabue's assistants, possibly under his personal direction. In the lower church of the same basilica Cimabue, succeeding Giunta da Pisa, is said to have adorned the south transept painting above the altar of the Conception, a colossal "Virgin and Child Between Four Angels," as well as a large figure of "St. Francis." In 1301 he was appointed *capomaestro* of the mosaics of the cathedral of Pisa, where he executed a majesty in the apse—"Christ in Glory Between the Virgin and John the Evangelist," a mosaic, now much damaged. The style of this work differs somewhat from that at Assisi, some of the linear dynamics being sacrificed for the equilibrium of volumes and the monumental dignity of the human form. Among other extant works possibly the most important is the "Madonna and Child" with eight angels, and some prophets in niches (Uffizi, Florence). A year before his death, Cimabue joined with Arnolfo di Cambio as architect for the cathedral at Florence.

According to a story related by Lorenzo Ghiberti, writing in mid-15th century, Cimabue was the master of Giotto whom he found as a shepherd boy of ten, in the pastures of Vespignano, drawing with a coal on a slate the figure of a lamb. Cimabue took him to Florence, and instructed him; and after Cimabue's death Giotto occupied a house which had belonged to his master in the Via del Cocomero. Another painter with whom Cimabue is said to have been intimate was Gaddo Gaddi.



ALINARI

"MADONNA AND CHILD," GIOVANNI CIMABUE, c. 1288, IN THE UFFIZI GALLERY, FLORENCE, ITALY

Cimabue was buried in the cathedral of Florence, Sta. Maria del Fiore, after 1302.

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CIMAROSA, DOMENICO (1749–1801), one of the principal Italian composers of comic operas. He was born of a poor family on Dec. 17, 1749, at Aversa in the kingdom of Naples. His parents were anxious to give him a good education and after moving to Naples they sent him to a free school there. Beginning in 1761 he studied for 11 years at the conservatory of Sta. Maria di Loreto, where his masters included Antonio Sacchini and probably Niccolò Piccini.

He began his career by writing the comic opera *Le Stravaganze del Conte*, performed at the Teatro de' Fiorentini at Naples in 1772. The success of his first opera was followed by *L'Italiana in Londra* (Rome, 1779), a work that is still performed in Italy. From 1784 to 1787 Cimarosa lived in various Italian cities, composing both serious and comic operas that were produced in Rome, Naples, Florence, Vicenza, Milan and Turin. In 1787, at the invitation of Catherine II, he went to St. Petersburg as court musician, replacing Giovanni Paisiello. He produced two operas in St. Petersburg in 1788 and 1789, and in 1791 proceeded to Vienna at the invitation of Leopold II. There at the Burgtheater on Feb. 7, 1792, he produced his masterpiece, *Il Matrimonio Segreto* ("The Secret Marriage"), one of the highest achievements in comic opera and the work upon which his reputation was based early in the second half of the 20th century. In 1793 he returned to Italy, where *Il Matrimonio Segreto* and many others of his works were enthusiastically received. New works of this period included *Le Astuzie Femminili* (Naples, 1794) and his tragic masterpiece, *Gli Orazi ed i Curiazi* (Venice, 1796).

His chief residence was now in Naples, and during the occupation of the city by the French Republican troops in 1799, Cimarosa openly showed his republican sympathies, so that on the return of the Bourbons he was imprisoned. After being released, he left Naples broken in health and died in Venice on Jan. 11, 1801, of inflammation of the intestines. The nature of his fatal illness led to the rumour of his having been poisoned by his enemies; a formal inquest proved the charge to be unfounded.

Cimarosa was a prolific composer whose music abounds in fresh and never-failing melody. His numerous operas are remarkable for their apt characterizations and abundant comic life. His main fault is his repetitiveness. Among his instrumental works, which, like his operas, have been successfully revived, are many sparkling harpsichord sonatas and a concerto for two flutes.

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(Cs. Ch.)

CIMARRON RIVER rises in northeastern New Mexico, U.S., in Colfax and Union counties near Capulin Mountain National monument, and flows for 600 mi. emptying into the Arkansas river at Keystone, Okla. From its source the Cimarron flows east through the northern Oklahoma panhandle, bends northward through the southeast corner of Colorado and the southwest corner of Kansas over land with low rainfall. The river bed in this area is dry except during spring and early summer or during occasional floods. South of Coldwater, Kan., where annual precipitation exceeds 20 in., the Cimarron re-enters Oklahoma as a permanent stream. From there to the Arkansas, about 250 mi., it flows over humid land with annual rainfall of 30 to 40 in.

The Cimarron has played an important part in the history of the western United States. The direct route of the Santa Fe trail coursed along the river valley for 100 mi. in southwestern Kansas and travelers knew the Oklahoma panhandle as the "Cimarron cutoff." No cities of any size are located on the Cimarron but Guthrie, Kingfisher, Fairview, Cushing and Yale, in Oklahoma, and Folsom, N.M., are located near the river. Land drained by the Cimarron is used to raise beef cattle and hard winter wheat.

(M. J. L.)

CIMBALOM, the Magyar name for an elaborate form of dulcimer (*q.v.*). Used in small instrumental ensembles in Hungary for the performance of light music, it has a chromatic compass of four octaves and, unlike the earlier dulcimer, a foot mechanism for damping the strings. The strings are set in vibration by two small, spoon-shaped hammers. The number of strings to each note varies from three to five, some of which are "bridged" into two or three parts. The hammer heads are covered on each side with hard and soft leather to produce two distinct tone qualities. Hungarian players of the cimbalom perform mainly by ear and add to the effect of a small orchestra with florid extemporization. The cimbalom was used in a large orchestra by Kodály in *Háry János* and in smaller combinations by Stravinsky in his *Ragtime* and *Renard*.

CIMBRI, one of the ancient German tribes which created a threat to the Romans in the late 2nd century B.C. They came from Jutland, called the Cimbric peninsula by Roman writers, where the modern Himmerland (Aalborg) bears their name. Overpopulation and a great encroachment by the sea caused them to emigrate southward, up the Albis (Elbe) river and across the Danuvius (Danube), where they were repulsed by the Scordisci near the modern Belgrade. Turning west, in 113 they defeated a Roman army at Noreia in Noricum (near Klagenfurt) and then passed along the northern Alpine foothills into Gaul, numbering, with their allies the Teutoni and other tribes, a host of perhaps 500,000. In 109 and 107 two consuls, M. Junius Silanus and L. Cassius Longinus, were defeated in the Rhodanus (Rhône) valley and near Tolosa (Toulouse); and in 105 the Roman armies under the proconsul Q. Servilius Caepio and the consul Gnaeus Mallius Maximus lost 80,000 men at Arausio (Orange) (*see* ARAUSIO, BATTLE OF). The terror at Rome was now intense and Gaius Marius (*q.v.*) was put in command; but the invaders gave the new general time to reorganize while they passed into Spain, where they failed to overcome the Celtiberians. In 103 they marched back into northern Gaul, but in 102 their forces were divided for an attack on Italy. The Teutoni were destroyed by Marius at Aquae Sextiae (Aix-en-Provence); the Cimbri moved eastward to cross the Brenner pass and drove back Q. Lutatius Catulus from the neighbourhood of Tridentum (Trento). In 101 Marius and Catulus combined forces, and the entire army of the Cimbri was annihilated at Campi Raudii near Vercellae (Vercelli).

Remnants of the Cimbri survived in Jutland, whence they sent envoys to Augustus in A.D. 5. Traces of the tribe's wanderings are found in dedications to Mercury of the Cimbri at Miltenberg and Heidelberg.

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(G. E. F. C.)

CIMICIFUGA, a genus of perennial herbs of the buttercup family (Ranunculaceae; *q.v.*), comprising 12 species widely distributed in the north temperate zone; the bugbanes. The root of *C. foetida* was used as a preventive against vermin and that of the North American black snakeroot or black cohosh (*C. racemosa*) as an emetic.

The genus is distinguished from *Actaea*, baneberry, by the elongate panicles of small, white flowers (instead of short, thick clusters) and by the one to eight follicles or dry fruits (instead of one berry) developed from each flower. Some species are used in partially shaded spots in the wild flower garden.

(L. BN.; X.)

CIMMERIANS, an ancient people, first spoken of by Homer, according to whom they lived in a country of fog and darkness on the confines of the inhabited world (*Odyssey*, xi, 13–19). Herodotus, in his account of Scythia, and other ancient authors, regarded them as the early inhabitants of southern Russia, after whom the Bosporus Cimmerius (Kerch strait) and other places were named (Herodotus, *History*, iv, 11–13). They were driven by the Scythians through the Caucasus into western Asia, where they became known for their savage plundering. Strabo, however, identified them with the Thracian Treres and credited them with invading Asia Minor via the Balkans and Dardanelles (*Geographica*, xiv, 1, 40). Assyrian sources call them Gimirrai, and their name has also been identified with the biblical Gomer, son of Japheth (Gen. x, 2–3).

In Assyrian and Greek records the Cimmerians were sometimes confused with the Scythians, but the following reconstruction of their history is the most reasonable: they assaulted Urartu (Armenia) about 714 B.C. In 705 B.C., being repulsed by Sargon II of Assyria, who fell in the battle, they turned aside into Asia Minor, seizing Sinope (Sinop) on the Black sea; in 696–695 B.C., they defeated Midas and conquered Phrygia; in 679 B.C. they were driven by Esarhaddon from the Assyrian border. In 652 B.C., by taking Sardis, the capital of Lydia, they reached the summit of their power. Then their decline began and their final defeat may be dated from 637 or 626 B.C. when they were routed by Alyattes of Lydia. Thereafter they disappeared from the stage of history but probably settled in Cappadocia, as the Armenian name of that country, *Gamir*, suggests.

The origin of the Cimmerians is obscure. Linguistically they are usually regarded as Thracian, or as Iranian, or at least to have had an Iranian ruling class; the names of their most famous rulers in Asia Minor, Teuspa, Tugdamme (known to Herodotus as Lygdamis) and his son Sandakhsatra, were Iranian. Despite several theories to the contrary it is unlikely that Herodotus and other ancient authors invented the story of the Cimmerians retreating from the North Pontic area. It may be assumed, therefore, that they did live there, but attempts to define their original homeland more precisely, to recognize an archaeological equivalent, or even to fix the date of their expulsion from their country by the Scythians, have not so far been completely successful.

The following are the main theories: Most scholars agree that the Cimmerians lived north of the Caucasus and the Sea of Azov. It is plausible to identify them with the "Catacomb" culture which was ousted from that territory by the "Srubna" culture advancing from beyond the Volga, just as were the Cimmerians by the invading Scythians, but this upheaval took place in the second half of the 2nd millennium B.C. and a gap of several centuries separates it from the appearance of historic Cimmerians in Asia. No self-evident intermediate stages link these events, although there are vague hints of such. Many Russian archaeologists connect the early Cimmerians with late Bronze Age remains north of the Sea of Azov and on the Lower Dnieper (*c.* 11–7th century B.C.), calling them the "Cimmerian" culture; but this construction ignores several vital points in the written records. It is even less justifiable to place them in the central Caucasian highlands assigning them to the Early Iron Age "Koban" culture (*c.* 11–8th century B.C.), or to associate them with Bronze Age and Early Iron Age remains of the Ukraine west of the Dnieper (*c.* 1200–700 B.C.). Some authors identify them with "Thraco-Cimmerian" remains of the 8–7th century B.C. found in the southwestern Ukraine and in central Europe; these may, perhaps, be looked upon as traces of the western branch of the Cimmerians who, under fresh Scythian pressure, eventually invaded the Hungarian plain and survived there to about 500 B.C. A split of the defeated Cimmerians into an Asian and a western branch can in fact be deduced from the description by Herodotus.

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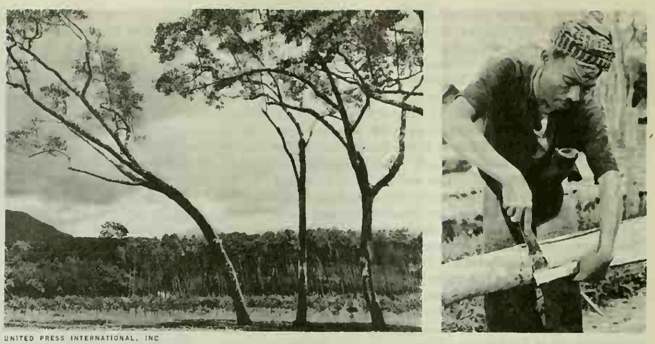
(T. SU.)

CIMON (*c.* 505–450 B.C.), Athenian general and statesman, who played an active part in building up the Athenian empire in the period following the Greco-Persian Wars, and whose conservatism and policy of friendship with Sparta were opposed to the policy of Pericles. He was the son of Miltiades, then tyrant of the Thracian Chersonese, and his second wife Hegesipyle, daughter of a Thracian prince, Olorus. For his father's return to Athens and subsequent career, *see* MILTIADES. The very large fine imposed on Miltiades after the expedition to Paros had to be paid by Cimon after his father's death in 489. He served at Salamis in 480, and under Aristides in 478 on the campaign to Cyprus and Byzantium commanded by the Spartan regent Pausanias, at the end of which the east Greek allies threw off Spartan control and formed the Delian league under the leadership of Athens. He was probably in command when the Athenians soon afterward expelled Pausanias from Byzantium, and certainly in 476 at the arduous siege of Eion at the mouth of the Strymon river in Thrace. In 475 he took Scyros, expelling the pirates, and found and brought home to Athens the supposed bones of Theseus, which greatly increased his popularity.

It is not told who commanded at the siege of Carystus in Euboea, or at the reduction of Naxos which had revolted from the league, probably in 470. But Cimon led the allied fleet in the campaign (probably of 469, though it has been dated later) in which Phaselis in Lycia was brought over to Athens, with many other com-



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LEFT. CINCHONA TREES, THE BARK OF WHICH IS THE SOLE SOURCE OF QUININE. MATURE TREES (FOREGROUND) AND YOUNG TREES (BACKGROUND) GROWING IN JAVA. RIGHT. STRIPPING BARK FROM A MATURE TREE

munities in Lycia and Pamphylia, and the Persians were decisively defeated by land and sea at the mouth of the Eurymedon river with the loss of 200 ships. Part of the spoils was used to build up the south wall of the acropolis at Athens. At the city Dionysia of 468, when the competition of tragedies came on, the judges handed over their task to Cimon and his fellow generals, and they awarded Sophocles his first prize. In 465 he was clearing the last Persians from the Thracian Chersonese when the large island of Thasos revolted from Athens. Cimon defeated the Thasians, and reduced the town after a long siege which ended in 463.

By now his popularity had waned a little, and the radical democrats Ephialtes and Pericles (*qq.v.*) were agitating for reform. Cimon was put on trial after his return from Thasos, on the charge of taking bribes from Alexander I of Macedonia to refrain from annexing territory on the mainland, but he was easily acquitted.

In 462 Sparta appealed for help against the Messenians, who had revolted at the time of the great earthquake in 464 and were now besieged on Mt. Ithome. Cimon with difficulty obtained his dispatch with 4,000 men to Ithome, but the Spartans soon dismissed the Athenian contingent, alone of their allies, as politically unreliable. The insult caused Athens to break off its alliance with Sparta (the panhellenic alliance against Persia which had been formed at the time of Xerxes' invasion) and join instead with Argos and Thessaly. It is not quite clear where Cimon was when Ephialtes carried his reform of the Areopagus (*q.v.*). but after his return to Athens he attempted without success to repeal it, and in the following spring (461) he was ostracized.

The story that he was recalled after the battle of Tanagra (458 or 457) is almost certainly untrue, and he is not heard of again until 451, when the ten years of his exile would be up. The Athenians had now given up the war in Greece, after the disaster in Egypt in 454, and were ready for peace with Sparta (*see* GREECE: *Ancient History*). Cimon negotiated a five years' truce, and in 450 led an allied expedition to Cyprus, where he died at the siege of Citium. His forces subsequently won a double victory at Cyprian Salamis and brought back his bones to Athens.

Cimon's foreign policy of friendship with Sparta greatly helped the development of Athens' hegemony after the Greco-Persian Wars, but inevitably ran into difficulties as Athens' power increased. With Aristides, he must rank as the main architect of the Athenian empire, and he was a great naval commander. His marriage with Isodice, of the Alcmaeonidae (*q.v.*), was probably of political importance, and his famous wealth and generosity also helped his career. The charge that he lacked culture was denied by his friend the poet Ion of Chios, but his culture was that of the generation before Pericles.

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CINCHONA, an important genus of shrubs and trees of the madder family (Rubiaceae; *q.v.*), closely related to coffee and ipecac. The 38 species are native to the warm, moist Amazonian slopes of the Andes from Colombia to Bolivia at elevations of 5,000–8,500 ft., a few above and some below this. They have opposite leaves and pink or whitish, sometimes fragrant, usually cymose, flowers in lilaclike clusters. A few of the species are of world importance because their bark is the only source of the alkaloid quinine (*q.v.*), the specific for malaria. Cinchona also contains other alkaloids which individually or as a mixture called totaquina are of considerable value in medicine.

The medicinal value of cinchona bark was unknown to the Incas, and it is not mentioned in Garcilaso de la Vega's *Royal Commentaries on the Incas* or in Pedro de Cieza de Leon's *Chronicles af Peru*, published in 1553. The oft repeated tale of the first use and introduction of cinchona bark to Europe by the countess of Chinchon in 1638 was completely disproved by A. W. Haggis in 1941, as the wife of the viceroy of Peru never had malaria, died at Cartagena on her way to Spain and hence could not have carried cinchona bark to Europe. Who took it there, and when, will probably never be settled. It was known to the Jesuits at Lima about 1630, hence its common appellation of Jesuits' bark and Peruvian bark. The first mention in European medical literature was by Herman van der Heyden in his *Discours et advis sur les flus de ventre douloureux* (1643).

For the next 200 years cinchona bark was ruthlessly exploited, especially after the isolation of its chief constituent by Joseph Pelletier and J. B. Caventou in 1820 had demonstrated that the quinine content dictated its price. Bark depletion seemed so inevitable that J. K. Hasskarl for the Dutch and Sir Clements Markham for the English were sent to South America between 1859–63 in an attempt to introduce cinchona culture to Java and India. Both expeditions failed because they did not secure varieties of high quinine content. In Dec. 1865 there arrived in Java a pound of seed from Charles Ledger of Puño, Peru, collected on the banks of the upper Marmoré river in Bolivia.

The progeny of these, and subsequent skilful cultivation by the Dutch, resulted in Java becoming the world source of cinchona bark and hence of quinine. Part of the Ledger seed was planted by the British at their government cinchona station in Madras, where it failed. That failure was disastrous, for India has the highest incidence of malaria in the world and the inferior Indian varieties have never yielded enough quinine. Private planters abandoned its culture for more profitable crops; and government plantations were supplemented by importation from Java. Dutch bark production is derived from *Cinchona ledgeriana*. The only other species grown commercially in Java is *C. succirubra*, which yields quinidine, cinchonine and cinchonidine.

See also CINCHONA BARK, ALKALOIDS OF; QUININE.

(N. TR.; X.)

CINCHONA BARK, ALKALOIDS OF. About 30 distinct alkaloids have been isolated from cinchona bark, of which quinine is by far the most important, followed by quinidine, cinchonidine and cinchonine.

Quinine, $C_{20}H_{24}O_2N_2$.—Quinine is still an important substance in the treatment of malaria in spite of the newer synthetic compounds now largely used. It is used in the form of its salts. The sulfate, $(C_{20}H_{24}O_2N_2)_2$. H_2SO_4, $2H_2O$, is sparingly soluble in water. The bisulfate, $C_{20}H_{24}O_2N_2H_2SO_4$, $7H_2O$ is more soluble;

the solution is levorotatory and shows a strong blue fluorescence. For injection the dihydrochloride, $C_{20}H_{24}O_2N_2.\ 2HCl$, is usually preferred. The monohydrochloride, $C_{20}H_{24}O_2N_2.\ HCl,\ 2H_2O$, is also used in conjunction with urethane for the treatment of varicose veins.

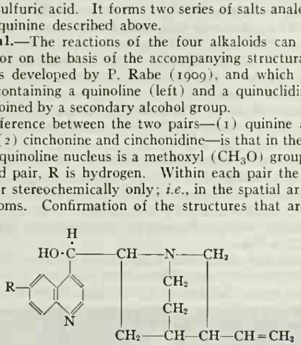
Quinidine, $C_{20}H_{24}O_2N_2$ (also called conquinine).—This alkaloid, which is a dextrorotatory isomeride of quinine, crystallizes from alcohol in colourless prisms and melts when dry at 171.5° C. It forms two series of salts analogous with those of quinine.

Cinchonine $C_{19}H_{22}ON_2$.—This alkaloid crystallizes from alcohol in rhombic prisms and melts at 264° C. It is dextrorotatory in solution and like the other cinchona alkaloids yields two series of salts with acids.

Cinchonidine, $C_{19}H_{22}ON_2$.—This levorotatory isomeride of cinchonine (*see* above) crystallizes from alcohol in large colourless prisms, melting at 207° C., and corresponds with quinine in being levorotatory in solution, but is unlike it in showing no fluorescence in dilute sulfuric acid. It forms two series of salts analogous with those of quinine described above.

General.—The reactions of the four alkaloids can all be accounted for on the basis of the accompanying structural formula which was developed by P. Rabe (1909), and which represents them as containing a quinoline (left) and a quinuclidine (right) nucleus, joined by a secondary alcohol group.

The difference between the two pairs—(1) quinine and quinidine and (2) cinchonine and cinchonidine—is that in the first pair, R on the quinoline nucleus is a methoxyl (CH_3O) group, while in the second pair, R is hydrogen. Within each pair the two alkaloids differ stereochemically only; *i.e.*, in the spatial arrangement of the atoms. Confirmation of the structures that are assigned to the cinchona alkaloids involved great difficulty. It was attained in 1931 with the synthesis of dihydroquinine and dihydroquinidine by Rabe and with that of quinine itself by R. B. Woodward and W. E. Doering in 1944.



Cinchona Alkaloids, Type Formula

(T. A. H.; L. F. Sl.; T. M. Sp.)

CINCINNATI, a city and seat of Hamilton county, O., U.S., on the right bank of the Ohio river opposite the mouth of the Licking river. Cincinnati is about 116 mi. S.W. of Columbus, about 281 mi. by rail S.E. of Chicago and about 755 mi. by rail W.S.W. of New York city. Through the city flows Mill creek; to the east the Little Miami and to the west the Great Miami empty into the Ohio. Pop. (1960) city, 502,550; standard metropolitan statistical area (which includes Hamilton county in Ohio and Campbell and Kenton counties in Kentucky), 1,071,624. Other cities in the metropolitan area are Norwood (*q.v.*) in Ohio and Newport and Covington (*qq.v.*) in Kentucky. (For comparative population figures *see* tables in OHIO: *Population* and KENTUCKY: *Population.*)

Cincinnati is on two plateaus—one about 600 ft., the other 100–150 ft. above low water—and on hills (400–460 ft.) which enclose these terraces on three sides. The city has a river frontage of about 27 mi. Bridges connect the city with Covington and Newport, Ky.; the suspension bridge between Cincinnati and Covington (1,057 ft. between towers), designed by John A. Roebling, was built in 1867 and rebuilt and enlarged in 1897.

On the terraces the streets generally intersect at right angles, but on the hills irregularly. The wholesale district is for the most part in the "bottoms." Manufacturing is scattered widely with the largest concentration also in the "bottoms" area of the city. Many of the finer residences are on the enclosing hills.

History.—The site of Cincinnati was a centre of the mound-builder civilization. La Salle is said to have been the first white man to pass this point on his way down the river in 1669. In 1788 John Cleves Symmes (1742–1814), New Jersey congressman, purchased for himself and others 1,000,000 ac. of land between the two Miami rivers from the U.S. government. Columbia, the first settlement, was founded near the mouth of the Little Miami in 1788. Six weeks later a town was laid out opposite the mouth of the Licking river and in Feb. 1789 a third settlement was begun at North Bend. John Filson named the second of these settlements Losantiville, a word which he himself fashioned from elements of Latin, Greek, French and Delaware Indian, and which he intended to mean "the town opposite the mouth of the Licking." Ft. Washington was built there in 1789. In the following year Gen. Arthur St. Clair, newly appointed governor of the Northwest Territory, created Hamilton county, changed the name of Losantiville to Cincinnati in honour of the Society of the Cincinnati, the Revolutionary officers' society, and made it the county seat. Gen. Anthony Wayne's victory at Fallen Timbers in 1794 opened the country to settlement. Cincinnati was incorporated as a town in 1802 and became a city in 1819.

In 1811 the "New Orleans," the first steamboat on western waters, passed Cincinnati and opened a new era in the commercial life of the region. The Miami canal was completed to Dayton in 1832 and the first section of the Little Miami railway was laid in 1843. Steamboat building and manufacturing began to grow. River commerce reached its height in 1852 with 8,000 steamboat arrivals.

In 1842 Cincinnati was one of the few U.S. cities admired by Charles Dickens but by the late 1840s another British visitor, a Mrs. Houston, called it "a city of pigs, a monster piggery." Small wonder that it received the nickname of "Porkopolis"; between 1842 and 1852, 27% of the hogs packed in the United States were packed there. As the grain fields moved west the meat packing industry went with them and Cincinnati lost its primacy to Chicago and St. Louis, Mo.

Although Cincinnati had close commercial and cultural ties with the south it became an important station on the Underground Railroad prior to the American Civil War and sided with the North when war came. In 1862 the fear of a threatened invasion by a Confederate force under Gen. Edmund Kirby-Smith caused the city to be put under martial law for a time, but the invasion did not take place.

Population Trends.—The early settlers in Cincinnati came mainly from the middle states, especially from New Jersey and Pennsylvania, and from the southern states of Kentucky and Virginia. By 1815 there were emigrants from all of the 17 other states in the union and from most of the countries of central and western Europe. It was not until the middle of the 19th century that Cincinnati began to have a large foreign-born population. Early immigrants came mainly from the central and northwestern European lands and by 1850 comprised nearly one-half the total population of the city. Germans were the most numerous, followed by Irish, English, Scots and Welsh. Of all the foreign-born groups the Germans were the most rapidly assimilated. They began the development of agriculture and grape culture in the area and also made significant contributions to the cultural life of the community, especially in music. By the 1890s the section of the city north of the canal was known as the Over-the-Rhine region. Since then the German population has spread throughout most of the areas of the city. In the 1880s some thousands of Italians and Russians moved to Cincinnati, the number of Russians reaching its peak in 1910 and the Italians in 1920. By the middle of the 20th century, however, Cincinnati had a small foreign-born population as compared with other industrial centres of the area. The non-white population, mainly Negro, was then approximately 11% of the total population but has increased since that time.

Government.—Since 1924 Cincinnati has had a council-manager form of government. There is a council of nine who for 32 years were elected by proportional representation. In 1957 this method was abandoned. The council elects one of its members as mayor and selects the city manager for an indefinite term. The mayor presides at meetings of the council and appoints the city auditor and members of independent commissions and boards.

The city manager prepares the budget, appoints heads of departments, and enforces legislation enacted by the council.

The rapid growth of Cincinnati led to the adoption of a city master plan in 1925. A revised metropolitan master plan completed in 1948 called for the redevelopment of the downtown water front, a system of motor expressways and off-street parking facilities, the reclamation of blighted areas and the protection of residential neighbourhoods.

Industry.—The Cincinnati metropolitan area has over 1,800 industrial plants producing a great variety of products. Cincinnati is a foremost producer of machine tools, playing cards and soap. It is also a leader in the production of building materials, cans, chemicals, children's vehicles, clothing, coffins and burial cases, cosmetics, electric motors and machinery, electrotypes, foundry and machine shop products, jet engines, malt and distilled liquors, mattresses, meat packing, motor vehicles and parts, office furniture, paper and paper products, pianos and organs, plastics and plastic products, printers inks, printing and publishing, processed seeds, sheet metal products, shoes, sporting goods, steel mill products and valves. Cincinnati is also a major bituminous coal shipping centre of the United States.

Transportation.—The city is served by the Cincinnati Transit company, operating diesel and gas buses and trolley buses. In the early 1960s a major road-building program was completed, providing 30 mi. of expressways in Cincinnati and 50 mi. in Hamilton county. Eight trunk line railroads radiate from the city. The Union terminal, completed in 1933, can accommodate 17,000 people and 216 trains daily. The Cincinnati Southern railway is municipally owned but is leased to and operated by a privately owned railroad. Other forms of transport include certified water freight carriers; numerous contract and private barge lines and several passenger carriers; airlines operate from Lunken Municipal airport and the Greater Cincinnati airport in Boone county, Ky.

Education and Cultural Activities.—The system of public-supported education includes in addition to the usual kinds of schools, one six-year college preparatory school, a vocational school and several special schools, and is completed by the University of Cincinnati, created under the Ohio municipal university act of 1870. The university was established by uniting Cincinnati college (1819), the Cincinnati Astronomical society (1842) and McMicken university (1859). The college of medicine (1819) and the college of law (1833) of the university are the oldest institutions of their kinds west of the Alleghenies. The co-operative system of technological education based on the idea that college instruction should be combined with practical work in industry was originated at the University of Cincinnati by Dean Herman Schneider.

There are Roman Catholic and Concordia Lutheran parochial schools and three Roman Catholic institutions of higher learning: Xavier university for men, founded in 1831 by Bishop Fenwick, and Our Lady of Cincinnati (1935), and Mt. St. Joseph-on-the-Ohio, Mt. St. Joseph, O. (1920), both for women. There are no Catholic seminaries within Cincinnati, but Mt. St. Mary of the West (1829) is in Norwood. The Institutum Divi Thomae (1915), primarily devoted to scientific research, is no longer under diocesan jurisdiction.

The Hebrew Union college (founded 1875) is the oldest rabbinical college in the United States. On Jan. 25, 1950, it was merged with the Institute of Religion of New York. Its archives are a depository for documents on American Jewish history and its library has an eminent Judaical collection as well as an outstanding collection on Spinoza.

Other institutions of higher learning are the Ohio Mechanics institute, a private technical college founded in 1828; Salmon P. Chase college (1893); the Art academy (1887); and the College-Conservatory of Music (formed in 1955).

Cincinnati has a large public library, established in 1867, and two excellent special libraries: the John Uri Lloyd library, with material in the fields of pharmacy, botany and the natural sciences; and the library of the Historical and Philosophical Society of Ohio, which has excellent collections of books and manuscripts on the history of the old northwest.

By 1825 musical academies and choral societies were numerous in Cincinnati. It was, however, the large influx of Germans in the 1840s and later that promoted music most. A sängerfest was held in 1849 and again in 1870, when a hall was built for it. Under Theodore Thomas (1835–1905) the Cincinnati Musical Festival association was incorporated and its biennial May festivals began in 1873. The Springer Music hall was built in 1875–78 and the Cincinnati College of Music was endowed in 1878. Theodore Thomas was director of the college until 1881 and of the May festivals until his death. The sängerfest met in Cincinnati for the third time in 1870 and its jubilee was held there in 1899. Choral societies have been important in musical life, as have the Cincinnati Conservatory of Music (1867), the Cincinnati Symphony orchestra (1893) and the summer opera performances.

A number of early U.S artists, including the sculptors Frederick Eckstein and Hiram Powers, lived in Cincinnati, where German influence greatly promoted the visual arts. In 1877 the Woman's Art Museum association brought about the building of the Art museum. An art academy was erected in 1887 near the Art museum. Frank Duveneck (*q.v.*) was for some time director of the academy and the Duveneck room in the museum contains a great many of his works. The Taft House museum (1932) was a gift to the city from Charles P. Taft and his wife; it included their home and art collection. The Rockwood pottery (1880) was the first in the United States to devote its attention exclusively to art ware.

Notable monuments in the city are the Tyler Davidson bronze fountain (1871) designed by August von Kreling; James A. Garfield by Charles H. Niehaus; William Henry Harrison by L. T. Rebisso; Abraham Lincoln by George Grey Barnard; the Galbraith memorial; and a monument to Ohio volunteers killed in the American Civil War.

In 1958 the *Cincinnati Post* bought the *Cincinnati Times-Star* to form the *Cincinnati Post-Times-Star;* this and the *Cincinnati Enquirer* becoming the only daily newspapers published in the

BY COURTESY OF CINCINNATI CHAMBER OF COMMERCE

THE TYLER DAVIDSON BRONZE FOUNTAIN (1871) SEEN AT NIGHT IN FOUNTAIN SQUARE, CINCINNATI. CAREW TOWER, THE TALLEST BUILDING IN CINCINNATI, IS IN THE BACKGROUND city. The Cincinnati Literary club celebrated its centennial in 1949.

Within close vicinity of the Cincinnati College of Medicine are the General hospital and the Children's, Christian R. Holmes, Jewish, Good Samaritan, Christ, Bethesda and Deaconess hospitals. A Veterans administration hospital was completed in 1954; Drake memorial and Longview state hospital for the mentally ill are also in Cincinnati.

The U.S. government building, Union terminal, Hamilton county courthouse and the city hall are monumental structures. Notable among the hundreds of churches are St. Peter in Chains, erected 1845 by Archbishop John B. Purcell, used as the cathedral church until 1938, restored and rehabilitated by Archbishop Karl Alter, and dedicated Nov. 3, 1953; St. Francis de Sales; the First (1835) and Second Presbyterian (1872); and Christ Church (1835) rebuilt and dedicated April 12, 1956. The city is the seat of a Roman Catholic archbishopric and a Protestant Episcopal bishopric.

Parks and Recreation.—Cincinnati parks are under a park board of three members appointed by the mayor. The board was created in 1908 when the city owned 488 ac. of parks; in the latter part of the 20th century the city's parks comprised about 4,000 ac. and in addition there were more than 50 playgrounds. In general, the parks are located on hilltops, affording a view of the downtown area, the Ohio river and the neighbouring hills. A few of the larger parks are Mt. Airy forest, the first municipal forest in the United States, containing a spectacular collection of vegetation native to the area; Eden park, overlooking the Ohio river and the location of the Irwin M. Krohn conservatory, featuring displays of tropical and greenhouse plants and special flower exhibits, and the Cincinnati Art academy; Ault park, where there is open-air dancing in the pavilion during the summer; Burnet woods, adjacent to the University of Cincinnati campus, with boating available on the lake; and Alms park, from which there is an especially fine view of the Ohio river. The Cincinnati Zoological gardens (founded 1875, acquired by the city in 1933) have the Fleischmann aquarium, containing native and tropical fish; lion and ape houses; and over 1,000 birds, mammals and reptiles. A summer opera with Metropolitan stars has been held at the zoological gardens each year since 1921.

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CINCINNATI, SOCIETY OF THE, a hereditary, military and patriotic organization formed by officers of the American Revolutionary army, was established in May 1783, shortly before the army was disbanded. Founded to promote friendship, to perpetuate the rights for which they had fought, and to aid members and their families in case of need, the Cincinnati took their name from the Roman citizen-soldier, Lucius Quinctius Cincinnatus (*q.v.*), whom they professed to follow.

The "Institution," or constitution of the society, was adopted May 13, 1783, at a meeting at Baron von Steuben's headquarters at Newburgh-on-the-Hudson, N.Y. It provided that membership was to pass through eldest male descendants or, should the line fail, through collateral branches judged worthy of membership. French officers who had served in America in the war were invited to organize a branch of the society in France. Provision was also made for honorary membership. More than 2,000 officers signed the rolls as original members and each contributed the one month's pay required to join. They organized branches in each of the 13 American states and in France. Gen. George Washington was elected the first president-general of the society, and Maj. Gen. Henry Knox (*q.v.*), with whom the plan for the Cincinnati originated, was elected secretary-general. Washington served until his death in 1799 when he was succeeded by Alexander Hamilton. James Monroe was also an original member. Benjamin Franklin and Gouverneur Morris were among early honorary members.

The hereditary feature and the restriction of membership to officers brought the society almost immediately under strong attack. Judge Aedanus Burke of South Carolina in a widely circulated pamphlet accused the Cincinnati of conspiring to create "a race of hereditary patricians or nobility," and Thomas Jefferson was one of the society's most influential critics. Attacks prompted the society at its first general meeting, in May 1784, to abolish the hereditary principle for membership, but the action was not ratified by the state societies; the hereditary qualification thus remained in effect.

Early opposition, together with the dispersion and the death of original members, hampered the growth of the society, and some of the state societies became dormant. By 1835, societies remained only in Massachusetts, New York, New Jersey, Pennsylvania, Maryland and South Carolina; these continued, and in the late 19th century all of the defunct societies were revived. L'Ordre de Cincinnatus, organized in France and permitted to wear the emblem of the society by Louis XVI, was dispersed by the French Revolution and was not revived until the 1920s.

The revived societies flourished both in the United States and in France. Branches remained restricted to each of the original 13 American states and France, but membership was widely scattered. In 1937, Larz Anderson, a member, bequeathed the society his home in Washington, D.C., as a headquarters and museum. The society has established medals, prizes and scholarships to promote education.

The insignia of the society, designed by Maj. Pierre Charles L'Enfant (*q.v.*), comprised a gold eagle suspended by a blue and white ribbon "emblematic of the union of America and France" and bearing the figure of Cincinnatus ready to leave his plow to defend his country. The city of Cincinnati, O., was named in honour of the society in 1790. (N. E. Cu.)

CINCINNATUS, LUCIUS QUINCTIUS (b. *c.* 519 B.C.), in ancient Rome dictator (*q.v.*) and one of the early heroes. He worked his own small farm. A persistent opponent of the plebeians, he resisted the proposal of Gaius Terentilius Harsa (462 B.C.) to draw up a code of written laws applicable equally to patricians and plebeians. According to Roman tradition Cincinnatus was twice dictator. In 458 he rescued the consular army which was besieged by the Aequi. Defeating them in one day, he entered Rome in triumph, before returning to his farm. In 439 he became dictator to check Spurius Maelius who was accused of aspiring to be king. The story of his success against the Aequi is probably historically accurate, but details given by Livy (late 1st century B.C.) are not credible.

See Livy, *History of Rome*, iii, 26–29; H. Last, in *Cambridge Ancient History*, vol. vii, pp. 501 ff. (1928).

CINCLIDAE, a family of small birds that can walk under water. They are about the size of a thrush, have thick and oily plumage that enables them to withstand severe cold and are found in the northern hemisphere. *See* DIPPER.

CINDERELLA, the heroine of an almost universal fairy tale (*i.e.*, little cinder girl). Its essential features are (1) the persecuted maiden whose youth and beauty bring upon her the jealousy of her stepmother and sisters; (2) the intervention of a fairy or other supernatural instrument on her behalf; (3) the prince who falls in love with and marries her. In the English version, a translation of Perrault's *Cendrillon*, the glass slipper which she drops on the palace stairs is due to a mistranslation of *pantoufle en vair* ("a fur slipper"), mistaken for *en verre*. It has been suggested that the story originated in a nature myth, Cinderella being the dawn, oppressed by the night clouds (cruel relatives) and finally rescued by the sun (prince).

CINEAS (3rd century B.C.), a Thessalian, the chief adviser of Pyrrhus (*q.v.*), king of Epirus. He was regarded as the most eloquent man of his age. He tried to dissuade Pyrrhus from invading Italy, and after the defeat of the Romans at Heraclea in Lucania (280 B.C.) was sent to Rome to discuss terms of peace. These terms, which are said by Appian to have included the freedom of the Greeks in Italy and the restoration to the Bruttii, Apulians and Samnites of all that had been taken from them, were rejected. Two years later Cineas was sent to renew negotiations on easier terms. The result was a cessation of hostilities, and Cineas crossed over to Sicily to prepare for Pyrrhus' campaign. Nothing is related of him thereafter. He is said to have made an epitome of the *Tactica* of Aeneas (4th century B.C.), probably referred to by Cicero, who writes of a Cineas as the author of a treatise *De re militari.*

Bibliography.—Plutarch, *Pyrrhus,* 11–21; Justin, xviii, 2; Eutropius, ii, 12; Cicero, *Ad Fam.,* ix, 25.

CINEMA: *see* Motion Pictures.

CINERARIA, the earlier name, still used by florists, for cultivated ornamental plants originated from species of *Senecio.* There are two distinct types, the garden species, of which one of the commonest is the dusty miller, *S. cineroria,* and the greenhouse varieties of *S. cruentus,* commonly referred to simply as cinerarias. Greenhouse cinerarias are of two types: one a dwarf, compact-growing plant with large flowers in dense clusters; the other a taller-growing variety with larger, more spreading clusters of small star-shaped flowers. These are known horticulturally as stellate varieties of *Cineraria cruentus.* Both are easily grown from seed and are sold commercially as potted plants. The very free-flowering stellate varieties are more popular than are the large-flowered types, and through a careful selection and crossing of varieties many beautiful colours are available.

T. H. EVERETT

CINERARIA (SENECIO CRUENTUS)

For a succession of blooming plants during the late winter and spring months seeds are first sown in August in the cool greenhouse. As soon as the seedlings can be handled conveniently they are put in 2¼-in. pots. Later they are shifted to three-inch pots as the root system develops. The final shift into six-inch flowering pots is made early in January. Soil for cinerarias should be of a light, porous character and a mixture of one-half fibrous loam, one-half leaf mold with a liberal sprinkling of sharp sand suits them admirably. They grow best in a night temperature of from 45° to 50° F. with an increase of about 10° during the day. The soft succulent character of foliage and stems makes cinerarias especially liable to be attacked by insect pests. The plants should be frequently fumigated with nicotine preparations or sprayed with nicotine solutions.

CINNA, in ancient Rome the cognomen, or third name, of a patrician family of the gens Cornelia.

Lucius Cornelius Cinna (d. 84 b.c.), leader of the popular party in Rome opposed to the legislation of L. Cornelius Sulla (*q.v.*), was consul successively from 87 to 84 b.c. After serving in the Social War (90–88), Cinna became consul in 87. When Sulla left for the east, Cinna repealed his laws and threatened him with prosecution. His proposed revival of the law of Sulpicius Rufus about newly enfranchised citizens caused riots in Rome, and Cinna was expelled. He at once collected an army, Gaius Marius (*q.v.*) joined him and they captured Rome. Proscriptions followed, and the death of Marius on Jan. 13, 86, left Cinna in control. He remained consul, with L. Valerius Flaccus in 86, and with Gnaeus Papirius Carbo in 85–84. He was responsible for some economic measures and for giving the recently enfranchised Italians fair voting rights. In 84 he prepared to advance against Sulla, but was killed in a mutiny at Ancona. His daughter Cornelia married Julius Caesar.

Lucius Cornelius Cinna, praetor in 44 b.c., son of the above, sided with Caesar's murderers.

Gnaeus Cornelius Cinna, consul in a.d. 5, the praetor's son (the *Cinna* of Corneille), was pardoned by the emperor Augustus for alleged conspiracy (about 16–13 b.c.?). (H. H. Sd.)

CINNA, GAIUS HELVIUS (1st century b.c.), Roman poet, wrote a mythological epic poem *Smyrna.* He was a friend of the poet Catullus, whom he accompanied to Bithynia in the suite of the praetor Memmius. Suetonius, Valerius Maximus, Appian and Dio Cassius all state that, at Caesar's funeral, a certain Helvius Cinna was killed by mistake for Cornelius Cinna, the conspirator. The last three writers add that he was a tribune of the people, while Plutarch states that the Cinna who was killed by the mob was a poet. This points to the identity of Helvius Cinna the tribune with Helvius Cinna the poet. The chief objection to this view is based upon two lines in the 9th eclogue of Virgil, supposed to have been written in 41 or 40 b.c., which seem to imply that Helvius Cinna was then alive. But such an interpretation of the passage is not absolutely necessary. Apart from the *Smyrna* Cinna is credited with having written a *Propempticon Pollionis,* a poem in the form of a "send-off" to his friend Asinius Pollio. In both these poems, the language of which was so obscure that they required special commentaries, his model appears to have been Parthenius of Nicaea.

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CINNABAR, sometimes written cinnabarite, is red mercuric sulfide, or native vermilion. Cinnabar is the principal ore of mercury (*q.v.*). The chief producing areas are Almaden, Spain, where it has been mined for 2,000 years; Idria, Yugos.; and the Monte Amiata district, Italy. Cinnabar also is mined in commercial quantities in the U.S. in Alaska, Arizona, California, Idaho, Nevada, Oregon and Texas, in Mexico and the U.S.S.R. Cinnabar is generally found in a massive, granular or earthy form, of bright red colour, but it occasionally occurs in crystals with a metallic adamantine lustre. The crystals belong to the hexagonal system and are generally of rhombohedral habit, sometimes twinned. Fine specimens come from the provinces of Kweichow and Hunan, China.

Cinnabar presents a remarkable resemblance to quartz (*q.v.*) in its symmetry and optical characters. Like quartz it exhibits circular polarization, and A. des Cloizeaux showed that it possessed 15 times the rotatory power of quartz (*see* Light). Cinnabar has a high refractive power, its mean index for sodium light being 3.08. The hardness of cinnabar is 3, and its specific gravity 8. The formula is HgS. Hepatic cinnabar is an impure variety in which cinnabar is mixed with bituminous and earthy matter. Metacinnabar is a black cubic dimorphous form of mercury sulfide.

(W. F. Fg.)

CINNAMON. The bark of the cinnamon tree, *Cinnamomum zeylanicum,* laurel family, native to Ceylon and adjacent India. This is not the biblical cinnamon, which is thought to be cassia, *Cinnamomum cassia.* Yet it ranks high among the spices of the east, in the pursuit of which fortunes were gained and empires built.

World production, several thousand tons annually, comes mostly from Ceylon, even though the species has been introduced around the world. Holdings of Singhalese princes and the later English overlords gave way to small private plantations.

The continuously pollarded trees (bushy and shrublike) produce suckers or "water sprouts," the bark from which contains up to 1% of a volatile oil high in cinnamic aldehyde, responsible for the cinnamon fragrance.

The bark is stripped in summer, when abundant sap permits easy peeling. Cut twigs, preferably second-year growth, are trimmed of the shiny, simple leaves and hand peeled at the peeling shed. Sections of inner bark, thoroughly dried and scraped free of epidermis, make the hollow, tubelike "quills" of commerce. Fragments are salvaged, as they can be pulverized to yield powdered cinnamon or cinnamon extract.

Cinnamon was once more valuable than gold; it was sought for embalming and witchery in Egypt, for rites in the Tabernacle and as a flavour in medieval Europe. Later it was the most profitable spice in the Dutch East India company trade. In modern times it finds most use in bakery goods and as a home flavouring. Oil distilled from the chips is said to be medicinal. (R. W. Sy.)

CINNAMON STONE: *see* Garnet: *Varieties.*

CINNAMUS, JOHN (fl. 2nd half of the 12th century), Byzantine historian, was probably imperial secretary (*basilikos grammatikos*) to Manuel I Comnenus (1143–80), whom he accompanied on his campaigns in Europe and Asia Minor. His history of the period 1118–76, continuing the *Alexiad* of Anna Comnena, covers the reigns of John II and Manuel I, down to the unsuccessful campaign against the Turks of Iconium when the Byzantines were routed at Myriocephalum. Cinnamus was probably an eyewitness of the events of the last ten years which he describes. The work breaks off abruptly, and appears to be in an incomplete form. The author's hero is Manuel, but in spite of his conviction that the Greek east was superior to the Latin west and his opposition to papal claims he retains considerable objectivity.

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CINO DA PISTOIA (whose real name was CINO SIGIBULDI) (*c.* 1270–*c.* 1336), Italian poet and one of the group described by Dante as of the "*dolce stil nuovo*" (*see* ITALIAN LITERATURE). He was born in Pistoia between 1265 and 1270, and in *c.* 1290 went to the University of Bologna to study law, remaining there for about ten years. A member of the faction of the Blacks, in 1300 he was exiled with them from Pistoia but was allowed to return in 1306. In 1309 he was sent as ambassador to Florence. Like Dante, of whom he was a friend, Cino had great political hopes of the emperor Henry VII's expedition to Italy; after the emperor's death (1313), he devoted himself to his juridical studies. On completing, in 1314, his commentary on the first nine books of Justinian's *Codex,* he obtained his doctorate at Bologna. Between 1321 and 1331 he was successively professor of law at Siena, Florence, Perugia and Naples. He then retired to Pistoia, where he died in 1336 or 1337.

Cino's sonnets and *canzoni,* written in the style of the *stil nuovo* school, even if with a more realistic psychology, possess literary interest rather than poetical value. Dante, however, considered him among "those who have most sweetly and subtly written poems in Italian" (*De vulgari eloquentia*, i, 10) and a line of Cino's (*la dolce vista e 'l bel guardo soave*) was included by Petrarch in one of his own poems.

See G. M. Monti, *Cino da Pistoia giurista* (1924); G. Zaccagnini, *Le rime di Cino da Pistoia* (1925). (G. A.)

CINQ-MARS, HENRI COIFFIER DE RUZÉ, MARQUIS DE (1620–1642), the last favourite of Louis XIII of France and the leader of the last great conspiracy against the cardinal de Richelieu, was a younger son of the marshal d'Effiat (Antoine Coiffier), whose territorial name Effiat he liked to use. Richelieu, who took him under his protection on the marshal's death (1632), decided in 1639 that the king's favourite, Marie de Hautefort, was to be dismissed from court and that Cinq-Mars might take her place. The king accepted him readily. Cinq-Mars was made *grand écuyer de France* ("grand master of the stable"; hence his designation as Monsieur le Grand, just as the inferior *premier écuyer* was Monsieur le Premier) and experienced the peculiar effects of Louis XIII's favour: intimate confidences, with jealousy and bickering followed by reconciliations drawn up as formal treaties between them. Impatient of this limited role (which impeded his love affairs and obliged him to go hunting, against his inclination), Cinq-Mars sought political influence, but was brusquely rebuffed by Richelieu when he tried to enter the council chamber. He then decided to get rid of his old benefactor. His participation in the abortive conspiracy of the comte de Soissons (Louis de Bourbon) in 1641 escaped detection. He then began a fresh plot with Gaston, duc d'Orléans (*q.v.*), and Frédéric Maurice, duc de Bouillon, for a *coup d'état* against Richelieu. Early in 1642 an agent was sent to Madrid to get Spanish help: the secret "treaty of Spain" was signed by Philip IV on March 13. Cinq-Mars went with Louis from Narbonne to besiege the Spaniards in Perpignan, but Richelieu, who was ill and felt himself in danger, went instead to Arles. There, on June 11, a document came into his hands proving the treason of the plotters, which he sent at once to Louis, now back at Narbonne. On June 13 Cinq-Mars was arrested, hiding in an attic. Bouillon was arrested in Piedmont on June 23; Orléans confessed his guilt. Brought to trial, Cinq-Mars and François-Auguste de Thou, a far less guilty conspirator, were beheaded at Lyons on Sept. 12, 1642.

It is doubtful what the compromising document was. If it was a copy of the treaty, who betrayed it to Richelieu?

(J. G. R.-S.)

CINQUECENTO, a term used to describe that period of the Italian Renaissance between 1500 and 1600. The word is often applied to the artistic styles prevalent at that time, and particularly to the classicism of the high Renaissance.

CINQUE PORTS, the name of a confederation of maritime towns in southeast England, formed during the 11th century to furnish ships and men for the king's service and still surviving in the 20th century. The ports originally constituting the confederation were five in number—Hastings, Romney, Hythe, Dover and Sandwich, but there were afterward added the "antient towns" of Winchelsea and Rye (*qq.v.*) with the privileges of "head ports." More than 30 other towns in Kent and Sussex were attached to the head ports as limbs or members; there were corporate members, their membership being confirmed by royal charter, and noncorporate members associated with their head port by private agreement. The ports constituted the only federation of towns in England. *See* HASTINGS; NEW ROMNEY; HYTHE; DOVER; SANDWICH.

The Cinque ports provided the permanent nucleus of the royal fleet until the 14th century. They were probably first associated in the reign of Edward the Confessor for the defense of the coast and the cross-channel passage. After the Norman conquest their importance grew and their privileges were increased. At first the confederation was informal and had no permanent rules or institutions. Loosely linked by common duties to the crown, geographical position and common economic interest in fishing, the ports were flourishing independent boroughs in their own rights, more closely tied to their "limbs" than to each other.

The Cinque ports reached their greatest importance in national affairs during the 13th and 14th centuries, when their duties and privileges were extended. They were first jointly granted liberties by charter in 1278. They played an important part in the civil wars of the 13th century, and as a result the crown tried to gain more control over them, giving the ports a common officer, the lord warden, and making the court of Shepway independent of other royal courts. Administrative unity was thus first imposed from without, and not developed by the portsmen themselves. After the 14th century the Cinque ports lost their monopoly of sea power. They continued to contribute to the navy, but their contributions declined in importance as the conditions of naval warfare changed, and in 1588 the ports sent only five ships against the Armada. Their decline was accelerated by the changing coast line, some ports silting up while others were gradually eroded.

The constitutional organization and permanent institutions of the Cinque ports were mainly developed between the 14th and 17th centuries. As they declined in importance the ports needed to act together to defend their privileges. To meet this need the court of Brodhull gradually developed into a representative assembly which dealt with local affairs and combated any encroachments on the members' ancient rights. The court of Guestling was another federal institution, developed later, and ultimately the two combined as the "courts of Brotherhood and Guestling."

The highest officer in the Cinque ports is the lord warden, who is also constable of Dover castle. One of the most important permanent features of the Cinque ports organization was his position as admiral of the ports, with maritime jurisdiction. Walmer castle is the official residence of the lord warden. Sir Winston Churchill was appointed to the office in 1941 by King George VI.

The court of admiralty of the Cinque ports holds a jurisdiction concurrent with the admiralty court, coextensive but not exclusive within limits extending from Shore Beacon in Essex to Redcliff, near Seaford in Sussex, and seaward to a point 5 mi. off Cape Gris-Nez. The judge sits as the official and commissary of the lord warden, just as the judge of the high court of admiralty sat as official and commissary for the lord high admiral. The Cinque ports' court is probably the older of the two, since the lord warden holds the more ancient office (*The Lord Warden* v. *King in His Office of Admiralty,* 1831, 2 Hagg. Admy. Rep. 438). Of old, the court sat sometimes at Sandwich, sometimes at other ports, but the regular place for the sitting of the court was for a long time at St. James's church, Dover, which was destroyed in

World War II. For convenience, the judge later sat at the royal courts of justice, and the last full sitting was in 1914.

The registrar who, according to general civilian practice, acts as the judge's deputy, deals at Dover with the matters which keep the ports' jurisdiction alive. Appeal is to the sovereign in council, advised by the judicial committee. For details of the jurisdiction *cf.* the Cinque Ports act, 1821. (For the barons of the Cinque ports *see* Baron.)

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CINTRA: *see* Sintra.

CINYRAS, the legendary first king of Paphos in Cyprus. He was traditionally the founder of the famous cult of Aphrodite there and the ancestor of a line of priest-kings. He also was said to have been the father of Adonis. Homer, in the *Iliad*, describes Agamemnon as wearing a magnificent breastplate, the gift of Cinyras, but later tradition describes how Cinyras, having failed in his promise to help the Greeks against Troy, was punished by the Greek invasion of Cyprus. (H. W. Pa.)

CIPRIANI, GIOVANNI BATTISTA (1727–1785), Italian painter, was the first exponent in England of neoclassicism as championed in Rome by Pompeo Batoni and Anton Raphael Mengs, and thus played an important part in directing English academic taste. He was the pioneer of what may be called the "Adam" style in decorative painting. Born in Florence, Cipriani was a pupil of the Anglo-Florentine painter Ignazio Hugford and was influenced by Antonio Domenico Gabbiani.

His early work is now represented by the painted organ curtain in Sta. Maria Maddalena dei Pazzi, Florence, and by two altarpieces at Pistoia. In 1750 he went to Rome, where he encountered the dawning taste for the neoclassic and met members of the English colony. The architect Sir William Chambers and the painter Joseph Wilton brought him to England in 1756 with the Florentine sculptor Giovanni Battista Capezzuoli. From then on he lived in England and died in Hammersmith on Dec. 14, 1785. He collaborated with Wilton and Capezzuoli in 1760–62 on the ornamentation (restored in 1953) of George III's state coach, designed by Chambers. He became a foundation member of the Royal Academy in 1768.

Cipriani's other important decorative works include the ceilings of the library at Buckland house, Berkshire (after 1757), and the tapestry room at Hagley hall, Worcestershire (before 1760), both of which still show baroque qualities; the painted room at Standlynch (now Trafalgar) house, Wiltshire (after 1766), an example of illusionistic wall painting with a continuous landscape with figures, certainly his most charming work; and the four allegorical panels surrounding Sir Joshua Reynolds' figure of "Theory" in the cove of the ceiling of the Royal Academy, Somerset house (1780). Cipriani was also a prolific draftsman of classical and allegorical subjects. (E. C.-My.)

CIRCAR (Sarkar) was a term applied to a subdivision of a subah, or province of the Mogul empire of India. The Northern Sarkars figured in British diplomacy during their rivalry with the French for control of India and afterward in their attempts to secure the aid of the nizam of Hyderabad against Haidar Ali. These Northern Sarkars correspond to the modern Srikakulam district southward to the Nellore district inclusive, and were then named Chicacole, Rajahmundry, Ellore, Kondapalli and Guntur. They were the richest parts of Andhra Pradesh (*q.v.*), Guntur being strategically as well as economically valuable.

See *Gazetteers* of the Godavari district (1907) and the Vizagapatam district (1915); E. J. Rapson, Sir Wolseley Haig and H. H. Dodwell (eds.), *Cambridge History of India*, vol. v (1929). (J. D. M. D.)

CIRCASSIA: *see* Cherkessia.

CIRCASSIAN (Cherkess), a Caucasus mountain people divided into two chief groups, the Adygei (Cherkess proper) and the Kabardians. The Adygei are at times referred to as the lower Cherkess and the Kabardians as the upper Cherkess. They inhabit the northwestern parts of the Caucasus in the vicinity of the Black sea; some live along the middle course of the Kuhan river, and a large group lives in Anatolia, Turk.

According to the Soviet census of 1959, there was a total of 284,000 persons in both divisions of the Cherkess; the Adygei numbered 80,000 and the Kabardians 204,000. About four-fifths of the Cherkess live in the Soviet Union, and about one-fifth live in Turkey. There were approximately 67,000 Cherkess listed in the Turkish census of 1945.

By their linguistic affiliation the Cherkess are a part of the larger Abkhaz-Adygei group, which, in addition to the Cherkess, includes Abkhaz, Abazin and Ubykh. All these languages are localized in the Caucasus and in neighbouring areas. They are spoken chiefly in the Soviet Union, with the exception of the Cherkess of Turkey and the Ubykh. The Ubykh moved from the Caucasus to Turkey in the 19th century and have remained there since. The entire group of languages is more distantly related to the Georgian (Gruzin) group, and together these two groups form the so-called Caucaso-Iberian family. These various linguistic groups have many members who live close together and have a common genesis. However, few of the tongues are mutually comprehensible. The entire Caucasus area is characterized by the prolixity of languages in a small compass. It has been known from the times of classical antiquity as a "mountain of languages." (*See* also Caucasian Languages.)

A large part of the Cherkess live in the plain immediately to the north of the Caucasus. Another part live in the mountain piedmont, and a small portion live in the upland and mountainous parts of their country. The Cherkess economy is typical of the Caucasus peoples both in subsistence pattern and technology. In their traditional economy they are a mixed pastoral and farming people, with a minor dependence on orchards for fruit growing. They long had a primitive plow of their own and were at one time famous in many parts of the world for their woolen cloth. More recent products of note are their felts and horses.

According to the great Caucasus scholar V. F. Miller, the Cherkess have existed in their locality from times antedating the period of classical antiquity. Greek and Roman writers describe the Cercetae, Heniochae, Maeotae, Sindi, Zichi and other tribes of the area who form an early link in the chain of Cherkess cultural history. Pastoralism was of great importance among these early peoples.

There is an Iranian element in their vocabulary dating from preclassical times. The north Iranian Schuths, later Ossetes, had a strong influence upon them. However, Miller has shown that this is not a genetic relationship but rather one of borrowing.

Their traditional society had a group of princes, *pshi*, who elected a supreme prince, *vali*. Below this rank were the nobles, *uork* and *uzden* (*vali* and *uzden* are derived from the Turkish). The princes and nobles controlled the herds and soil, while the mass of the people were organized in a complex system of subordinate ranks, living in extended families and tribes. Families were patriarchal and in part polygynous. Slavery was maintained until recent times.

The Kabardians had a more complex organization than the Adygei or Cherkess proper, who had a weakly developed aristocracy and no princedom. Both had a type of primitive village commune, the *psukho*.

Officially, the Cherkess religion is Sunni Muslim, which came to them from the Crimea and Turkey during the 16th–18th centuries. Christianity had been introduced from the 6th century on through Byzantium and Georgia but disappeared. Pre-Christian cults, associated with thunder, fertility rites and the sacred grove, were reported in modern times.

Women traditionally held a low place in Cherkess society; they were to be found in harems of oriental potentates and magnates. In the winter they were often confined to the hearth for lack of warm clothing.

The Circassians were subjected by Russia in 1864 and have subsequently diminished in number and territory. In the present period they live chiefly in the Karachai-Cherkess Autonomous *oblast* (*q.v.*) of the Russian Soviet Federated Socialist Republic and in the Kabardino-Balkar Autonomous Soviet Socialist Republic (*q.v.*).

See also CAUCASUS, PEOPLES OF.

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CIRCE, in Greek legend, a famous sorceress, the daughter of Helios and the ocean nymph Perse. She was able by means of drugs and incantations to change human beings into the forms of wolves or lions, and with these beings her palace was surrounded. Odysseus visited her island, Aiaie, with his companions, whom she changed into swine, but the hero, protected by the herb moly, which he had received from Hermes, compelled her to restore them to their original shape. He lived with her for a year, and when he determined to leave she instructed him how to sail to the House of Hades in order to learn his fate from the prophet Teiresias. Upon his return she also gave him directions for avoiding the dangers of the journey home.

Greco-Italian tradition placed her island near Italy, or located her on the promontory Circei. *See* also PICUS; SCYLLA AND CHARYBDIS.

CIRCEO, MONTE, an isolated promontory on the southwest coast of Italy, about 80 mi. S.E. of Rome, dominating the landscape at the southern end of the Pontine marshes, opposite Terracina. It consists of a conspicuous ridge of limestone, 3½ mi. long by 1 mi. wide, rising to a height of 1,175 ft. and connected with the mainland by a low saddle of Tertiary deposits, nowhere more than 53 ft. high. From the sea in particular it bears all the appearance of an island, and its association with the legend of Circe was already well established in classical times. The modern village of San Felice Circeo (pop. [1957] 2,772), toward the east end of the promontory, occupies the site of the ancient Circei. About 8,000 ac. are preserved as a national park, notable particularly for its flora. The numerous coastal grottoes have yielded plentiful traces of Paleolithic settlement, referable to two distinct phases, the one (Pontinian) Mousterian in character, the other (Circeian) Middle Aurignacian. In 1939 a Neanderthal skull came to light in association with the former, in circumstances suggestive of ritual cannibalism. Previously a Volscian fortress, Circei became a Latin colony in 393 B.C. As a site for wealthy villas Cicero compares it with Antium, and the emperors Tiberius and Domitian both possessed residences in the neighbourhood. During the middle ages the castle of San Felice changed hands many times and was twice totally destroyed, in 846 by the Saracens and in 1441 by Alfonso of Aragon. Its principal function was that of a papal outpost against attack by sea. As late as 1727 Tunisian pirates carried off 27 inhabitants.

The remains of an enclosure of massive quasi-cyclopean masonry high up on the mountain are those of the acropolis of the colony of 393 B.C.; it was linked by a wall with the lower city. An artificial platform on the summit is that of a temple dedicated to Circe, apparently identified as Venus. Around San Felice and at the opposite end of the promontory there are the remains of several large villas. Among them, partly excavated and yielding much fine statuary, is that of Domitian on the lagoon called Lago di Paola near the small town of Sabaudia. There are many traces of ancient fisheries and oyster beds. The district produces an excellent table wine.

BIBLIOGRAPHY.—G. Lugli, *Forma Italiae*, I, i, 2 (1928); S. Aurigemma *et al.*, "Circeo, Terracina, Fondi," *Itinerari dei Musei e Monumenti d' Italia*, no. 97 (1957). For the geology and prehistory of the region, *see* A. C. Blanc in *Quarterly Journal of the Geological Society of London*, 93:621–651 (1937). (J. B. W.-P.)

CIRCLE, a curve consisting of all those points of a plane that lie at a fixed distance from a particular point in the plane, called the centre.

The circle is the simplest example of a plane curve and alone possesses the property of being exactly alike at all points. If the curve is turned in its plane about its centre, the new position taken up is the same as the original position. This property constitutes the "roundness" of the circle, and distinguishes it from other plane curves. A circle may be traced upon a plane by the continuous movement of a point rigidly connected with the centre, as in the use of compasses, and it is in part the simplicity of this construction that explains the fundamental importance of this curve. The tracing of a circle is a much simpler problem than the tracing of a straight line, since the common method of drawing the latter, with the aid of a ruler, only reproduces the straight line already constructed along the ruler's edge. A difference in the use of the word "circle" is observable between the older writers and those of the present century. With the former the word is understood to mean the part of the plane enclosed by the curve, while the curve itself is called the circumference. The latter consider the circle and its circumference identical, except that the latter is often spoken of as the measure of the former; and the enclosed portion of the plane is spoken of as the *interior*, not as the circle itself.

The straight line joining the centre to a point on the circle, *e.g.*, OP or OQ (fig. 1), is called a radius; from the definition of a circle, the radii drawn to various points on the circle are equal. A straight line drawn through the centre and having its ends on the circle, *e.g.*, EOH (fig. 1), is called a diameter; evidently all diameters of the same circle are equal in length, and twice as long as a radius. A straight line, such as ABC (fig. 1), joining any two points on a circle is called a chord; and the greatest possible chord is a diameter. The portion of the circle intercepted between two points is called an arc. Any two points on the circle divide it into two arcs; thus, in fig. 1, ADC is the minor arc, and APEC the major arc, between A and C. The figure composed of an arc and the chord joining its extremities is a segment of the circle. In fig. 1, ADCB and APECB are respectively the minor and major segments made by the chord AC. A sector of a circle is the figure formed by two radii and one of the arcs joining their extremities. The angle between these radii and within the sector is called the angle of the sector. Thus ODKC (fig. 1) is a sector, and DOC its angle.

Geometrical Properties.—A number of properties of the circle are direct results of the symmetry and regularity of the curve. For instance, if two chords in the same circle are equal, the arcs corresponding to them are equal; if two sectors of the same circle have equal angles, they have equal arcs, and contain equal areas, etc. A useful property of this kind is that *every chord is bisected by the perpendicular drawn to it from the centre.* This allows the centre to be found when the circle is given, and the circle to be drawn when three points on it are given. Thus, to construct the circle through H, P and Q, draw the perpendicular bisectors LO and RO to HP and PQ as in fig. 1, and take as centre the point O where these meet.

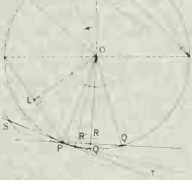

FIG. 1.—THE CIRCLE AND ITS PARTS

Showing the radius OP or OQ, diameter EOH, chord ABC, minor arc ADC, major arc APEC, minor and major segments ADCB and APECB, sector ODKC and the angle of sector DOC

A less evident property is that, *when any arc is taken, the angle between the lines joining its end points to the centre is double the angle between the lines joining these end points to any point on the remaining part of the circle, each angle being measured in the position facing the arc.* In fig. 1, by using the minor arc CD, the angle COD is double the angle CED, and also double the angle CAD. By using the major arc APE, the outer (reflex) angle AOE is double either ACE or ADE. An immediate consequence is that the angle ACE is equal to the angle ADE. Here A, C, D and E are any four points on a circle so placed that C and D lie on the same arc having A and E for end points. The theorem is commonly stated in the form: *angles in the same segment are equal.* (To exhibit the segment it is necessary to join AE.) It is a property of wide application, and numerous instances of it may be seen in fig. 1 by joining various pairs of points. Thus the angles

CAD, CED, CGD, CQD (when the lines CQ, QD and CG are drawn) are equal. In particular, *the angle in a semicircle is a right angle.* Closely related to this is the theorem that *a four-sided figure whose four corners all lie on the same circle has the sum of either pair of opposite angles equal to two right angles.* The converse is true that if the sum of one of the pairs of opposite angles of a four-sided plane figure is two right angles, a circle may be drawn to pass through the four corners.

It is readily seen that a straight line whose shortest distance from the centre is less than the radius cuts a circle in two points, and that a line whose shortest distance is greater than the radius does not meet the circle at any point. The intermediate case occurs when the line is at a distance from the centre equal to the radius, as is the case with SPT (fig. 1). Such a line has only one point in common with the circle; it is said to touch the circle and is called a tangent to the circle. The tangent at any point of a circle is the line through that point drawn at right angles to the radius; thus OPT is a right angle. The tangent at P is the limiting position approached by a chord PQ, drawn through P, as the other extremity Q approaches P. The chord must be prolonged as shown in the figure, in order that it may not be lost as its length vanishes. It is known that the perpendicular OR from the centre falls on the middle point of the chord. As Q moves to Q′, R moves to R′, and, as Q approaches P, R approaches P also. Finally the right angle ORQ approaches the limiting position OPT, and the chord PQ, prolonged sufficiently, is finally represented by the tangent PT at right angles to the radius OP. This second view of a tangent, as the limiting form of a short cord, is more generally applicable than the former, being valid for curves other than circles. It also enables many tangent theorems to be recognized as the limiting forms of related theorems on chords, and leads to a better understanding of tangent relations.

From a point F outside a circle two tangents may be drawn. The points of contact G and G′ of these may be found by first drawing the tangent at a point P on the circle, finding with the compasses a point S on this such that OS = OF, and then finding G and G′ on the circle and at a distance from F equal to PS. *The angle made by a tangent with a chord through its point of contact is equal to the angle in the segment on the other side of the chord.* Thus the angle FGD is equal to the angle GED. An important theorem on intersecting chords follows readily from the law of equal angles in a segment. *If two chords intersect, the product of the distances of the extremities from the point of intersection is the same for either chord.* Thus, in fig. 1, AC and DE intersect at B. The figure represents the case where AB contains 4.5 units, BC 3.2 units, DB 1 unit, and BE 14.4 units. It will be seen that $4.5 \times 3.2 = 1 \times 14.4$. The relation remains true when the chords have to be prolonged to meet outside the circle, as AD and CE, meeting at F. In the figure AF = 7.2, DF = 3.2, CF = 1.6 and EF = 14.4, so that AF × DF = CF × EF, each being 23.04. In the case of external intersection each of the equal products is also equal to the *square of the distance from the point of intersection.* In the figure, FG = 4.8, the square of which is 23.04. This is one of the cases where the tangent represents a chord whose ends are coincident.

Circle Constructions.—The circle plays an important part in the problems of constructive geometry. This will be easily understood when it is remembered that, in the traditional view, a geometrical solution means a solution by ruler and compasses; that is, the only steps available are to rule a straight line through two given points and to draw a circle having a given centre and radius. It is therefore a matter of importance to the student of geometry to be able to construct circles to satisfy various standard sets of conditions; and several of these processes will be indicated briefly:

1. *Circle through three given points.* The method of finding the centre by the right bisectors of the joining lines has already been given. When the three points are thought of as the corners of a triangle, the circle is said to be circumscribed to the triangle.

2. *Circle touching three given straight lines.* Bisect the angles between two of the lines l and m, obtaining a pair of bisector lines a and b. Bisect in the same way the angles between l and the third line n by a pair of bisectors c and d. The centre of a circle touching l and m must be equidistant from l and m, and so must lie either on a or on b. The centre of a circle touching l and n must be either on c or on d. Four solutions are obtained, the positions of the centre being the intersections of a and c, of a and d, of b and c, and of b and d. The circle that lies between the given lines and touches them is said to be inscribed to the triangle.

3. *Circle through two given points and touching a given line* (which does not pass between the points). Let A and B be the given points, and l the given line (fig. 2). Let AB cut l at O. Draw any circle c through A and B, by taking as centre any point on the right bisector of AB. Draw the tangent OT touching c at T. Find points H and K on l so that KO = OH = OT. The circle c_1 through A, B and H and the circle c_2 through A, B and K will each be a solution of the problem. The proof is briefly that $OH^2 = OK^2 = OT^2 = OA \times OB$, so that OH and OK are each of the right length for a tangent from O.

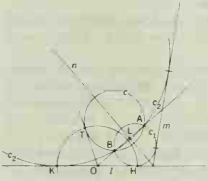

FIG. 2.—CONSTRUCTION OF A CIRCLE THROUGH TWO GIVEN POINTS AND TOUCHING A GIVEN LINE, AND THROUGH A GIVEN POINT TOUCHING TWO GIVEN LINES (*see* TEXT)

4. *Circle through a given point and touching two given lines.* Let l and m (fig. 2) be the given lines, and A the given point. Draw n, the bisector of that angle between l and m in which A lies. Draw AL perpendicular to n and prolong to B so that LB = AL. The circles c_1 and c_2 constructed as in 3 to pass through A and B and to touch l will then constitute the two solutions of the problem.

Circle constructions in which some of the conditions are that the circle should touch certain given circles require refined geometrical methods. A celebrated case of this type is Apollonius' problem: *to construct a circle to touch three given circles.* If the three circles are entirely external to one another, this problem admits of eight solutions. A number of problems of this kind, credited to Jakob Steiner and others, are discussed by Coolidge (*see* bibliography). It is often useful to remember that a circle through two given points may have its centre anywhere on the right bisector of their joining line, and that a circle touching two given intersecting straight lines has its centre anywhere on either of the lines bisecting the angles between them. A circle through a given point and touching a given line has its centre on a curve known as a parabola; but this fact is not of much direct assistance in finding constructions.

In many cases a point moving under specified conditions traces a circular path. The definition of the circle shows that this curve is the locus (or path) of a variable point whose distance from a fixed point remains constant. But there are numerous other ways in which the circular path may be recognized. If the base of a triangle is fixed, and the angle at the vertex is of constant magnitude, the moving vertex traces an arc of a circle as long as it remains on the same side of the fixed base; the property involved here is that of equal angles in a segment. If the base of a triangle is fixed, and the other two sides are in constant ratio, the moving vertex traces a circle which encloses one of the fixed vertices. If the sum of the squares of the distances of a variable point from two fixed points is constant, the point traces a circle whose centre is halfway between the two fixed points.

Analytic Treatment.—Taking for axes of reference two lines, OX and OY, at right angles (fig. 3) and, drawing PN perpendicular to OX from any point P, denote by x and y the measurements ON and NP. The two quantities x and y are called the co-ordinates of P, and the position of P depends on their values. The point P is denoted by (x, y).. If C is a fixed point (h, k), P will be restricted to a circle of centre C and radius r provided $CP = r$; *i.e.*, $CP^2 = r^2$, or $CL^2 + LP^2 = r^2$, if CL is perpendicular to NP; therefore

$$(x-h)^2 + (y-k)^2 = r^2 \qquad (1)$$

This is the *equation of the circle*. The variable point P will lie on the circle if, and only if, (1) is satisfied.

The equation

$$x^2 + y^2 + 2ax + 2by + c = 0 \qquad (2)$$

may be written in the form $(x + a)^2 + (y + b)^2 = a^2 + b^2 - c$, which is equivalent to (1) if $h = -a$, $k = -b$ and $r^2 = a^2 + b^2 - c$. The last of these conditions is not possible for any real value of r if $a^2 + b^2 - c$ is negative; but, if $a^2 + b^2 - c$ is positive, equation (2) is seen to represent a circle whose centre is $(-a, -b)$ and *radius* $\sqrt{(a^2 + b^2 - c)}$. The constants a, b and c in (2) may be determined to satisfy specified conditions, and the circle becomes then definitely fixed. For instance, if the circle is to pass through three given points, the co-ordinates of these must satisfy equation (2), and, on substituting them for x and y, three equations are obtained giving a, b and c. If the point (x, y) is not on the circle, but outside it, as at P′ (fig. 3), the left-hand side of equation (2) is not equal to zero, but, when written as $(x + a)^2 + (y + b)^2 - (a^2 + b^2 - c)$, or $(x - h)^2 + (y - k)^2 - r^2$, is seen to represent $CP'^2 - CT^2$ (if P′T is a tangent), which can be plotted as $P'T^2$.

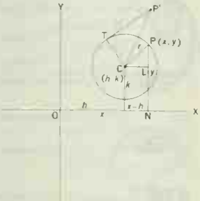

FIG. 3.—ANALYSIS OF THE CIRCLE TO DETERMINE ITS EQUATION (*see* TEXT)

A point (x, y) from which the tangent to the circle (2) is equal to the tangent to the circle

$$x^2 + y^2 + 2a'x + 2b'y + c' = 0 \qquad (3)$$

satisfies the equation

$$x^2 + y^2 + 2ax + 2by + c = x^2 + y^2 + 2a'x + 2b'y + c'$$
$$i.e.,\ 2(a - a')x + 2(b - b')y + (c - c') = 0$$

This equation, if the circles (2) and (3) have not the same centre, is of the first degree, so that the point (x, y) lies on a fixed straight line, called the radical axis of the circles. If the circles (2) and (3) have two points in common, the radical axis is the line joining these points. The equation $x^2 + y^2 + 2kx + c = 0$ represents, for different values of c, different circles of which any two have OY for radical axis. These circles are said to form a coaxial system. If c is negative, all the circles pass through the same two points on OY. If c is positive, none of the circles intersects. In either case one circle of the system may be found to pass through any given point not on OY.

The equation of the tangent at a point (x_1, y_1) on the circle (2) may be shown to be

$$x_1x + y_1y + a(x + x_1) + b(y + y_1) + c = 0 \qquad (4)$$

If, however, (x_1, y_1) is not on but outside the circle, equation (4) represents the polar of (x_1, y_1), that is, the straight line joining the points of contact of tangents from (x_1, y_1).

Mensuration of the Circle.—The ratio of the length of the circumference to the diameter is the same for all circles. This number can only be calculated approximately, and is 3.14159265358979323846 as far as 20 places of decimals. The true value of this number is always denoted by π, and has been recognized from antiquity as a most important constant.

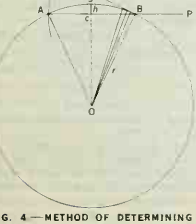

FIG. 4 —METHOD OF DETERMINING THE AREA OF A CIRCLE (*see* TEXT)

The fraction $\frac{22}{7}$ may be used as a rough approximation to π. Mathematicians have devoted an incredible amount of time to the calculation of this number, even reaching hundreds of decimal places. It is difficult to believe, however, that more than about ten figures could ever be put to any practical use; in fact 3.1415926 is likely to serve well enough. If r is the radius, the length of the whole circumference is $2\pi r$.

Let s measure the arc AB, c the chord AB, and h the distance from the middle of the arc to the chord. By dividing up the area of the sector AOB as suggested (fig. 4), and reasoning from the sum of a number of small triangles, it is inferred that the *area of the sector* is $\frac{1}{2}rs$; the area of the whole circle is $\frac{1}{2}r \times 2\pi r = \pi r^2$.

It has long been known that no construction by ruler and compasses can furnish a straight line of length equal to that of the circumference of a given circle, or a square equal in area to a given circle; though in ancient times "squaring the circle" was considered an important unsolved problem. Also a straight line cannot be constructed equal to any given arc of a circle, though approximate methods exist which work well for an arc which is not too large compared with the radius. For instance, produce AB to P, making BP = ½ AB. With centre P and radius PA draw an arc cutting at Q the tangent at B. Then BQ = the arc AB approximately. For an arc forming a quarter circle the error is about one part in 300. For $\frac{1}{36}$ of the circumference the error is less than one in a million. An approximate relation between c, h and s is $s = c + 8h^2/(3c)$. For a value of h less than $\frac{1}{12}$ of c, this gives s to within $\frac{1}{10{,}000}$ of its value. The radius of the circle does not appear in this relation. As an example of its use, if $c = 144$, and $s = 144.2$, then $h = 3.3$.

See also references under "Circle" in the Index volume.

Bibliography.—Euclid, *Elements*, bk. iii; J. L. Coolidge, *A Treatise on the Circle and the Sphere* (1916); H. S. Hall and F. H. Stevens, *A School Geometry* (1924); D. M. Y. Sommerville, *Analytical Conics* (1924).

CIRCUIT, in electrical engineering, is a path for transmitting electric current. *See* Electricity: *Direct-Current Circuits;* Electricity, Conduction of; also references under "Circuit" in the Index volume.

CIRCUIT COURT, one of many titles for judicial tribunals, usually applied to trial courts of general jurisdiction but occasionally, as with the United States courts of appeal, to intermediate appellate courts. The title originally referred to a court that made a circuit traveling through the geographic area assigned to it. *See* Court; Assize. (P. B. K.)

CIRCUIT RIDER, a characteristic American Methodist frontier institution, was originated in England by John Wesley and taken to America by Francis Asbury (*q.v.*) and his fellow labourers in 1771; in fact, however, Robert Strawbridge had been riding circuit in the colonies since about 1764. Asbury himself for 45 years traveled on horseback at the rate of 5,000 mi. a year, preaching twice a day on weekdays and three times on Sunday.

Each circuit was under the supervision of a Wesleyan conference preacher who might have any number of lay assistants. Any young man who showed aptness for public speaking and willingness to endure the hardships of traveling in the saddle for weeks over wild country might become an assistant and finally a circuit rider. The salary was $64 a year until 1800, when it was raised to $80 with the horse furnished by the circuit. There were few meeting-houses, and services were held in cabins, barrooms or in the open. Circuit riders were a considerable religious and moral force along the frontier, and they were largely responsible for the even distribution of Methodism throughout the United States. Best known of them was Peter Cartwright (*q.v.*), whose *Autobiography* (1856; often reprinted) is one of the best sources of information on the circuit rider's life.

See W. W. Sweet (ed.), *The Rise of Methodism in the West.*

CIRCULATION OF BLOOD means the movement of the blood through the body, from the heart by way of the arteries and back to the heart by way of the veins. Its function is to carry nutrient and oxygen to the body tissues and to remove from them the waste products of metabolism.

The unicellular organism receives all the supplies necessary for its growth and maintenance directly from its environment, either by diffusion of substances held in solution or by direct intake of foodstuffs, which undergo chemical disintegration in vacuoles containing liquid into which the necessary enzymes are secreted. In the multicellular organism, such direct intake of foodstuffs by diffusion by every individual cell is impossible, for only the outer layer of cells is in contact with the environment and this layer is usually protected by some form of membrane that is impermeable to water and food substances.

The vascular system has been developed to convey nutrient materials, etc., to the various parts of the organism, and the blood serves as intermediary between the environment and the organs of the body. This function can be fulfilled only if the blood is in continuous circulation, carrying nutrient materials and oxygen to the tissues and conveying the waste products of metabolism from the tissues to the places where they are excreted. The heart is the organ that provides the necessary energy for this circulation, and the blood vessels are the channels that convey the blood to and from the tissues.

In the case of most invertebrate animals, the blood or analogous fluid is not all enclosed in blood vessels, and the various tissues lie freely in the fluid, which is kept in constant motion. In the higher animals, however, the blood is entirely enclosed in a system of tubes, and the nutrient substances, etc., are brought into contact with the cells only after their diffusion through the thin walls of the finest blood vessels. By the force of cardiac contraction, the blood is driven through the tissues by way of thick-walled tubes, the arteries, and back to the heart by a system of thinner-walled vessels, the veins. In the tissues the blood passes through a fine meshwork of capillaries, the walls of which consist of a single layer of delicate cells, which allow a free interchange of material to take place between the blood within and the tissue fluids outside the vessel.

This article is organized as follows:

- I. The Heart
  - 1. Course of the Circulation in Mammals
  - 2. The Valves of the Heart
  - 3. Fetal Circulation
  - 4. Physiological Properties of the Heart
  - 5. Sequence of Events in the Cardiac Cycle
  - 6. The Apex Beat
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  - 8. The Electrocardiogram
  - 9. The Isolated Mammalian Heart
  - 10. The Work of the Heart
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- II. The Blood Vessels
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  - 9. Cardiac Output in Man
  - 10. Spleen, Lungs and Other Factors
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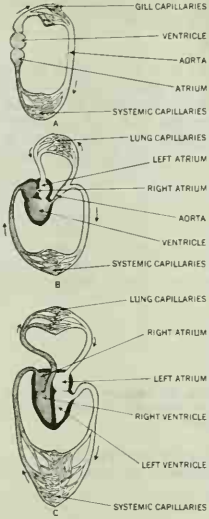
  - 14. The Cerebral Circulation
  - 15. The Coronary Circulation
  - 16. The Influence of Posture on the Circulation
  - 17. Circulation During Muscular Exercise

I. THE HEART

In fishes (fig. 1 [A]) the heart consists of one atrium and one ventricle. The blood is received from the great veins into the atrium. By the contraction of the atrium the blood is forced into the ventricle, and this, when it contracts, sends the blood on to the bulbus arteriosus. The blood passes through the branchial arteries into the gills, where it takes up oxygen, and then flows on into the aorta, by which it is distributed to the organs of the body. From the capillaries of these organs the blood is collected by the veins and is carried once more back to the atrium. The fish heart is thus entirely on the venous side of the vascular system.

In amphibia, such as the frog, the heart consists of two atria and but one ventricle (fig. 1 [B]). The right atrium receives venous blood from the body and by its contraction forces the blood into the ventricle. From the ventricle the blood passes into the aorta, whence it is carried partly by the pulmonary artery to the lungs, partly by other arteries to the different organs of the body. The blood, which has passed through the lungs and has been oxygenated, flows through the pulmonary veins to the left atrium, whence it passes into the ventricle and mixes with the venous blood which is arriving from the right atrium. The pulmonary circulation is thus merely a branch of the general or systemic circulation. The bulbus arteriosus in the frog is divided into two parts by means of a spiral valve, by which a partial separation of the blood coming from the right and left atria is effected, and the venous blood from the right atrium is directed especially into the pulmonary artery.



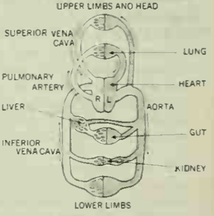
FROM E. H. STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY," J. & A. CHURCHILL

FIG. 1.—DIAGRAM OF CIRCULATORY SYSTEM IN (A) FISH, (B) AMPHIBIAN (FROG), (C) MAMMAL, ILLUSTRATING DEVELOPMENT OF VASCULAR SYSTEM AND SEPARATION OF SYSTEMIC CIRCULATION FROM PULMONARY CIRCULATION

1. Course of the Circulation in Mammals.—In mammals and birds the heart has become entirely divided into two halves, right and left, which have no direct communication with one another (fig. 1 [C]). The right atrium receives the venous blood from all parts of the body. From the right atrium, the blood passes to the right ventricle, and from there it is forced into the lungs along the pulmonary artery. In the lungs it loses wastes, takes up oxygen and then is returned by the pulmonary veins to the left atrium and to the ventricle. The left ventricle forces the blood into the aorta, whence by the branching arteries it is carried to all parts of the body.

There are thus two circulations—the one pulmonary, from the right side of the heart to the pulmonary artery and the capillaries of the lungs and to the left side of the heart by the pulmonary veins; the other systemic, from the left side of the heart, by the aorta, to the arteries and capillaries of the body tissues and organs, from which by the veins to the right side of the heart.

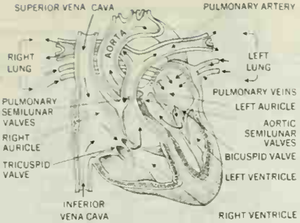
A schematic representation of the circulatory system is given in fig. 2. The muscular walls of the right ventricle are much thinner than those of the left ventricle. This is so because the energy required of the left ventricle must exceed that of the right ventricle, as resistance in the systemic circuit exceeds that in the pulmonary circuit.



FROM J. C. B. GRANT, "METHOD OF ANATOMY," 6TH ED., 1958

FIG. 2.—CIRCULATORY SYSTEM IN MAN, SHOWING RIGHT SIDE OF HEART (R) PUMPING BLOOD LADEN WITH CARBON DIOXIDE THROUGH LUNGS WHILE LEFT SIDE (L) PUMPS OXYGENATED BLOOD (SHADED) THROUGH BODY

The heart becomes filled with venous blood during its relaxation, or diastole, and forces the blood into the arteries during its contraction, or systole. The large arteries are of smaller capacity than the corresponding veins, and their walls are essentially extensile and elastic. The small arteries and arterioles are essentially muscular tubes and can vary considerably in diameter. The arterioles open into the capillaries, and these are so numerous that each organ may be regarded as a sponge full of blood. The skeletal muscles and the muscular walls of the viscera at each contraction express the blood within them and materially influence the circulation. The whole muscular system must therefore be regarded as an accessory pump to



B. G. KING AND M. J. SHOWERS, "HUMAN ANATOMY AND PHYSIOLOGY," 5TH ED., 1952; REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO.

FIG. 3.—DIRECTION OF BLOOD FLOW SHOWN THROUGH HEART CHAMBERS AND VALVES

the vascular system. The veins are of larger calibre than the corresponding arteries and have tough and less extensile walls. The veins are not, as a rule, distended with blood to their full capacity. Their capacity is so great that all the blood of the body can collect within the veins.

The heart and lungs are placed within the thoracic cavity, the floor of which is formed by the muscular diaphragm; the heart is itself enclosed in a tough inextensile bag, the pericardium, the function of which is to check overdilatation of the heart. Below the heart, the pericardium is fixed to the central tendinous part of the diaphragm; above, it is suspended by the mediastinum. Because of this fixed position of the pericardium, the heart is prevented from oscillating.

2. The Valves of the Heart.—As regards the valves of the heart (fig. 3), the tricuspid guards the right atrioventricular opening, and consists of three flaps of fibrous tissue covered, like all the internal surfaces of the heart, with a smooth, shining membrane, the endocardium. The flaps are continuous at their base, forming an annular membrane surrounding the opening. The bicuspid (or mitral) valve consists of two cusps, and it guards the left atrioventricular opening. The undersurface and free edge of each cusp of these valves are attached by chordae tendineae to two papillary muscles; these are pillars of muscle which rise up from the inner surface of the ventricles.

The papillary muscles and chordae tendineae pull down the diaphragm formed by the closed valves (the floor of the auricles), thus expanding the atria and enabling the valvular as well as the muscular parts of the wall of the ventricles to approach together and force out the blood. The ventricles are never completely emptied, for some blood remains in contact with the atrioventricular valves up to the end of systole and ensures their closure. The aortic and pulmonary valves consist of three semilunar, pocket-shaped cusps. A fibrous nodule is placed centrally in the free edge of each cusp, whence numerous tendinous fibres radiate to the attached borders of the cusp. Opposite the aortic cusps are bulgings of the walls—the aortic sinuses (of Valsalva). From the anterior one arises the right coronary artery, and from the left posterior arises the left coronary artery; these vessels supply the substance of the heart with blood.

3. Fetal Circulation.—The fetus has no independent respiration or digestion and therefore depends entirely on the oxygen and nutritive substances that diffuse through the placenta from the mother's blood (fig. 4). The purified blood flowing from the placenta through the umbilical vein is partly conveyed to the inferior vena cava by means of the ductus venosus. Even a greater quantity mingles, within the liver, with the portal stream returning blood from the intestine; from the liver it is conveyed to the vena cava by the hepatic veins. The oxygenated blood flowing from the placenta becomes mixed in the vena cava with the venous blood which has returned from the trunk and the lower extremities. In the right atrium it would also become freely mixed with the venous blood returning from the head and upper extremities were it not for a special arrangement which impedes but does not entirely prevent this mixture.

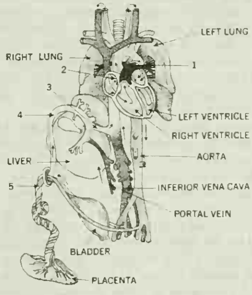
The presence of a special valve of the inferior vena cava (Eustachian valve) directs the upward stream into the left side of the heart through the foramen ovale—an opening in the interatrial septum—while the venous current from the superior vena cava is directed into the right ventricle. When the ventricles contract, the purer blood contained in the left ventricle is expelled into the ascending aorta and thence to the head and upper extremities, while the venous blood of the right ventricle is expelled into the pulmonary artery and then through the ductus arteriosus (which branches off from the pulmonary artery before it passes into the lungs) into the descending aorta. This separation of the two streams is not perfect, but it is responsible for the fact that the upper parts of the fetus receive blood that contains more oxygen than that received by the lower parts. This is possibly the reason why the head and the arms of the fetus are always considerably more developed than the pelvis and legs. A portion of the blood flowing through the descending aorta enters the two umbilical arteries and is conveyed to the placenta, where it is reoxygenated.

At birth, the course of circulation undergoes changes. As soon as the lungs become distended by the first respiration, a portion of blood is diverted from the pulmonary artery into the lungs. As the pulmonary circulation increases, the ductus arteriosus becomes functionless and slowly turns into a ligament. The foramen ovale between the atria also becomes closed. The circulation, which in the fetus was carried out upon the plan of that of the higher reptiles, becomes that of the warm-blooded animal, and the venous blood becomes separated from the arterial blood. After birth the umbilical arteries and vein shrink, close up and then form the ligaments of the bladder and the ligamentum teres of the liver. The ductus venosus becomes the ligamentum venosum.

4. Physiological Properties of the Heart.—The cardiac muscle must be regarded as endowed with four fundamental properties; viz., rhythmicity, the function of originating its impulse; conductivity, the function of transmitting the impulse; irritability, the function of responding to stimuli; and contractility, the function of developing tension which may be utilized for performing the work of circulating the blood.

Rhythmicity.—The cause of the heart beat has naturally been one of the most continued subjects of inquiry. H. Allen in 1757 was the first to show that the activity of the heart is not dependent on its connections with the nervous system. The heart is controlled and influenced by the nervous system, but this control is not essential for life. The excised heart of a frog continues to beat rhythmically for days, provided that it is supplied with oxygen and prevented from drying. In the case of the warm-blooded animal, the heart is similarly capable of continuing its rhythmic contractions for some time after excision.

The frog's heart consists of a sinus venosus, which receives the venous blood from the body, two atria, the ventricle and the bulbus



FROM W. F. WINDLE, "PHYSIOLOGY OF THE FETUS," 1940; REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO.

FIG. 4.—HUMAN FETAL CIRCULATION AND PROBABLE COURSE OF BLOOD THROUGH (1) DUCTUS ARTERIOSUS; (2) FORAMEN OVALE; (3) DUCTUS VENOSUS; (4) UMBILICAL VEIN; (5) UMBILICAL ARTERIES

arteriosus, which divides into the two aortas. The frog's heart in the body, or after excision from the body, beats regularly, the contractions starting in the sinus, then traveling to the atria, ventricles and bulbus.

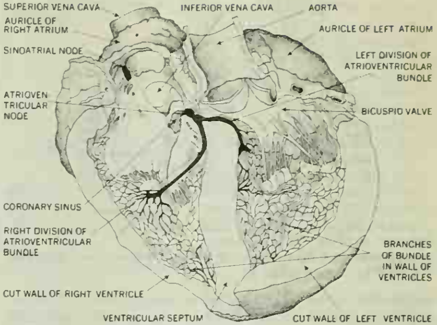
At one time the rhythmic contraction of the heart was attributed to the action of groups of nerve cells in the sinus that were discovered by Robert Remak in 1848. Some experimental support for this theory, which is known as the neurogenic theory of the heart beat, was given by Stannius, who demonstrated that the atrium and ventricle of the frog's heart cease to beat for some time if the sinus is tied off with a ligature, while the sinus goes on beating regularly. Further experiments have shown, however, that the beat of the heart cannot be ascribed to the rhythmic activity of these ganglion cells, for every strip of the heart muscle is capable of rhythmic action, whether it contains nerve cells or not. In the developing chick, the heart contracts by the 29th hour of incubation, while the nerves do not grow into the heart before the 6th day. The inherent power of rhythmic contraction belongs to the cardiac muscle itself (the myogenic theory of the heart beat).

Furthermore, the power to contract rhythmically belongs to every part of the heart, but there is a descending scale of this automatic power, from the sinus where it is highest to the lower parts of the ventricle where it is very slight (Gaskell). The normal sequence of contraction of the four parts is determined by the natural rhythm of these parts, but in the whole heart it is impossible for the ventricle to contract at its own rhythm because before it is ready to beat again, after a preceding contraction, it receives an impulse from the atrium. In the same way, the atrium never beats at its own rhythm; it is always subordinated to the faster rate of impulses coming from the sinus. If, however, the ventricle is electrically stimulated at a rate slightly faster than the beat of the sinus, the normal sequence of contractions becomes reversed, the ventricle now contracting first and the sinus last. Experiments tend to confirm the myogenic theory of the heart beat.

The mammalian heart lacks a separate sinus venosus, yet its contractions are as regular and as independent of the nervous system as those of the lower vertebrates. Both in the heart *in situ* and in the excised heart the two atria contract together, and after a short interval there follows the contraction of the two ventricles.

In the mammalian heart, within the region where the superior vena cava opens into the right atrium, there lies a club-shaped formation known as the sinoatrial or S-A node; functionally it is identical with the sinus of the amphibian and reptilian heart. The node is composed of slender fusiform cells with little striation. It can be considered as definitely proved that, in the normal heart, the sinus serves as the centre in which the stimulus for the cardiac contraction originates. The S-A node is, however, by no means the only place in which the impulses for the heart can originate. The seat of these rhythmically recurring impulses may shift to some other portion of the heart since, as in the frog's heart, the function of rhythmicity is potentially present in every part of the heart, and the S-A node governs the rate of the whole heart only in virtue of its faster rate of discharge of these impulses. On this account the S-A node has often been described as the "pacemaker" of the heart. Other centres in which the impulses sometimes originate, and which in certain cases may gain mastery over the whole heart, are known as ectopic centres.

It has been shown that a very distinctive system of muscle fibres lies enclosed within its own sheath beneath the endocardium. This system is known as the conducting system of the heart. It begins as a few strands of fibres in the region of the coronary sinus; these strands converge in a thickening which is known as the atrioventricular or A-V node; it is composed of the same type of cells as the S-A node. The two nodes are not connected with each other but are divided by the ordinary contractile elements of the auricle. From the A-V node, a thin bundle of tissue passes through the atrioventricular septum toward the ventricle. This bundle was first described by Wilhelm His and is known as the A-V bundle of His. On penetrating the interventricular septum, the bundle divides into two branches, which pass to the right and left ventricle respectively. The two branches divide and subdivide, forming an arborization on the inner surface of the ventricles (fig. 5).


SUPERIOR VENA CAVA
INFERIOR VENA CAVA
AORTA
AURICLE OF RIGHT ATRIUM
AURICLE OF LEFT ATRIUM
SINOATRIAL NODE
LEFT DIVISION OF ATRIOVENTRICULAR BUNDLE
ATRIOVENTRICULAR NODE
BICUSPID VALVE
CORONARY SINUS
RIGHT DIVISION OF ATRIOVENTRICULAR BUNDLE
BRANCHES OF BUNDLE IN WALL OF VENTRICLES
CUT WALL OF RIGHT VENTRICLE
VENTRICULAR SEPTUM
CUT WALL OF LEFT VENTRICLE

ADAPTED FROM D. J. CUNNINGHAM "TEXTBOOK OF ANATOMY"

FIG. 5.—CONDUCTING SYSTEM OF THE HEART, SHOWN ON A SPECIMEN WITH FRONT WALLS REMOVED

Various parts of the conducting system may become centres of ectopic rhythms. If the S-A node is destroyed or injured, or if the irritability of the A-V node is increased, the latter assumes the role of initiating the heart beat. Many nervous and other influences may modify the relative irritability of the two nodes, and a shift of the pacemaker from one to the other may occur temporarily even under normal conditions. Destruction of the A-V bundle is equivalent to a complete functional separation of the ventricles from the atria. The ventricles develop a rhythm of their own, the idioventricular rhythm. Both ventricles, however, continue to contract together, the centre for their activity being localized in the higher part of the bundle. It is probable that still lower centres may assume a rhythmicity, but it is doubtful whether these can ever dominate the rhythm of the whole heart. Their significance consists rather in the fact that they serve to disturb some other dominant rhythm.

Thus, every part of the heart may serve as a centre of origin of an impulse. The natural rate of the discharges of these centres is in the following descending order: the S-A node, the A-V node, the bundle, its branches and muscle. If several centres are active simultaneously, the rate of the heart as a whole will be dominated by that centre which discharges most frequently.

The "normal" heart rate presents considerable variations in different individuals and in different species of animals. For man it may be estimated at 68 to 76 beats per minute and for woman 74 to 80; but the normal rate for some individuals may be much lower (50) or much higher (90). Small animals as a rule have a higher heart rate than large animals; *e.g.*, elephant 25–28, horse and ox 36–50, sheep 60–80, dog 100–120, rabbit 150–180, mouse 700. Small birds such as the canary have the extremely high rate of 1,000 beats per minute. Usually in man, under normal conditions, the heart rate declines with age. While at birth it is about 140, it is 100–110 at the age of five; in childhood it is about 90 and in the adult about 70. In old age it accelerates slightly and becomes about 80.

Conductivity.—The impulses that originate in the S-A node spread along the ordinary muscular tissue to every part of the atria. The rate of conduction in the atrium ranges from 600 to 1,200 mm. per second. In its fanlike spread, the excitation wave reaches the A-V node. There is no indication of a preferential path of conduction between the two nodes, so that the impulse travels at the rate over the atrium and reaches the A-V node about 0.03 second after the origin of the impulse. In the A-V node the rate of conduction is considerably slower, the impulse passing the node at about 150–200 mm. per second. Once it has passed the node, the impulse travels rapidly down the bundle and its ramifications at the rate of about 5,000 mm. per second.

The slow conduction in the A-V node and the rapid conduction in the bundle tissue ensure two important features of cardiac activity. Because of the former, atrial contraction is given time to end before the onset of the ventricular contraction, and because of the latter the impulse arrives at every part of the ventricle at approximately the same time. Thus the whole ventricular muscle contracts approximately at the same time, which is a condition necessary for the development of a high pressure in the ventricular cavities.

Irritability.—When a skeletal muscle is stimulated by an increasing strength of electrical stimulus, it responds by an increasing strength of contraction, until a certain maximum is reached. A heart under the same conditions gives a contraction which is maximal for a given condition of the heart in response to the first effective stimulus; further increase in the strength of the stimulus does not lead to an increase in the strength of the response. This difference between the skeletal and the cardiac muscle is not due to fundamentally different properties but depends on the fact that in cardiac muscle the muscle fibrils are in free intercommunication within a syncytium, and in this way a stimulus which originates in one part spreads over the whole of the organ; by contrast, in the skeletal muscle the contractile fibrils are collected into muscle fibres which are separated by the homogeneous coat of the sarcolemma. Since the threshold value of a stimulus which will evoke contraction is different for the different muscle cells, it is only to be expected that a greater number of these cells will contract in the skeletal muscle when the stimulus is strengthened, the result being a stronger total effect of contraction of the muscle. In the heart, when a stimulus evokes a contraction of a few fibres, this contraction will spread over the whole heart, so that with increase in the stimulus there is no further strengthening of the contraction. This behaviour of the heart is known as the All-or-None Law (*q.v.*). It is most evident in the cardiac muscle but is not peculiar to it.

The irritability of the heart undergoes rhythmical variations that are determined by the heart beat itself. Like all excitable tissues, the heart exhibits the phenomenon of the refractory period, which is a period of loss of irritability following each impulse that evokes a contractile response. In the heart this period is extremely prolonged, lasting as long as the contraction of the heart. If a second stimulus is applied to the heart during the contraction evoked as a response to the first stimulus, it is found that it has no effect. In the skeletal muscle, because of the fact that the refractory period is shorter than the time occupied by the contraction, a second stimulus evokes a second contraction, or a summation of the two contractions. The period of complete loss of irritability is followed by gradual recovery, after which there is a phase of supernormal irritability before it returns to the normal.

The length of the refractory period depends in the first place on the strength of the contraction of the heart. Thus drugs and physiological conditions which strengthen the heart beat also increase its refractory period. Of greater significance, however, is the relation of the refractory period to the rate of the heart beat. Thomas Lewis found that the duration of the refractory period of mammalian atrial muscle contracting 100, 130 and 250 times per minute was 0.2, 0.15 and 0.01 seconds, respectively.

It is obvious that as a result of the shortening of the refractory period the heart is able to respond to more rapid rates of excitation than would otherwise be possible. As soon, however, as stimuli occur at intervals which are shorter than the refractory period, alternate stimuli will fail to evoke any response, the heart beating at a half-rhythm or 2:1 response. The change from a 1:1 to a 2:1 response does not occur abruptly. Between these rates there exists a phase in which large and small beats alternate; with further acceleration of the stimulation, some beats are dropped, and with a still further acceleration a regular 2:1 rate sets in. This stage of irregular response is due to the fact that apparently all the parts of the cardiac muscle have not the same minimal refractory period, and consequently at some definite rate of excitation parts of the heart will contract in response to every stimulus while other parts will respond by a 2:1 rate.

Contractility.—The strength of contraction of the heart is independent of the strength of the stimulus. It is, however, highly dependent on the condition of the cardiac muscle. Any interference with the nutrition of the heart, inadequacy of the oxygen supply or accumulation of the products of metabolism such as carbonic acid or lactic acid will lead to a weakening of the contractile response and even to a complete loss of contractility.

There is also a physiological factor of primary importance which modifies the strength of contraction. Briefly it can be stated that, other conditions being equal, the greater the filling of the heart during diastole, the stronger is the following systole. This dependence of strength of contraction is so marked and is of such importance for the whole circulation that E. H. Starling named it the Law of the Heart. It must be remembered, however, that it is not a feature peculiar to the cardiac muscle alone; it belongs to all contractile tissues, whether heart, skeletal muscle or plain muscle, but in the heart it is of a greater immediate vital importance. The practical significance is obvious; it enables the heart to eject the amount of blood which it receives during diastole, whether small or large, and thus enables the heart to adapt its beat to considerable variations of the blood flow without changing its rate. A dog's heart weighing 50 g. can put out 100 or 3,000 c.c. of blood per minute without changes of the heart rate.

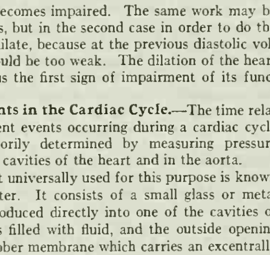
This remarkable adaptation is due to the fact that the larger the output, the more the heart will be filled during each period of relaxation (diastole), and hence its contraction (systole) will be stronger, so that the heart will empty itself of the extra amount of blood. When a heart is in good condition, it performs a given amount of work with a smaller diastolic volume than when the contractility of the heart becomes impaired. The same work may be performed in both cases, but in the second case in order to do the work the heart has to dilate, because at the previous diastolic volume its contractions would be too weak. The dilation of the heart at constant work is thus the first sign of impairment of its functions.

5. Sequence of Events in the Cardiac Cycle.—The time relation between the different events occurring during a cardiac cycle can be most satisfactorily determined by measuring pressure changes in the different cavities of the heart and in the aorta.

The apparatus almost universally used for this purpose is known as the optical manometer. It consists of a small glass or metal tube which can be introduced directly into one of the cavities of the heart. The tube is filled with fluid, and the outside opening is sealed with a thin rubber membrane which carries an excentrally placed small and light splinter of a mirror. A beam of light reflected from the mirror is made to play on a moving photographic plate or film, and thus the minute movements of the membrane, which are of course proportional to the pressure changes, are greatly magnified without the danger of increasing the inertia of the apparatus.

The pressure changes in the heart (fig. 6) were described by Starling as follows (using the old term "auricle" for "atrium"):

The cardiac cycle begins with the contraction of the auricles, which may or may not give rise to a slight rise of pressure in the ventricles. As the auricular contraction dies away, the ventricular contraction begins at I. This causes a very rapid rise of pressure. Almost immediately after the beginning of the rise, the auriculo-ventricular valves close. The pressure then rises rapidly



FROM E. H. STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY," J. & A. CHURCHILL

FIG. 6.—PRESSURE CURVES FROM AORTA, VENTRICLE AND LEFT ATRIUM, TOGETHER WITH VOLUME CURVE OF THE TWO VENTRICLES DURING ONE COMPLETE CARDIAC CYCLE (MODIFIED FROM WIGGERS) (*see* TEXT)

in the ventricular cavity. During this period, the contraction of the ventricular muscle is isometric. It is raising the pressure within the ventricles without causing any change in its contents, or in the length of the muscle fibres. Directly the pressure exceeds that in the aorta, the aortic valves open at the point marked II, and the aortic pressure thereafter rises with the ventricular pressure. During the whole duration of the ventricular contraction, the aortic pressure remains somewhat below the ventricular pressure, showing that the blood is flowing continuously from the ventricle into the aorta. The ejection of blood is at first rapid, so that the pressure in the ventricles continues to rise. As the heart gets smaller, the amount of blood ejected into the aorta becomes less than that flowing out in the unit of time through the peripheral branches, so that the pressure begins to fall in the aorta and ventricle, even though the outflow of blood is still going on. The ejection period may therefore be divided into two phases, that of maximum ejection and that of reduced ejection. The ventricular muscle suddenly relaxes at the point marked IV, causing a sudden fall of pressure in the ventricle and a slight fall in the aorta. The latter is, however, arrested almost at once by the closure of the aortic valves, marked by the sharp depression, the *dicrotic notch*, in the aortic tracing. The pressure in the ventricle continues to fall until at the point VI it drops below that in the auricle and the auriculo-ventricular valves open, allowing the inflow of blood from the pulmonary veins and auricles. Between V and VI the relaxation is isometric, since all the valves guarding the orifices of the ventricles are closed.

The pressure in the ventricles then continues to fall more slowly until it reaches the line of zero pressure, and remains at or near this line during the greater part of diastole. With a big inflow there may be a slight rise towards the end of diastole, which may be accentuated by the auricular contraction. If the chest is opened the pressure in the ventricle never sinks below zero during any part of diastole. In the closed chest the pressure in the heart cavities during diastole will be negative, on account of the negative pressure within the thorax.

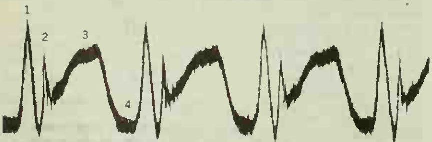
The duration of the separate phases of the heart beat depends naturally on the rate of the beat. In all cases of change of heart rate, the period of diastole is affected relatively much more than the period of systole. Because of the absence of valves between the atria and the large veins, changes of pressure within the auricle will be transmitted along the veins.

In every case the atrial pressure tracing exhibits the following features (fig. 7): (1) the first positive wave, which occurs during atrial systole; (2) the second positive wave, which is due to the sharp closure of the atrioventricular valves; (3) the third positive wave, which is due to the filling of the atria while the atrioventricular valves are closed; (4) a negative wave, which is due to the rapid emptying of the atrium after the opening of the atrioventricular valves. The chief function of the atrium is not to propel blood into the ventricle by its contraction but to serve together with the big veins as a reservoir for the blood which flows in from the body but which cannot enter the ventricle while the latter is in a state of contraction.

6. The Apex Beat.—The pulsation that is felt over the region of the heart is known as the apex beat and was formerly thought to be attributable to the twisting forward of the apex at each systole. Its origin, however, is different. During diastole the ventricles form a flabby flattened cone, lying against the chest wall and slightly depressed by the latter. In systole the ventricles become hard and rigid and assume the form of a rounded cone. This sudden change in shape and hardening of the ventricular wall pushes out that part of the chest wall which is in immediate proximity to the ventricle, giving rise to the apex beat.

7. The Sounds of the Heart.—When the ear is applied to the chest above the cardiac region, two sounds may be heard; the first, which is heard most intensely over the apex, is a duller and longer sound than the second, which is heard best over the base of the heart. The first and second sounds resemble the syllables *lubb dup—lubb dup*. The first sound is of twofold origin. It arises from the sudden closure of the atrioventricular valves and from the contraction of the thick muscular wall of the ventricles. The second sound is due to the sharp closure of the aortic and pulmonary valves.

When fluid escapes through a narrow orifice, vibrations are set up in the fluid giving rise to various sounds. Under normal conditions, when the valves of the heart are closed completely, sounds produced in this way are either absent or negligible; in abnormal conditions (*e.g.*, after disease affecting the orifices of the heart or the valves) these vibrations may become loud enough to be easily heard. These murmurs or bruits, as they are called, are of great importance, for they enable the physician to judge the condition of the valves and to determine which valve is affected.

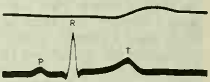


FROM E. H. STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY," J. & A. CHURCHILL

FIG. 7.—CURVES OF PRESSURES IN LEFT ATRIUM OF CAT (AFTER STRAUB) (*see* TEXT)

8. The Electrocardiogram.—The contractions of the different cavities of the heart are accompanied by electrical changes which can be recorded if any two parts of the heart are connected to a sensitive galvanometer. The apparatus which is generally used for this purpose is the string galvanometer, in which a very delicate thread of silvered quartz or of platinum is stretched between the poles of a strong magnet. If the connection is made not with the heart itself but with tissues which are in contact with the heart, the electrical changes at each heart beat can still be obtained. An electrocardiogram so obtained is reproduced in fig. 8.

The deflection P is due to the atrial contraction, and QRS marks the beginning of the ventricular contraction. Thus the P-R interval represents the period between the atrial and ventricular contractions. The total duration of the excitatory state of the ventricle is measured by the distance between Q and T. A case of A-V block, as for instance in Adams-Stokes's disease, is shown at once on the electrocardiogram by the dissociation of the normal relations between the atrial and ventricular deflections. A delay in conduction of the excitatory wave is accompanied by a prolongation of the P-R interval, while a beat originating from the A-V node instead of the S-A node is immediately shown by a shortening or even disappearance of the P-R interval. The exact origin of the T wave is not known. The electrocardiogram has become an important aid in the study and diagnosis of abnormal heart activities.



FROM E. H. STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY," J. & A. CHURCHILL

FIG. 8.—(BELOW) ELECTROCARDIOGRAM OF MAN, OBTAINED BY LEADING OFF FROM THE TWO HANDS TO A STRING GALVANOMETER; (ABOVE) THE CAROTID (ARTERIAL) PULSE TRACING TAKEN AT THE SAME TIME (*see* TEXT)

9. The Isolated Mammalian Heart.—The nutrition of the mammalian heart is carried out by means of the coronary arteries, which leave the aorta at the place of its origin. A mammalian heart which has been removed after the death of the animal can easily by revived if the coronary arteries are perfused under pressure with blood or a salt solution which resembles the saline medium of the blood in composition. This procedure was first introduced by K. F. W. Ludwig for the frog's heart and by O. Langendorff for the mammalian heart. Sydney Ringer first determined the exact amount and type of salts necessary for the most successful survival of the frog's heart, and F. S. Locke modified Ringer's solution for the mammalian heart. With the use of such a solution, a mammalian heart can be restored to activity as long as seven days after death. The beat of the isolated heart of a child can be restored 20 hours after death from pneumonia. The excised heart of a cat can be kept beating for four days. The heart of a monkey was restored after freezing the dead body of the animal.

Conditions Essential for the Heart Beat.—For perfusion experiments, a cannula is tied in the aorta pointing to the heart. The pressure of the column of fluid closes the aortic valves, and the only way of escape is through the coronary arteries; after having passed through the heart muscle, the fluid flows out of the coronary veins. In this manner it is possible to study the influences directly affecting the heart beat and the coronary blood vessels.

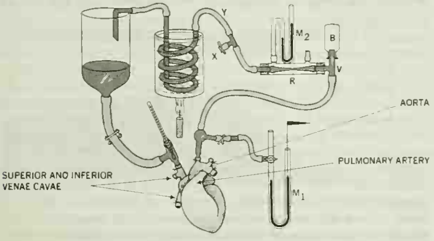
The first and most essential condition for reviving a heart is an abundant supply of oxygen; the second is the maintenance of the perfusion fluid at a reaction similar to that of blood; *i.e.*, slightly on the alkaline side of neutrality (sodium bicarbonate is usually added for this purpose). A third important factor is the maintenance of the temperature within physiological limits. An increase in temperature causes an increase in heart rate, but at about 44°–45° C. the beat ceases entirely. At temperatures ranging from 13° to 19° C. the beat ceases, but on rewarming the co-ordinated contractions are re-established. In all these cases the effect of temperature is primarily on the S-A node, and warming or cooling the node duplicates the effect of warming or cooling the perfusion fluid, except that at some stage the lower rhythm centre of the heart will begin to be dominant, whereas in the cooling of the whole heart the rhythm of all the centres becomes depressed.

The main purpose of the sodium chloride in the fluid is to keep the osmotic pressure of the fluid the same as that of blood. Calcium and potassium, however, have a direct influence on the contractility of the heart. After a short perfusion with a fluid that lacks calcium and potassium, the heart soon stops beating altogether. Addition of calcium salts will immediately evoke contractions, which will grow in force, but the heart will soon fail to relax completely and will gradually stop in systole. On addition of potassium salts, the heart resumes a normal beat. Excess of calcium salts leads to a systolic standstill, and excess of potassium salts leads to a diastolic standstill. The normal activity can proceed only if salts of both calcium and potassium are present in the proper proportions.

The Heart-Lung Preparation.—A great advance in the study of the heart was made when Starling succeeded in investigating the heart under conditions like those of the perfused heart but with the great advantage that the heart performed work and pumped blood in exactly the same way as in the whole animal. The arrangement of the method is shown in fig. 9.

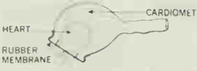
Artificial respiration being maintained, the chest is opened under an anesthetic. Cannulae are placed in the brachiocephalic artery and the superior vena cava. All other blood vessels going to and from the heart are tied off. The blood emerging from the heart is made to flow against an artificial variable resistance (R), through a glass spiral immersed in warm water, into a reservoir. From the reservoir the blood flows through the superior vena cava into the heart. The aortic blood pressure can be varied in this preparation by changing the artificial resistance against which the heart is made to work.

The output of the heart can be measured at any time by opening the tube X, clamping tube Y and allowing the blood to flow into a graduated cylinder. The volume changes of the heart at each beat can be measured by the so-called cardiometric method. A glass cardiometer of the shape shown in fig. 10 is fitted over the beating heart. The opened pericardium is tied around the lip of the cardiometer, which is then connected with a tambour with a slack rubber membrane. The movements of this membrane are recorded by a lever on the smoked surface of a revolving drum. The difference between the diastolic and the systolic volume thus recorded is obviously equal to the amount of blood put out by the two ventricles during a single heart beat.



FROM E. H. STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY," J. & A. CHURCHILL

FIG. 9.—APPARATUS FOR WORKING ON THE ISOLATED MAMMALIAN HEART (*see* TEXT)



FROM E. H. STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY," J. & A. CHURCHILL

FIG. 10.—HENDERSON'S GLASS CARDIOMETER, USED IN MEASURING VOLUME CHANGES OF THE HEART (*see* TEXT)

This preparation enabled Starling and his co-workers to study the main features of the physiological activity of the heart. It was found that the heart itself cannot modify the blood flow and that, within wide variations of the heart rate and of the arterial resistance against which the heart beats, the output remains constant provided the inflow is not changed. This means that the heart will adapt the strength of its beat within very wide limits and will perform the work required if it is within the functional capacity of the organ. If the inflow into the heart is, say, 1,000 c.c. a minute, this output will be maintained if the heart rate is 100 or 200 beats per minute, or if it has to beat against a pressure of 60 or 160 mm. of mercury. Increase in the heart rate does not modify the output, but it increases the maximum amount of blood which the heart is able to expel, since at the faster heart rates the inflow of blood can be increased without causing overdistension of the ventricles. Another important observation made by Starling was that, in the heart-lung preparation, the heart rate is independent of the pressure against which the heart works and of the output. The heart rate is here determined by the temperature of the S-A node; *i.e.*, by the temperature of the circulating blood. It is clear that the extent of this effect will vary from heart to heart, depending on the natural rhythmicity of the node.

10. The Work of the Heart.—The energy of the contraction of the heart is expended (1) in forcing a certain amount of blood against a certain resistance presented by the arterial pressure and (2) in imparting a certain velocity to the blood. The work done by each ventricle can be calculated from the formula

$$W = Mr + \frac{Mv^2}{2g}$$

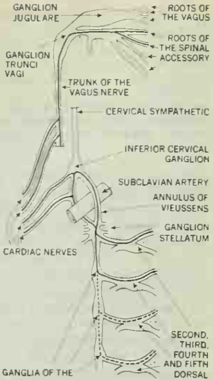
where W is the work done, M is the mass of blood expelled at each beat, r is the mean arterial pressure, v is the velocity at the root of the aorta, and g is the factor of acceleration. The work of the right ventricle is approximately one-fifth that of the left. The work of both ventricles in the human heart at rest is about 100 g.-m. per beat, which is equivalent to about 10,000 kg.-m. in 24 hours. During very strenuous muscular exercise, when the output is considerably increased, the work of the heart per beat is about 400 g.-m., or 80,000 kg.-m. in 24 hours. This rate of work could probably be maintained for not more than a few minutes.

The energy required for the cardiac contraction is derived from the oxidation of the deposits of glycogen (possibly also of fats) within the heart itself. It was found by Lovatt Evans that, on increasing the arterial pressure from 80 to 140 mm. of mercury, the oxygen consumption of a heart was increased from 228 to 404 c.c. per hour, and on increasing the output from 9.3 to 92 l. per hour it increased from 155 to 649 c.c. per hour. The maximum efficiency of the heart is of the same order as that found for skeletal muscle, 20%–28%.

11. The Nervous Regulation of the Heart Beat.—In the vertebrates the heart is supplied with two sets of nerve fibres: those which pass from the central nervous system in the vagus nerve, and those which pass in the sympathetic nerves (fig. 11). The cardiac fibres of the vagus terminate around nerve cells situated in the heart itself (preganglionic fibres); the ganglionic cells serve as relays from which new fibres (postganglionic fibres) emerge and run directly to the cardiac muscle and to the S-A node. The sympathetic fibres leave the spinal cord by the anterior roots mainly of the second and third thoracic nerves, run in the white rami communicantes to the stellate ganglia where they end; from the stellate ganglia, postganglionic fibres begin, which go to the various parts of the cardiac muscle.

The Vagus Nerve.—In 1845 the brothers E. H. and E. F. Weber made the important discovery that stimulation of the vagus nerve retards or even arrests the heart beat. The cardio-inhibitory nerves have since been found in all classes of vertebrates and in many invertebrates. During a stimulation of the vagi, the heart heat is considerably retarded or stops altogether, and as the result of this the arterial blood pressure falls. Blood accumulates on the venous side of the heart and is not forced out in sufficient amount to maintain the blood pressure. If the stimulation of the vagus is prolonged, the heart often begins to beat again with a slow rhythm; this beat is seen to be confined to the ventricles only, the atria still remaining at a standstill. Such a beat is spoken of as an "escape." The ventricle is really beating at its own idioventric rhythm in response to impulses originating with itself.

A detailed study of the effect of vagus stimulation on the heart has shown that it affects all the four fundamental properties of the heart muscle (fig. 12). By inhibiting the S-A node, it depresses the rhythmicity; by affecting the conductive system, it retards the propagation of the impulse in the atrial muscle and in the A-V bundle; by affecting the muscle proper, it diminishes its contractility and each beat becomes weaker, in consequence of which the refractory period of the heart is shortened; and finally it diminishes the irritability of the heart. Whether the vagus has a direct action on the mammalian ventricle is still doubtful.

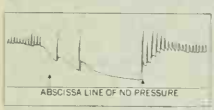


FROM E. H. STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY," J. & A. CHURCHILL

FIG. 11.—CARDIAC INHIBITORY AND ACCELERATOR FIBRES IN THE DOG (FROM FOSTER) (*see* TEXT)

If both vagi are cut, the heart immediately begins to beat faster, showing that under normal conditions a continuous stream of impulses passes down the cardioinhibitory nerves, which do not allow the heart to beat at its full independent rate. For obvious reasons, section of the vagi cannot be performed in man, but there is available a drug that paralyzes the peripheral nerve endings of the postganglionic vagal fibres, namely atropine (*q.v.*), an alkaloid obtained from belladonna.

The question as to what controls the normal tone of the vagi has been the subject of many researches, and at present several factors are known to be concerned. Among them must be mentioned first the blood pressure. E. J. Marey was the first to show that, other conditions being equal, the vagus tone increases with increase in the blood pressure. This effect is probably due not to the direct stimulation of the vagus centre in the medulla but to stimulation by high blood pressure of special sensory endings in the aorta, in the ventricles and in some of the blood vessels going to the brain. The sensory impulses reflexly retard the heart by stimulation of the vagus centre. Changes in the composition of the blood and various drugs may also affect the vagus centre. Asphyxia and the action of morphine may be mentioned as such centrally acting stimuli; they retard the heart, but only if the vagi are intact. Reflexes from various sensory nerves may stimulate or inhibit the vagus centre; for instance, inflation of the lungs diminishes vagus tone (the Hering-Breuer reflex); increase in the output of the heart has the same effect (Bainbridge reflex). Stimulation of the respiratory passages, as in the case of inhalation of an irritant volatile substance, retards the heart, and high intracranial pressure has the same effect. There are also stimuli which may excite the peripheral nerve endings of the vagi in the heart itself; *i.e.*, substances which will act even after section of the vagi but not after injection of atropine—for instance bile salts, which enter the general circulation in the case of jaundice.



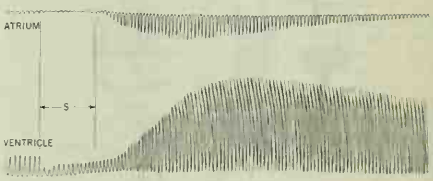
FROM E. H. STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY," J. & A. CHURCHILL

FIG. 12.—BLOOD PRESSURE TRACING FROM CAROTID OF A DOG SHOWING EFFECT OF EXCITATION OF VAGUS (BETWEEN ARROWS) (*see* TEXT)

The intimate mechanism by means of which the vagus produces its effect on the heart has been a field of intense experimentation and theorization. It has been suggested that the vagus impulses produce "interference" waves with the impulses originating in the S-A node; that the vagus is a nerve which abolishes the catabolism or distintegration processes associated with activity and leads to anabolism or reconstruction processes; that because of similarity in the effect of stimulation of the vagus with that of potassium salts, the vagus possibly liberates free potassium from a colloidal combination or from an adsorbed state from the proteins. According to Otto Loewi, the vagus acts by producing some chemical substance (of the choline type) which is the active factor. His experiments support the theory most brilliantly. If a perfused frog's heart is stopped by stimulation of the vagus, and if the perfusion fluid is collected from the heart and transferred to a beating frog's heart, the second heart will show all the effects of vagus stimulation. The chemical substance responsible has been extracted and dried; it is now generally accepted that the effective substance is acetylcholine, which is produced in the near vicinity of the nerve endings.

The Sympathetic Nerve.—Stimulation of the sympathetic cardiac nerve produces effects which are the reverse of the vagus stimulation. It increases the rate by raising the rhythmicity of the heart, augments the contractions, increases the rate of conduction of the impulse and raises the irritability of the heart. Because of the increased strength of contraction, the refractory period becomes somewhat more prolonged than that normally associated with the given heart rate. The sympathetic nerves are much less easily tired than the vagus fibres and have a longer aftereffect. In most animals the inhibitory and the accelerator fibres, which were discovered by Élie de Cyon, become mixed in the cardiac nerves, so that if these are stimulated a double effect is produced on the heart. During the period of stimulation the vagus effect predominates, but after the end of stimulation the sympathetic effect becomes apparent, and the heart accelerates and the beat increases in strength (fig. 13). Stimulation of either set of fibres before they are mixed together produces effects typical of one or the other only. In the dog, whose normal heart rate is about 100 beats per minute, stimulation of the accelerator nerves may increase it to 260 beats, and at the same time the strength of each contraction will be increased. The latter effect is most marked in hearts which have begun to fail and which are therefore dilated.

The question whether, under normal conditions, the accelerator fibres are in a state of tone like that of the inhibitory fibres of the vagus is not definitely settled. It is customary to assume the existence of such a tone but to consider it as less pronounced than that of the vagus. In most experiments, extirpation of the stellate ganglia leads to a retardation of the heart. Many observers have shown that the tonic conditions of the two centres stand in a reciprocal relation to one another. Whenever the tone of the inhibitory fibres is increased, that of the accelerator fibres is diminished; thus the final effect on the heart will be an algebraical summation of the two influences. The tone of the accelerator centre is greatly increased in asphyxia, in cerebral anemia, in the case of



FROM E. H. STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY," J. & A. CHURCHILL

FIG. 13.—TRACING TO SHOW EFFECT OF STIMULATION OF VAGOSYMPATHETIC NERVE ON FROG'S HEART (AFTER GASKELL) (DURING STIMULATION [S] THE HEART IS INHIBITED; AFTER STIMULATION IT ACCELERATES, THEN TENDS TOWARD THE NORMAL)

various sensory stimuli (especially painful stimuli) and probably in the case of muscular exercise. In the first two states, which are pathological, the tone of both nerves is increased simultaneously. Thus, in the absence of the sympathetic nerves, asphyxia produces retardation of the heart by stimulating the vagus, and in the absence of the vagus it produces an acceleration. In the presence of both nerves, it first retards the heart and may even arrest it until the vagi become paralyzed, after which the heart greatly accelerates above the normal, because of the coexistent stimulation of the sympathetic centre.

The Suprarenal Gland.—It has already been mentioned that the influence of the vagus can be modified by stimuli affecting the centre, or by substances which stimulate or paralyze the peripheral nerve endings of the vagus within the heart itself. In the case of the sympathetic innervation, the organism normally produces a chemical substance which stimulates all the sympathetic nerve endings.

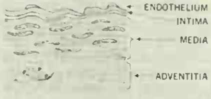
The production of this substance is the function of the suprarenal (or adrenal) gland, and the substance not only has been obtained in a chemically pure state but has also been synthesized. It is known as adrenaline or epinephrine. Adrenaline is active in very small amounts, concentrations of 1 in 100,000,000 producing a strongly exciting effect. Under normal conditions, however, the quantities entering the blood are probably too small to have any physiological effect. The liberation of adrenaline is under the influence of the splanchnic nerves, section of which diminishes the secretion while stimulation greatly increases it. Certain drugs, asphyxia and various emotions such as fear or anger lead to an excessive production of adrenaline. Directly the adrenaline reaches the heart, even when its connections with the nervous system are all severed, the contractions become considerably faster and extremely energetic, and the heart becomes able to cope with a greater strain (either in the shape of arterial resistance or increased venous inflow) than it could do without the stimulus of adrenaline. (*See* also ADRENAL GLANDS; ADRENALINE AND NORADRENALINE; HORMONES, VERTEBRATE.)

To summarize, it may be stated that the heart beat is a property of the heart itself, and as such it is independent of the nervous system. The latter, however, may be said to keep the activity of the heart under constant supervision, moderating its action by means of the vagus and increasing it by means of the sympathetic nerves, thus adapting it to the general requirements of the body. Under conditions of great physical strain, the organism is able to make use of its store of adrenaline, which assists the nervous regulation of the heart beat. Thus, even after complete denervation of the heart, a certain amount of adaptation of its activity is still possible. The total regulatory mechanism is highly efficient.

II. THE BLOOD VESSELS

1. Structure of the Blood Vessels.—The hemodynamic conditions in the various parts of the vascular system are very different, and it is not surprising to find that the structure of the various blood vessels is accordingly different. A cross section of a blood vessel shows several coats. The innermost is lined with flat endothelial cells and is common to all vessels. The second coat, the tunica media, varies greatly in thickness; it contains most of the contractile elements of the arterial wall (smooth-muscle fibres) and a variable amount of elastic fibres. Both have in general a regular circular arrangement. At their outer and inner surfaces they form elastic membranes which belong to the outer and inner coats. Outside the media lies the third coat, the adventitia, which consists in the arteries almost entirely of connective tissue but in some veins principally of contractile elements. Between the internal elastic membrane and the endothelial layer is a fibrous layer which, together with the endothelial layer and internal elastic membrane, comprises the tunica intima.

2. The Arteries.—In the great arterial trunks such as the aorta, the pulmonary, the carotid and iliac arteries, the tunica media is divided by elastic fibres and membranes into a large number of concentric layers containing (especially in the aorta) only a few muscle fibres. The adventitia of the large arteries is also composed of fibroelastic tissue, but its structure is looser and the fibrous tissue is more abundant. The medium-sized arteries and arterioles differ in structure from the larger ones in that the elastic elements of the media are largely replaced by smooth-muscle fibres (fig. 14). To this type belong the majority of the arterial vessels. Arterioles gradually lose their coats and become precapillaries and capillaries. (*See* also ARTERIES; ARTERIES, DISEASES OF.)



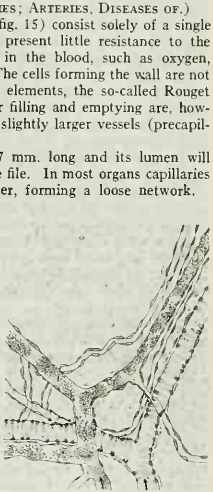
FROM A. A. BOHM, M. VON DAVIDOFF AND G. C. HUBER, "TEXTBOOK OF HISTOLOGY," SAUNDERS & CO.

FIG. 14.—TRANSVERSE SECTION THROUGH ONE OF SMALLER OF MEDIUM-SIZED HUMAN ARTERIES

3. The Capillaries.—These (fig. 15) consist solely of a single layer of endothelial cells, which present little resistance to the passage of substances dissolved in the blood, such as oxygen, carbon dioxide, sugar and salts. The cells forming the wall are not contractile; neither do encircling elements, the so-called Rouget cells, control their calibre. Their filling and emptying are, however, controlled by sphincters on slightly larger vessels (precapillaries).

A capillary segment is 0.4–0.7 mm. long and its lumen will pass red blood corpuscles in single file. In most organs capillaries freely anastomose with each other, forming a loose network.

4. The Veins.—Precapillaries, venules and veins drain the capillary bed. They gradually acquire a connective tissue coat, the adventitia (fig. 16), and with increase in size muscle fibres appear in the form of a badly defined media. Some of the larger veins, such as the brachial and subcutaneous veins, have a better-developed muscular layer, while in others (jugular, subclavian, veins of the meninges) muscle is greatly deficient or entirely lacking. Generally speaking, the muscular and elastic elements are much less prominent in the veins than in the arteries, and they contain a preponderance of inelastic connective tissue fibres. In many veins the adventitia shows an inner longitudinal layer of muscle. All subcutaneous veins and some internal veins are supplied with valves which restrict any possible backflow. The valves of the veins are reduplications of the intima, and the greater part of the valvular structure consists of white fibrous connective tissue and elastic fibres. (*See* also VEINS; VEINS, DISEASES OF.)



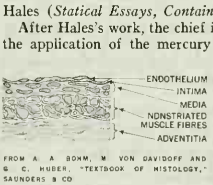
FROM HARVEY E. JORDAN, "TEXTBOOK OF HISTOLOGY," 9TH EDITION, 1952, COURTESY APPLETON CENTURY-CROFTS, INC.

FIG. 15.—PRECAPILLARY AND CAPILLARY BRANCHES OF (A) VENULE AND (B) ARTERIOLE

5. The Blood Pressure.—It has long been known and can easily be demonstrated that the blood is under different pressures in the various parts of the vascular system. When an artery is cut, blood flows out with great force in a series of jerks which are synchronous with the heart beat. When a large vein is cut, the blood also flows out rapidly, but the stream has very little force.

The first measurement of arterial pressure was made by Stephen Hales (*Statical Essays, Containing Haemastaticks,* 1733).

After Hales's work, the chief improvements in the method were the application of the mercury manometer by J. M. Poiseuille, the invention of the recording manometer and the kymograph by K. F. W. Ludwig (fig. 17) and the introduction of the more accurate membrane manometer by K. Hürthle and Frank.



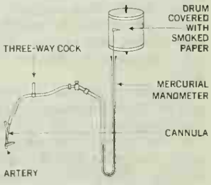
FROM A. A. BOHM, M. VON DAVIDOFF AND G. C. HUBER, "TEXTBOOK OF HISTOLOGY," SAUNDERS & CO

FIG. 16.—TRANSVERSE SECTION THROUGH SMALL HUMAN VEIN

The manometer of Ludwig consists of a U-tube which is half-filled with mercury. On the surface of the mercury of one limb is a float from which a stiff light rod projects, bearing on its upper end a writing point which is made to write on the smoked surface of a revolving drum. The other limb of the manometer is connected by means of a glass or metal cannula to the artery. The tube between the artery and the manometer is filled with a solution of some anticoagulant salt (sodium citrate, magnesium sulfate).

The mercury manometer allows a direct reading of pressure, but because of its inertia it does not accurately record rapid changes in the pressure. The membrane manometer, which is merely a tube filled with fluid and sealed at one end with a stretched rubber membrane, records rapid changes in pressure more accurately, but each membrane requires special calibration if absolute values are desired. The venous pressure is recorded by a similar method but with a water manometer or a manometer with a lightly stretched membrane.

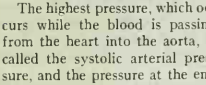
The highest pressure, which occurs while the blood is passing from the heart into the aorta, is called the systolic arterial pressure, and the pressure at the end of diastole is the diastolic pressure; the range between these two extremes is known as the pulse pressure. In the dog, with a mean arterial pressure of about 120 mm. of mercury, the systolic pressure may be as high as 160 mm. and the diastolic pressure as low as 65 mm.; here the pulse pressure would be 95 mm. of mercury. By taking the pressure at different parts of the vascular system, a result is obtained which is diagrammatically represented in fig. 18.



FROM E. H. STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY," J. & A. CHURCHILL

FIG. 17.—APPARATUS FOR TAKING BLOOD PRESSURE TRACING (*see* TEXT)

Close to the heart, the mean arterial pressure is about 100–120 mm. It falls only slowly in the large arteries, but between the smaller arteries and the capillaries there is a very extensive fall of pressure, so that the capillary pressure is only about 10 to 30 mm. of mercury; from the capillaries to the veins the blood pressure falls steadily, until in the large veins near the heart it may be negative.



FROM E. H. STARLING, "ELEMENTS OF HUMAN PHYSIOLOGY," J. & A. CHURCHILL

FIG. 18.—BLOOD PRESSURES (BP) IN SYSTEMIC CIRCULATION

(H-LV) In left ventricle, (A) in arteries, (C) in capillaries, (V) in veins, (H-RA) in right atrium; (0-0) zero pressure level (*see* text)

The arterial blood pressure in man is determined by means of the Riva-Rocci sphygmomanometer (fig. 19), which consists of a rubber bag that can be strapped round the upper arm. The bag is connected with a manometer, and the pressure in the bag is raised by pumping air into it. The pressure at which all pulsations disappear in an artery below the place of compression represents the systolic pressure. The diastolic pressure can also be determined by the same apparatus.

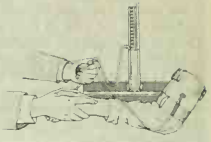
To determine the venous pressure in man, an apparatus is used which is constructed on the same principle as the sphygmomanometer. The skin is greased, and an annular rubber bag is placed over a vein and cemented over with a glass plate (fig. 20). On blowing air into the bag, the pressure can be determined at which the vein collapses.

The blood pressure in the capillaries is usually determined by the Von Kries method. A small glass plate is placed over the skin; attached to this plate is a small scale pan on which weights are placed until the pressure is just sufficient to blanch the underlying skin.

The mean blood pressure in the circulatory system of a young adult man in the horizontal position was found to be as follows:

Large arteries	90 mm. mercury (65-110)
Medium arteries	85 mm.
Capillaries	10–30 mm.
Small veins	9 mm.
Large veins	0–8 mm.

From this it may be seen that the largest drop in pressure occurs between the small arteries and the small veins. This shows that the main resistance of the vascular system is situated in the arterioles. The arterioles are always in a semicontracted state (tone), partly determined by impulses coming from the central nervous system and partly by the properties of the smooth muscles of which they are composed. Since the total vascular bed of the capillaries is very much larger than that of the arterioles, the main drop in the pressure must occur just past the arterioles. The mean arterial pressure depends on two factors: (1) the total resistance to the outflow of blood from the arterial system—*i.e.*, the state of constriction of the arterioles; (2) the output of the heart in a given time, which depends on the inflow of blood. (*See* also BLOOD PRESSURE.)



FROM E. H. STARLING, "PRINCIPLES OF HUMAN PHYSIOLOGY," HAWKSLEY BROTHERS

FIG. 19.—MEASUREMENT OF BLOOD PRESSURE IN MAN WITH RIVA-ROCCI SPHYGMOMANOMETER

6. The Arterial Pulse.—Because of the elasticity of the arteries, every systolic rise of the blood pressure produces an expansion of their walls, which can be felt by placing a finger on any superficial artery. It is obvious that the nearer the artery is to the heart, the more pronounced will be the pulse. The rate of transmission of this pressure wave will depend on the elasticity of the arteries. If they were rigid, no pulse could be recorded. The more elastic the arteries, the slower will be the transmission of pressure along them. Under normal conditions, the pulse wave in man is transmitted at the rate of about seven meters per second, but if the arteries are initially stretched by high pressure their walls will tend to approximate to rigidity, and therefore the propagation of the pulse wave will be faster. It is important not to confuse the velocity of the pulse wave, which is simply a transmission of pressure along the tubes, with the velocity of the blood flow. The latter is of the order of about 0.5 m. per second in the aorta and considerably less in the smaller blood vessels.

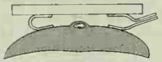


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FIG. 20.—APPARATUS FOR DETERMINATION OF VENOUS PRESSURE (*see* TEXT)

The elasticity of the arterial system determines another important feature of the blood flow; it is the cause of the continuity of the blood flow (except for slight increases during systole and decreases during diastole), in spite of an intermittent ejection of blood by the heart into the aorta. A sufficient amount of blood is accommodated in the arterial system to maintain a flow into the capillaries during the whole period of diastole. In the capillaries the pulse disappears and the blood flow is continuous. Arterial pulse tracings recorded by means of sphygmographs (a system of levers which can be placed on a pulsating artery, the pulsation of which is thus registered on a moving plate with blackened surface) shows various secondary undulations, either in the ascending part of the wave (anacrotic pulse) or in the descending (catacrotic pulse). These are due partly to extra vibrations set up in the arterial wall by the inrushing blood and partly to pressure waves reflected from the periphery.

7. Velocity of the Blood Flow.—This depends on the relation between the bore of the blood vessel and the amount of blood passing through it in a unit of time. The total area of the cross sections of the arterial system gradually increases from the aorta to the periphery. The increase in area is especially great when the arteries break up into capillaries, the area of which is probably over 1,000 times larger than that of the cross section of the aorta. The velocity of the blood flow will obviously be proportionately reduced farther toward the periphery, so that while in the aorta the mean velocity under resting conditions may be about 500 mm. per second, in capillaries it is barely 0.5 mm. per second. As the capillaries join to form veins, the area of the vascular bed diminishes and the velocity of the blood flow increases; however, it never reaches the velocity which is observed in the aorta, since the cross section of the large veins near to the heart is about double that of the aorta.

8. Intensity of the Circulation.—The amount of blood received by the heart from the veins and passed to the arteries in a unit of time cannot be measured directly. However, a knowledge of the cardiac output is of considerable importance because it controls the amount of oxygen carried to the tissues and the rate of the removal of various products of metabolism from the tissues. The great value of the study of the cardiac output of man and animals has only been realized comparatively recently, and there still remains much to be done; nevertheless, methods of sufficient precision have been worked out, and the main factors governing the cardiac output are gradually being disclosed and the total work done by the heart being determined.

N. Zuntz calculated the output by comparing the difference in the oxygen content of the arterial and venous blood with the amount of oxygen consumed in a given time. For instance, in a horse weighing 360 kg., 2,735 c.c. of oxygen were consumed per minute; the arterial blood contained 10.33% more oxygen than the venous. Since every 100 c.c. of blood that passed through the lungs had taken up 10.33 c.c. of oxygen, 2,733 c.c. of oxygen had been taken up in the course of one minute by $\frac{100\times 2,733}{10.33} = 26,457$ c.c. of blood. August Krogh modified this method by making the animal or man breathe a gas which was harmless and easy to detect; viz., nitrous oxide. He knew how much of the gas could be absorbed by one cubic centimetre of blood, and was therefore able to calculate the cardiac output by determining the amount of gas taken in during one minute. Later, other methods were introduced which were claimed to be more exact. In one of them, ethyl iodide is the gas absorbed, and in another the principle of Zuntz is modified and the output is calculated by comparing the carbon dioxide content of the arterial and venous blood with the amount of carbon dioxide given off in a unit of time.

9. Cardiac Output in Man.—In man, under conditions of rest, the cardiac output varies in different individuals between about 3½ and 6 l. of blood per minute; that is, between 60 and about 110 c.c. for each heart beat. The cardiac output (*i.e.*, the inflow of blood into the heart, as in the heart-lung preparation) is within wide limits independent of the heart rate. It primarily depends on (1) how freely the blood passes from the arterial system through the tissues into the venous system—*i.e.*, on the peripheral resistance; (2) the power of the heart to pump the inflowing blood into the arteries; and (3) the capacity of the vascular system relative to the amount of blood. When the arterioles dilate, the blood passes quickly through the organs and, since the capacity of the vascular bed will be changed but little, the blood will reach the heart during the next few beats in a larger amount. The heart will therefore force more blood into the arterial system, and thus within limits prevent a fall of arterial blood pressure, which would have taken place if the arterioles dilated without causing an increase in the blood flow.

Considering the second way in which the output may be increased, namely the strengthening of the heart beat, it is clear that, if the pumping action of the heart becomes inadequate, blood will stagnate on the venous side and the output will diminish. If the heart beat is improved by nervous or pharmacological agencies, there will be better emptying of the venous side and a consequent increase in the circulation rate.

The third factor governing the output is the capacity of the vascular bed relative to the amount of blood. This factor can be appreciated by considering the tremendous capacity of the capillary system. Krogh showed that $\frac{1}{20}$ to $\frac{1}{10}$ of a muscle is made up of capillaries, and in any muscle there is at least one capillary to every muscle fibre. If all these capillaries lost their tone, the animal would literally bleed into them, the arterial and venous system would become empty, and the output of the heart would fall to vanishing point.

The amount of blood in the circulation and the capacity of the vascular bed should not be considered as rigidly fixed for any individual. The vascular system is in a perpetual state of variation because of the continuous changes of the vasomotor tone. It is obvious that unless vasoconstriction is compensated for by a simultaneous vasodilation elsewhere it will lead to a change in the resistance as well as a change of capacity. Arterial vasoconstriction will chiefly affect the resistance, while even small changes in the tone of the enormous capillary bed will mainly affect capacity. Thus because of these changes of capacity more or less blood may be in active circulation and more or less blood may be left behind to fill the vascular bed.

10. Spleen, Lungs and Other Factors.—There are two organs which play a predominant role as reservoirs of blood, namely the spleen and the lungs, the difference being that the spleen seems to change its capacity mainly as the result of active contraction and relaxation, while the lungs play a purely passive role and act only because of the very great elasticity of their blood vessels. With every increase in the pulmonary blood pressure or with a certain decrease in the intrathoracic pressure, the pulmonary blood vessels contain more blood, and therefore less blood is available for the systemic circulation. On the other hand, the capacity of the spleen is to a much greater extent independent of the blood pressure, changes in its vascularity being due to active contractions of its muscles and valves. These contractions seem to be specially adapted to meet the requirements of the whole organism. Whenever, for instance, more blood is needed in circulation, as when the animal loses blood or when blood goes to fill widely dilated vascular areas of other organs, the spleen contracts. This also happens in anoxemia following diminution of the oxygen supply, or during diminution of the oxygen-carrying power of the blood as in the case of carbon monoxide poisoning.

As has been seen, the vascular resistance, the fitness of the heart and the vascular capacity are the three main factors which determine the blood flow in the whole animal. There are, however, accessory factors, the chief of which are the respiratory movements and the contractions of the skeletal muscles. Any increase in respiratory movements leads to a more negative pressure in the thorax and therefore to a better aspiration of blood from the periphery into the large veins and the heart. This is probably the main cause of the so-called respiratory variations of the blood pressure; during inspiration the inflow into the heart is increased, and after a certain lag the output is also increased. The contractions of the skeletal muscles press the blood from the capillaries to the veins, the backflow of blood being prevented by the valves.

11. The Nervous Control of the Blood Vessels.—During increased activity an organ requires more oxygen. Theoretically this could be accomplished by an increased degree of deoxygenation of the blood without a change in the blood flow, or by an increase in the blood supply without any change in the degree of deoxygenation. The organism uses both methods, but the first in preference. In some cases the increase in the blood supply is such as to overcompensate the need, so that, although the oxygen consumption of the organ is increased, the blood supply is so great that each cubic centimetre of blood gives to the tissues less oxygen than usual. Increased blood supply to an active organ is due either to an increase of the general circulation rate, which increases the blood flow through all the organs, or to changes in the distribution of the blood among the various organs, more blood being diverted to the active and less to the resting organs.

Knowledge of the nervous control of the blood vessels dates from Claude Bernard's discovery that in the sympathetic chain run nerve fibres which maintain the vessels in a state of tonic constriction. Section of these nerves leads to a considerable vasodilation and therefore to an increased blood flow; stimulation of them causes vasoconstriction. A few years after this discovery it was found that there are also vasodilator nerve fibres which are antagonistic in function to the vasoconstrictor nerves, and that these nerve fibres also have in many cases a constant influence on the blood vessels; section of them slightly diminishes the blood flow, and stimulation greatly increases it. The blood vessels therefore, like the heart, are under the influence of double innervation. The tonic state of the blood vessels does not itself depend on nervous control, and it does not completely vanish after section of all the nerves going to an organ. The function of the vasomotor nerves is merely to increase or decrease this tone.

It can easily be shown that the continuous stream of impulses descending to the blood vessels along the vasoconstrictor fibres originates in the central nervous system. If the spinal cord of a dog is divided below the medulla, the blood pressure falls from about 120 mm. of mercury to about 50 mm. Stimulation of the divided spinal cord immediately causes an increase in blood pressure, which may be as high as 280 mm. or more. Section of the central nervous system above the medulla has no lasting effect on the blood pressure. As the result of these experiments it may be said that the vessels of the body are kept in a state of increased tone by impulses arising in the medulla. The portion of the medulla concerned with sending out these impulses is spoken of as the vasomotor centre. The activity of this centre is constantly under the influence of various afferent stimuli originating within the various organs of the body or as the result of excitations of higher or lower parts of the central nervous system.

The Vasoconstrictor and Vasodilator Fibres.—The vasoconstrictor fibres leave the spinal cord in the thoracic region. They have a cell station in the ganglia of the sympathetic chain, and are then distributed along various nerves to the organs. The most important vasoconstrictor nerve is the splanchnic nerve, which supplies all the abdominal organs.

The typical vasodilator nerves take their origin from various parts of the central nervous system. Thus the vasodilators to the salivary glands and tongue are distributed with the cranial nerves, and probably originate from the nervus intermedius between the seventh and eighth cranial nerves. The nervi erigentes going to the genitalia leave the lower end of the cord by the anterior roots of the second and third sacral nerves. The vasodilator fibres going to some of the abdominal organs and to the extremities have the same origin and course as the ordinary sensory nerves. Since the vasodilator impulses pass along these nerves in a direction opposite to that taken by the normal sensory impulses, they have been termed antidromic impulses. This appears to be one of the few cases in mammals in which the same nerve fibre performs two different functions.

The vasodilator and vasoconstrictor fibres are generally mixed in common trunks innervating an organ, and it is only by special means that they can be functionally separated.

Peripheral Tone of the Blood Vessels.—It has been mentioned above that the function of the vasomotor nerves is only to change the tonic condition of the blood vessels; the tone itself does not disappear, however, even after complete denervation. This peripheral tone of the blood vessels is considerably influenced by the composition of the blood, especially the oxygen tension, the degree of alkalinity and the presence of vasoconstrictor substances which are normally secreted by the pituitary and the suprarenal glands. Whether the nerves are intact or severed, the capillaries of the body are never all open at the same time. The capillary bed seems to be, at least in some organs, in a perpetual state of variation. Capillaries constantly close and open so that blood flows through various channels. Whenever the oxygen tension of the blood diminishes, the blood vessels dilate, a large number of capillaries open, and the blood flow through the organ increases; excess of carbon dioxide has the same effect.

On the other hand, an increase of the pituitary secretion or of adrenaline in the blood increases the tone of the blood vessels and capillaries. Some authors regard these two substances as being primarily responsible for the peripheral tone of the blood vessels in general. Superimposed upon these perpetual variations of the peripheral tone is the effect of the vasomotor nerves, and it often happens that agencies which would affect the peripheral tone in some definite direction are prevented from doing so because of antagonistic influences from the vasomotor centre. For instance, in the case of increased carbon dioxide tension of the blood, the carbon dioxide acting peripherally tends to dilate the blood vessels, but it is also a strong stimulus to the vasomotor centre and excites the vasoconstrictor fibres to such an extent that the blood vessels constrict; the blood pressure then rises until the central nervous system succumbs to the toxic effect of the carbonic acid.

The Vasomotor Centre.—Besides being sensitive to carbon dioxide and to the acid products of metabolism which accumulate in consequence of lack of oxygen, the vasomotor centre is constantly influenced by impulses arriving from the sense organs on the surface of the body and from various other organs. Among these, impulses originating in the vascular system are the most important and are practically the only ones which have been studied. The afferent stimuli may be of two kinds. First are those which affect the vasomotor centre in such a way as to cause vasoconstriction either in some definite organ or in many organs; in the latter case the general vascular resistance increases and the arterial pressure rises. These afferent impulses are described as pressor impulses. On the other hand, impulses may reach the vasomotor centre which will lead to vasodilation; this again may be restricted to a small area or may involve sufficient blood vessels to bring about a fall in the arterial blood pressure. These are known as depressor impulses.

Pressor reflexes can be evoked by stimulation of almost any of the sensory nerves of the skin, the digestive tract or other abdominal viscera. The chief depressor nerve originates in the heart and in the first part of the aorta. In the rabbit this nerve runs in a separate and easily accessible trunk. Stimulation of the central end of the depressor produces such a large dilation of most of the blood vessels that the arterial blood pressure falls to a very low level. In the intact animal the physiological stimulus which brings this depressor mechanism into operation is the high blood pressure in the aorta. Distention of the aorta by pressure stimulates the depressor nerve and leads to a compensatory dilation of arterioles and to a fall in pressure. The nerve can be regarded as a safety valve which prevents excessive rises of blood pressure.

It is highly probable that in the case of an excessive fall of pressure another reflex mechanism comes into action, a pressor reflex which also originates in the heart and aorta and which tends to antagonize the fall. It has been amply shown that the carotid artery at the point of its division into the internal and external branches is also sensitive to pressure. Increase of pressure in this part leads to a reflex vasodilation, and fall of pressure leads to a vasoconstriction. Besides these two influences, it seems that the vasomotor centre itself can be excited or inhibited by variation in the blood pressure. Fig. 21 gives an example of the effect on the blood pressure of changes in the pressure of the brain (controlled experimentally by perfusion through the carotid arteries).

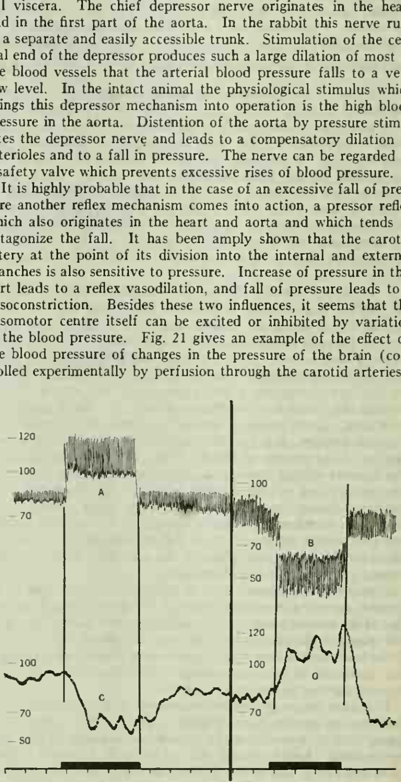

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FIG. 21.—SIMULTANEOUS BLOOD PRESSURE TRACINGS TO SHOW INFLUENCE OF CHANGES IN CIRCULATION THROUGH THE BRAIN ON THE ACTIVITY OF THE VASOMOTOR CENTRE

(A) Rise or (B) fall of pressure in arteries of head brings about, respectively, (C) fall or (D) rise in remaining arteries of body

Thus it is seen that the organism possesses several mechanisms by means of which it can keep the blood pressure constant and counteract any influences which would tend to raise or lower it. In the case of hemorrhage, a considerable amount of blood may be removed from the body, but the blood pressure soon returns to normal. Blood may be withdrawn from the system slowly to the extent of about 4% or rapidly to the extent of about 2% without lowering the arterial pressure, because of the compensatory constriction of the arterioles. Such withdrawal of blood, though it does not affect the blood pressure, will greatly diminish the intensity of the circulation and will reduce the output of the heart. Conversely, injection of salt solution (0.9%) or transfusion of blood will not, within certain limits, affect the arterial blood pressure, because of compensatory vasodilation. Transfusion, however, will increase the circulation of blood and thus lessen the harmful consequences of hemorrhage. Considerable hemorrhages will not be effectively compensated and will therefore lead to fall of blood pressure, and transfusion will be absolutely necessary to save the animal from death.

Since most blood vessels are innervated by vasoconstrictor and vasodilator fibres, it is obvious that a pressor or depressor reflex could be carried out by several means. Vasodilation could for instance be produced by means of a reflex inhibition of the vasoconstrictor tone or by a stimulation of the vasodilator fibres which would depress the tonic state of the blood vessels. What actually happens is that the two sets of fibres in all known cases act in a reciprocal fashion. Thus a depressor reflex involves a simultaneous diminution of the vasoconstrictor influence and increase of the vasodilator influence, and vice versa in the case of a pressor reflex.

12. Chemical Factors.—There has been a considerable accumulation of facts which show that chemical factors affecting the blood vessels, apart from nervous influence, are of great importance for the regulation of circulation, and that these factors can exercise their action on either the arterioles or the capillaries.

It is known for instance that in many conditions (*e.g.*, pain, asphyxia, the physiological state that accompanies emotion) there is a considerable rise in the production of adrenaline by the suprarenal glands. Adrenaline, as has been mentioned before, stimulates the nerve endings of the sympathetic nervous system, and it therefore also stimulates the nerve endings of the vasoconstrictor nerves. Thus, in all cases associated with increased production of adrenaline, there is widespread vasoconstriction and a rise in the blood pressure; this vasoconstriction is independent of the integrity of the vasomotor nerves. In the case of activity of an organ, vasodilation occurs in most cases not because of concurrent depressor reflexes but because of the production of chemical substances within the organ. These substances mainly affect the tone of the capillaries, and in their presence a great number of previously closed capillaries open or dilate widely. It has been shown that in the case of a contracting muscle the capillaries may be increased from 2% to 15% of the total volume of the muscle.

There is, however, one substance which may possibly be produced in the organism under normal conditions and which is known to have a powerful capillary dilator effect. This substance is histamine, a product of the amino acid histidine, which is a normal constituent of most proteins. It has been suggested that the production of histamine plays an important part in giving rise to the symptoms of surgical shock. In this condition there is a universal dilation of the capillaries, and therefore a fall of blood pressure and a diminution of the amount of blood in circulation which finally leads to death. This condition, which occurs after laceration especially of muscles, can easily be reproduced by injection of large doses of histamine.

The mechanism of adaptation of the circulation in various organs to their needs must at present be regarded as in part dependent on the delicate balance of the nervous vasodilator and vasoconstrictor influences, which modify the tone chiefly of the arterioles, and also on chemical substances produced locally as the result of activity, which modify the tone of the capillaries.

13. The Portal Circulation.—The portal circulation is peculiar in that the blood passes through two sets of capillaries. Arterial blood is conveyed to the capillary networks of the stomach, spleen, pancreas and intestines by branches of the abdominal aorta. The portal vein is formed by the confluence of the mesenteric veins with the splenic vein, which together drain these capillaries. The portal vein breaks up into a second plexus of capillaries within the substance of the liver. The hepatic veins carry the blood from this plexus into the inferior vena cava. The portal circulation is largely maintained by the action of the respiratory pump, the peristaltic movements of the intestine and the rhythmic contractions of the spleen; these agencies help to drive the blood through the second set of capillaries in the liver. Obstruction in the right heart or pulmonary circulation at once affects the circulation in the liver. The increased respiration which results from muscular exercise greatly furthers the hepatic and portal circulation.

14. The Cerebral Circulation.—The circulation of the brain is somewhat peculiar, since this organ is enclosed in a rigid bony covering. The limbs, glands and viscera can expand considerably when the blood pressure rises, but the expansion of the brain is confined. By the expression of venous blood from the veins and sinuses, the brain can receive a larger supply of arterial blood at each pulse. Increase in arterial pressure increases the velocity of flow through the brain, the whole cerebral vascular system behaving like a system of rigid tubes when the limits of expansion have been reached. The pressure of the brain against the skull wall is circulatory in origin; in the infant's fontanelle the brain can be felt to pulse with each heart beat and to expand with expiration. The arterial supply to the brain by the two carotid and two vertebral arteries is so abundant, and so assured by the anastomosis of these vessels in the circle of Willis, that at least two of the arteries can be tied without grave effect. Sudden compression of both carotids may render a man unconscious but will not destroy life, for the centres of respiration, etc., are supplied by the vertebral arteries. The vertebral arteries in their passage to the brain are protected from compression by the cervical vertebrae.

Whether or not the muscular coat of the cerebral arteries is supplied with vasomotor nerves is uncertain.

15. The Coronary Circulation.—Extremely peculiar conditions exist in the coronary circulation; *i.e.*, the blood supply to the heart muscle itself. The coronary arteries originate at the root of the aorta. They turn back into the substance of the cardiac muscle and break up into a rich meshwork of capillaries which convey the blood into the coronary veins, the majority of which collect the blood into the coronary sinus, while some open on the inner surface of the chambers of the heart (Thebesian veins). During systole the heart muscle develops a pressure which must be higher than that in the aorta, as otherwise no ejection of blood from the ventricle into the aorta would be possible. The coronary arteries, which are at any time distended by the pressure prevailing in the aorta, are thus compressed, and during systole the inflow of blood into those of the left ventricle is stopped. The right ventricle by its weak contraction affects the coronary circulation only to a slight extent. While restraining the inflow of blood into the coronary arteries, the contraction of the heart greatly facilitates the outflow from the veins by mechanically expressing their contents. It is interesting to note that adrenaline, which greatly increases the strength of the cardiac beat, also produces a great dilation of the coronary blood vessels, so that a larger amount of blood is provided to meet the increased expenditure of energy. The coronary blood vessels are richly provided with vasodilator and vasoconstrictor nerves; the sympathetic supplies the vasodilator and the vagus the vasoconstrictor fibres.

Since the coronary blood flow is so readily affected by the heart beat, great difficulties are encountered in the study of the regulation of the coronary circulation. A knowledge of all the influences affecting it, however, is extremely important because the activity of the heart, and therefore the fate of the organism, ultimately depends on the blood supply to the cardiac muscle. It is known that even temporary occlusion of the coronary blood vessels is fatal. The disease known as angina pectoris, which usually leads to death, is most probably due to such occlusion as the result of arteriosclerosis or thrombosis of the arteries; it is highly probable that in some cases it may also be due to disorders of the nerves which regulate the tone of the coronary blood vessels. In most cases of weakening of the heart, the coronary flow increases. Lack of oxygen produces an enormous augmentation of the coronary circulation, thus ensuring the survival of the heart so long as there is a trace of oxygen left in the blood.

16. The Influence of Posture on the Circulation.—The circulation remains efficient not only in the horizontal but also in the erect position. Yet in a man standing six feet high the hydrostatic pressure of a column of blood reaching from the vertex to the soles of the feet is equal to 14 cm. of mercury. The blood, because of its weight, continually presses downward, and under the influence of gravity would sink if the veins and capillaries of the lower parts were sufficiently extensile to contain it. During the evolution of man there have been developed special mechanisms by which the determination of the blood to the lower parts is prevented and the assumption of the erect posture rendered possible. The abdominal viscera are slung upward to the spine, while below they are supported by the pelvic basin and the wall of the abdomen, the muscles of which are arranged so as to act as a natural waistband. In tame hutch rabbits, with large patulous abdomens, death may follow in from 15 to 20 minutes if the animals are suspended and immobilized in the erect posture, for the circulation through the brain ceases and the heart soon becomes emptied of blood. If, however, the capacious veins of the abdomen are confined by an abdominal bandage, no such result occurs. Man is naturally provided with an efficient abdominal belt, although this is often rendered toneless by neglect of exercise or gross and indolent living. The splanchnic arterioles are maintained in tonic contraction by the vasomotor centre, and thus the flow of blood to the abdominal viscera is confined within due limits.

The veins of the limbs are broken into short segments by valves, and these support the weight of the blood in the erect posture. Every contraction of the skeletal muscles compresses the veins of the body and limbs, for these are confined beneath the taut and elastic skin. Guided by the valves of the veins, the blood is by such means driven upward into the venae cavae.

17. Circulation During Muscular Exercise.—An attempt to understand the changes in the circulation during muscular exercise can be made only if every part of the complex regulation of the cardiovascular system is kept in mind.

In muscular exercise, every available mechanism concerned in the regulation of the blood flow is brought into operation, everything being centred on the achievement of two objects, (1) to carry the all-important oxygen to the muscles and (2) to remove the excess of waste products as quickly as possible. In violent exercise the common effort of all the cardiovascular mechanisms involved is often inadequate, but fortunately the muscles and other organs do not require an immediate supply of sufficient oxygen to fulfil their needs; fortunately also the muscles can withstand a certain degree of accumulation of waste products without much alteration of the intensity of the activity. In other words the muscles can to some extent run into debt as regards the oxygen supply. But the excess oxygen requirements must at some time be made good, or the activity will have to stop. The complete adaptation of the vascular and respiratory systems, when the oxygen supply and the removal of waste products entirely meets the demand, is achieved comparatively slowly. The first period of severe muscular activity proceeds under somewhat less favourable conditions than hold after complete adjustment. This is probably the explanation of the phenomenon of "second wind." The organism is better adapted to exercise, the more rapidly this state of adjustment is reached.

Since the arterial blood is normally about 95% saturated with oxygen, not much extra oxygen can be obtained by increasing the saturation of the hemoglobin. As already explained, the muscle obtains the required oxygen in two ways: (1) by increased utilization of the oxygen of the blood (*i.e.*, by a greater desaturation of the hemoglobin) and (2) by an increase in the blood flow. The first factor alone would be inadequate even if the muscles were able to remove all the oxygen from the blood. A simple example will serve to illustrate this. If the total blood flow is taken as 4.5 l. per minute, even if the impossible assumption is made that the whole of the blood goes through the muscles, it will mean that the muscles will be supplied with only about 800 c.c. of oxygen per minute. Now the normal oxygen requirements at complete rest are about 300 c.c. per minute, and during severe exercise they may rise to 3,000 c.c. per minute or more. Moreover, the desaturation of hemoglobin is never carried to completion, and even during severe muscular exercise the venous blood still contains some oxygen. Thus the increased oxygen demand can be met to only a limited extent by increasing the coefficient of the oxygen utilization.

The second factor, namely the increase in the output of the heart, is far more important. Among all the factors involved in this increase in the blood flow, the heart will be considered first. This organ plays only a subordinate role. The output of the heart depends on the inflow, and under normal conditions changes in the activity of the heart have little or no effect on blood flow. The main factor in the augmentation of the inflow concerns the peripheral blood vessels. Considerable changes in the heart beat must take place, however, in order to make it possible for the heart to cope with the larger inflow. The first effect of the larger inflow will be to increase the filling of the heart and therefore the output on account of the stronger beat. This is a purely automatic reaction of the cardiac muscle and is independent of the central nervous system. The adaptation of a denervated heart stops at this point. The limit to this adaptation of the heart muscle is set by the pericardium. The adaptation of the innervated heart does not, however, stop here. The increase in the strength of contraction in this case is out of proportion to the inflow, so that the heart becomes able to give progressively stronger beats. It is not only more filled in diastole but it also empties better during systole. This additional strengthening of contraction depends on the diminution of the influence of the vagus nerve and on the excitation of the augmentor fibres of the sympathetic nerve.

But usually in addition to this increase in strength of the beat there is a quickening of the heart rate. This is also based in the first instance on a diminution of the vagus tone, and probably in most cases on an augmentation of the sympathetic tone. Further increase of the inflow is therefore met by a corresponding quickening of the heart beat. The acceleration of the heart in muscular exercise is a purely reflex phenomenon, based (especially at the beginning of the exercise) partly on impulses descending to the cardiac medullary centres from the cortex of the hemispheres, which are probably conditioned reflexes. In part the acceleration is due to concurrent changes in the respiratory activity and to reflexes originating within the vascular system of the animal itself. It has been seen that each inspiratory phase is accompanied by a diminution of the vagus tone and hence by an acceleration of the heart. Thus if there is a greater number of respirations per minute, the periods of acceleration become more frequent and finally fuse, so that the periods of retardation typical of the expiratory state have no time to develop.

Among the reflexes which affect the cardiac rhythm and which originate within the organs of the body itself, the reflexes from the heart should be considered first. It has been shown repeatedly that increased inflow into the heart brings about reflex acceleration of the heart beat. Changes in the activity of the heart should be regarded not as the cause of increased intensity of circulation but as an adaptation which enables the increase to be performed.

The chief causes of increased total blood flow during muscular exercise can be grouped under the following headings: (1) the increase in the aspiration by the thorax; (2) the pumping action of the contracting muscles; (3) the increase in the amount of circulating blood; (4) the diminution of the total vascular resistance. To these should be added the factors which are not likely to affect the total blood flow but which alter the distribution of the blood among the organs. These are: (1) constriction of the splanchnic area and (2) dilation of the blood vessels of the muscles.

These factors have all been discussed in the preceding pages and need only be mentioned shortly. The increased and more frequent expansion of the chest, which follows the deepening and acceleration of respiration, accentuates the negative pressure in the thorax and tends to diminish the pressure in the large veins. These are therefore more quickly and more completely filled with blood from the periphery. The working muscles, by each contraction, expel blood from their capillaries to the veins, and thus actively help the propulsion of blood into the heart. The spleen contracts and empties its blood into the vascular system, and an extra amount of blood thus becomes available. The dilation of the blood vessels in the muscles is so intense that the general resistance diminishes and the blood passes from the aorta into the venous system at a considerably faster rate. All these factors are helped by the contraction of the splanchnic vascular area, which diverts the blood to the muscles. The blood vessels in the muscle dilate, and the capillaries open so that the capillary bed in the muscles may increase 40 to 100 times during maximal activity. This dilation is chiefly if not exclusively due to the local production of vasodilator substances. It is not at present known how far the vasomotor innervation participates in this dilation.

Thus it is seen that during muscular exercise the organism meets the demand for an increased oxygen supply to the muscle by an intricate series of correlated mechanisms. The necessary adjustments involve the respiratory system and the whole cardiovascular system, and probably afford one of the finest examples of coordination that has yet been discovered in the realm of physiology.

See ARTERIES; BLOOD; BLOOD VESSELS, SURGERY OF; CIRCULATORY SYSTEM; HEART, ANATOMY OF; HEART, COMPARATIVE PHYSIOLOGY OF; LYMPH AND LYMPHATIC SYSTEM; NERVOUS SYSTEM; RESPIRATION; VEINS; *see* also references under "Circulation of Blood" in the Index volume.

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CIRCULATORY SYSTEM. This article is a general, comparative survey of the features of anatomical circulatory systems. For more detailed treatment of the components and operation of the circulatory system *see* ARTERIES; BLOOD; CIRCULATION OF BLOOD; HEART, ANATOMY OF; HEART, COMPARATIVE PHYSIOLOGY OF; LYMPH AND LYMPHATIC SYSTEM; VEINS.

The characteristic feature of a typical circulatory system is a set of branching tubes that transport a fluid medium to and from all parts of the body. Important mechanically is a contractile organ, or heart, which beats rhythmically and so propels the fluid in a continuous stream. The vessels that distribute this circulating fluid from the heart to the various organs and parts are arteries, whereas the collecting vessels that return the fluid to the heart are veins.

Interconnecting the terminal arteries and veins are still smaller tubes, the capillaries, which come into intimate relation with all tissues of the organism. In its typical expression the circulating fluid is a coloured blood. But in every instance the fluid acquires oxygen and nutrients from organs specializing in respiration and digestion. These materials are given up to the tissues of the body and from these tissues certain wastes of cellular activity, such as carbon dioxide and urea, are returned to the lungs, gills and kidneys for elimination. The pumping heart and transporting arteries and veins are useful and necessary auxiliaries. But most important functionally are the capillaries, because it is through them that the actual transfers of dissolved gases and solids, outward and inward, are made. Thus the circulating blood serves as a common carrier that makes possible the performance and integration of important vital activities.

It is clear that some multicellular animals have no need of a special distributing apparatus such as the circulatory system provides. Sponges have an intricate set of water canals that penetrate their body mass; even though a sponge may attain large size, all of its cells are in close relation with the water in which it lives. The two-layered coelenterates (hydroids, anemones, corals) have a branching gastrovascular cavity extending into their tentacles and other remote parts; every cell is in direct contact with its watery environment. Although the flatworms have advanced to a three-layered condition, their body mass is provided for by a ramifying alimentary tract and set of excretory tubes. In each of these groups all parts of the organism are brought into intimate relation with mechanisms specializing in nutrition, respiration and excretion.

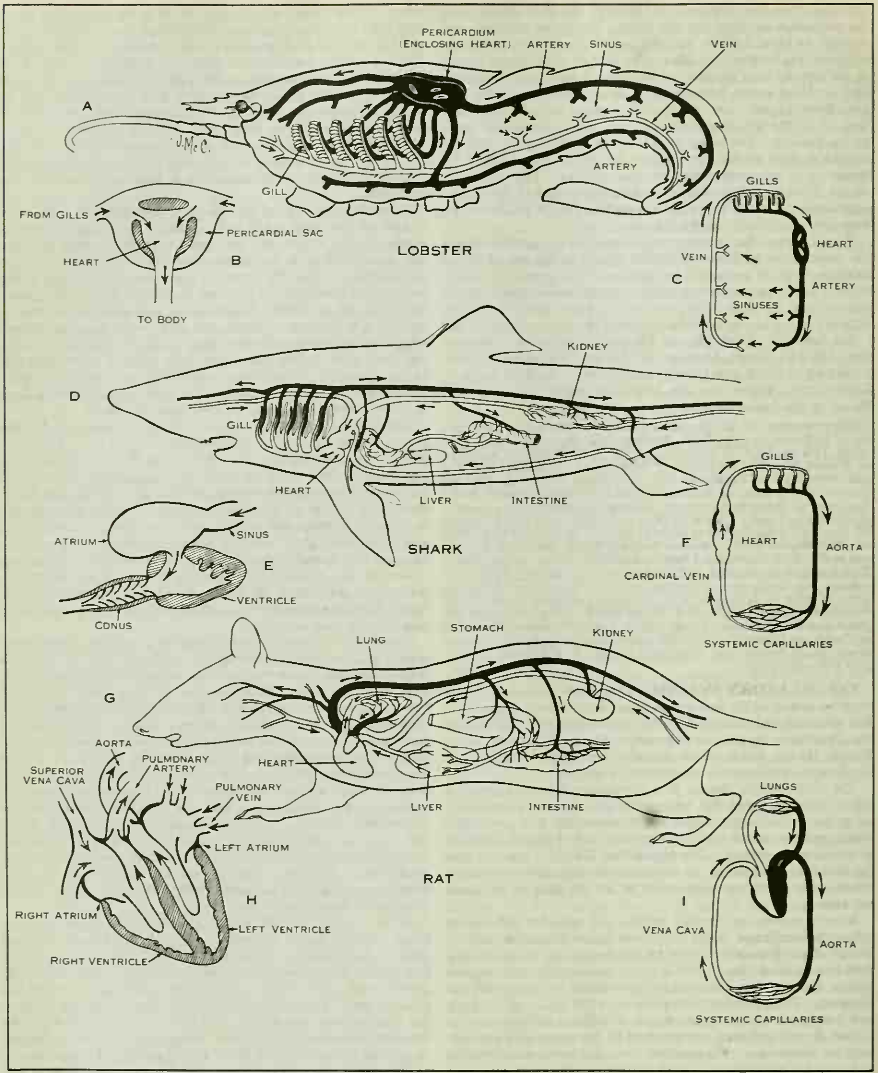
However, some sort of circulatory system becomes a necessity in animals that reach a size and complexity that place the regions supplying food, oxygen and hormones fairly remote from the muscles, glands and other organs requiring these substances. A further need exists when the excretory organs are concentrated in one locality and hence are far removed from most of the sites where cell wastes are produced. Invertebrates, such as segmented worms and the echinoderms, mollusks and arthropods, have introduced a body cavity between the alimentary canal and the external body wall, and part of this space commonly plays a prominent role in the transport of nutritive, respiratory and excretory fluids. Hearts appear in these groups, and in some representatives there is even a closed system of vessels containing blood.

The circulatory system of invertebrates is organized, for the most part, on an open or lacunar plan (fig., A-C). This term implies that the vessels in some regions lose the character of tubes and continue into blood cavities, or sinuses, which lack special walls and lie between the alimentary tract and other organs; from such a sinus the blood re-enters the heart by passing through slits in its wall. In order that any circulatory system can move its fluid about effectively there must be definite regions that are contractile, and this is made possible by the incorporation of muscular tissue into the wall of the conducting tubes. In the lower animals, large portions of the entire system are contractile, but in higher forms the circulation is made more regular by the emergence of a definite, propulsive heart.

Opposed to the open, lacunar scheme of circulation is the closed system of a few invertebrates and all vertebrates (fig., D-I). This term implies the presence of a complete circuit of tubes with their own distinctive walls. With the adoption of a closed system of vessels the body cavity no longer plays a role in the scheme of circulation and, at best, only a temporary role in excretion by the embryo or larva. It is a truism that among the various animal groups the arrangement and structure of the circulatory system have been influenced much more by respiration than by nutrition; always there is a significant correlation in the total expression of respiratory and circulatory organs. In all animals that have developed gills or lungs, two types of capillary beds exist (fig., F, I). One of these occurs throughout the body in general, and its supplying and draining vessels are known as systemic arteries and veins, respectively. The other type of capillary bed, serving only the respiratory organs, is associated with respiratory (branchial or pulmonary) arteries and veins.

Hearts range from the merely thickened wall of an ordinary blood vessel, as in the earthworm, to the highly complicated and efficient double heart of birds and mammals. In order to permit free motion of the heart, it invariably lies either free within the general body cavity or is enclosed within a special sac called the pericardium. Hearts tend to specialize into a receiving portion, the sinus venosus and atrium, and into an expelling portion, the ventricle and conus (or bulbus). Valves also commonly develop to prevent the backflow of blood during periods of relaxation.

The vessels that conduct blood away from the heart toward any capillary bed are called arteries, regardless of whether their blood is pure (*i.e.*, oxygenated) or not. Such vessels are notable for the muscular and elastic components in their walls. The smallest arteries, or arterioles, open into the tiny hairlike tubes called capillaries. These latter consist of only a single layer of thin cells, and this feature enables the oxygen and nutrients (and some of the fluid plasma) to escape into the tissues by diffusion, whereas


A
PERICARDIUM (ENCLOSING HEART)
ARTERY
SINUS
VEIN
J.McC.
ARTERY
GILL
GILLS
FROM GILLS
PERICARDIAL SAC
HEART
B
LOBSTER
TO BODY
HEART
VEIN
C
ARTERY
SINUSES
KIDNEY
D
GILL
HEART
LIVER
INTESTINE
GILLS
ATRIUM
SINUS
SHARK
E
VENTRICLE
CONUS
F
HEART
AORTA
CARDINAL VEIN
SYSTEMIC CAPILLARIES
STOMACH
LUNG
KIDNEY
G
AORTA
HEART
SUPERIOR VENA CAVA
PULMONARY ARTERY
PULMONARY VEIN
LIVER
INTESTINE
LUNGS
LEFT ATRIUM
RAT
H
I
RIGHT ATRIUM
LEFT VENTRICLE
VENA CAVA
AORTA
RIGHT VENTRICLE
SYSTEMIC CAPILLARIES

DRAWN FOR ENCYCLOPÆDIA BRITANNICA, INC., BY JEAN MC CONNELL

REPRESENTATIVE CIRCULATORY SYSTEMS
General plans of three types in side view (A, D, G); the three hearts in section (B, E, H); diagrams of the three types of circulation (C, F, I)

carbon dioxide and other wastes are taken up by a transfer in the opposite direction. Although individually tiny, the capillaries are exceedingly numerous and form networks that in the aggregate present an extremely large surface area. Veins are vessels that return blood from the capillary beds to the heart; the smallest of these vessels, draining the capillaries directly, are called venules.

As before, it is the direction of flow with respect to the beart, and not the quality of the contained blood, that is the essential feature of a vein. Veins are weaker vessels than arteries, and their wall is poorer in muscle and elastic tissue. Since their blood lacks the driving force of a beating heart, veins tend to develop valves which restrict flow to an onward direction.

The circulating fluid of most invertebrates is a colourless plasma that is common with that of the body cavity. When colour is present, as occurs in some invertebrates and all vertebrates, the fluid is called blood. The colouring matter is a respiratory pigment, containing a metallic component concerned with the binding of oxygen. The pigment when present in invertebrates usually resides in the plasma, yet a few types possess coloured corpuscles. In vertebrates the pigment is hemoglobin, carried in red cells named erythrocytes. A general feature of both the invertebrate and vertebrate groups is the amoeboid white cells, or leucocytes; yet even these may be absent in some invertebrates, and the circulating fluid then lacks cellular elements of any kind.

Blood performs a number of functions: it distributes oxygen, nutrients and chemical substances such as hormones; it is an intermediary in the collection and disposal of cell wastes; its leucocytes provide a defense mechanism; it elaborates chemical substances such as fibrinogen and antibodies. Some animals are designated as cold blooded and others as warm blooded. Actually, what is meant is that the first type has variable temperatures through a dependence on the temperature of the immediate environment, whereas the second type maintains a constant temperature through the power of regulating the warmth of its body; this constancy is achieved either by limiting the production of heat or by controlling its loss. (*See* also ANIMAL HEAT.) The terms arterial blood and venous blood are commonly used to designate the quality of blood with respect to its content of either oxygen or carbon dioxide, but these are inappropriate names. The so-called arterial blood travels in veins when returning from seats of oxygenation such as gills, lungs or the placenta of the fetus. Conversely, the so-called venous blood is transported to these sites in arteries.

The vertebrate plan of circulation bears certain resemblances to the condition in animals as far down in the scale as the segmented worms. Both possess a completely closed system of vessels. Also, as in the worms, there is—in the developmental period if not permanently—a dorsal and a ventral longitudinal vessel interconnected by a series of loops. But a fundamental difference in the vertebrate plan is the interposition of a heart in the ventral vessel rather than in the dorsal one (compare A, D in fig.). A special feature, found only in vertebrates, is the system of lymphatic vessels evolved for the purpose of returning tissue fluids to the great venous trunks.

The concept that blood actually makes a complete circuit within the cardiovascular system, rather than being subject to a mere ebb and flow, came tardily in view of the fact that Galen came close to the truth about A.D. 180 and Vesalius demonstrated the proximity of the minute terminals of arteries and veins in 1543. The pulmonary circulation was described correctly by Michael Servetus in 1553, but the larger credit for the establishment of the concept of the systemic circulation belongs to William Harvey (1628). Marcello Malpighi in 1661 first saw the capillary connections between arteries and veins and thus demonstrated the final link in the set of proofs.

A number of distinct steps were made by the several vertebrate groups toward the perfecting of an increasingly complex and efficient circulatory system. Simplest is the gill plan, especially characteristic of fishes, which contains but a single circuit (fig., D-F). The heart is a flexed tube, receiving impure blood and pumping it to the gills for oxygenation; thence the purified blood flows to the tissues of the body. On the return journey to the heart, some of the impure blood passes through additional capillary beds in the kidneys and liver.

When vertebrates became land inhabiting, lungs replaced gills and a lung plan with a double vascular route was gradually perfected; one is the pulmonary circuit and the other, the general systemic circuit (fig., G-I). This development necessitated changes in the heart, leading to its subdivision and the production of a twin pumping mechanism that might be considered as two hearts, each with two chambers. Amphibians and reptiles show several stages of advance in this direction. They have separate atria, but the ventricle is incompletely divided and permits some mixing of blood; in a sense, this is one and a half hearts. Birds and mammals attained a completely partitioned double heart (and ventral aorta). The right half contains impure blood and supplies the pulmonary circuit; the left half contains pure blood and supplies the systemic circuit.

With the diminishing importance of a tail and the increased use of the legs in locomotion by land animals, the routing of venous, tail-region blood through the kidneys was discontinued. Thus in mammals there is no renal portal system; by contrast, the hepatic portal system, in which venous blood is interrupted by the sinusoids of the liver, is prominent in all of the vertebrate groups.

See also references under "Circulatory System" in the Index.

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CIRCULATORY SYSTEM, DISEASES OF: *see* ARTERIES, DISEASES OF; VEINS, DISEASES OF; HEART, DISEASES AND DEFECTS OF.

CIRCULUS IN PROBANDO, in logic, a phrase used to describe a form of argument in which the very fact which one seeks to demonstrate is used as a premise; *i.e.*, as part of the evidence on which the conclusion is based. This argument is one form of the fallacy known as *petitio principii*, "begging the question." It is commonest in lengthy arguments, the complicated character of which enables the speaker to make his hearers forget the data from which he began.

The following duologue may serve as a simple illustration of circular argument. "He speaks with angels," said one of the Master's disciples. "How know you that?" I asked. "He himself admits it," he replied solemnly. "But suppose he lies?" I persisted. "What!" he exclaimed, "a man who speaks with angels capable of telling a lie?"

See also FALLACY.

CIRCUMCISION, the operation of cutting away the whole or part of the foreskin of the penis. The origin of the practice is unknown. The widespread ethnic distribution of circumcision as a ritual, and the quite widely preferred use of a stone knife rather than a metal one, suggest a great antiquity for the operation. Only the Indo-Germanic, the Mongol and the Finno-Ugrian-speaking peoples were unacquainted with the practice. Wherever the operation is performed as a traditional rite it is done either before or at puberty, and sometimes, as among some Arabian peoples, immediately before marriage.

Among the ancient Egyptians, boys were generally circumcised between the ages of 6 and 12 years. Among the Ethiopians, the Jews, the Muslims and a few other peoples, the operation is performed shortly after birth. Among most other peoples who practise it, the operation is performed at puberty. At both age periods the operation is regarded as of the profoundest religious significance. For the Jews it represents the fulfillment of the covenant between God and Abraham (Gen. xvii, 10–14), the first divine command of the Pentateuch, that every male child shall be circumcised. That Christians are not obliged to be circumcised is first recorded in Acts xv. The operation at puberty represents a beginning of the initiation into manhood and the leaving behind of childhood.

At whatever age performed, circumcision usually signifies the formal admission of the individual into his group or to the achievement of a certain status, thus fixing his social position, rights and duties. To this day the operation among many peoples remains a necessary preliminary to the admission of proselytes. It is said that Pythagoras (*c.* 530 B.C.) had to submit to the operation before he was permitted to study in Egyptian temples. One of the best-known, but not the earliest, representations of circumcision, occurring on the wall of an Egyptian tomb at Saqqara dating to about 2400 B.C., presents scenes showing a boy whose wrists are being held by a man who stands behind him, while the priest stoops to perform the operation. Earlier representations and descriptions indicate that the practice was already well established in Egypt as early as 4000 B.C. and probably earlier. In Egypt it apparently was at first principally performed on the priestly class, being later adopted by the warrior classes, the nobility and royalty.

There are numerous theories concerning the origin of circumcision. The following constitute a representative sample: it represents a blood-offering to the gods, in order to maintain the latter's immortality and also to extend the life of the individual; it is a substitute for sacrifice; it is a dedication; the sacrifice of a part to ensure the welfare of the whole; the cutting off and preservation of part of oneself ensures preservation after death, and reincarnation; it represents the atonement made for incestuous desires entertained in childhood, unconsciously expiated by the fathers through their sons; since the foreskin often exerts a constricting effect it was considered magically to inhibit fertility, hence the necessity of its removal; finally, it has been suggested that it was practised for purely hygienic reasons.

There is probably some truth in some of these conjectures, perhaps in all, but precisely how much or how little it is impossible to say. The origins of the practice are as dark as an Egyptian night. A lucky series of archaeological finds may some day provide a more exact understanding of the origin of the custom.

Female circumcision or excision is widely practised in such places as New Guinea, Australia, the Malay archipelago, Ethiopia, Africa, Egypt, southern Europe, South America and by various Islamic peoples of western Asia and India. The operation consists in cutting away the whole or part of the external genitalia. Strabo, the Greek geographer, in the 1st century A.D. noted female circumcision among the Egyptians. In Egypt the operation appears to have been performed upon females at puberty at least several centuries before Strabo reported it. It is quite possible that female circumcision antedates male circumcision.

From the medical aspect the operation consists in removal of the foreskin to allow its free retraction beyond the glans penis. The foreskin or prepuce consists of a double layer of skin which more or less completely covers the glans penis. Under the inner layer of foreskin there are situated a number of glands which secrete a cheeselike substance called smegma. Accumulation of smegma beneath the foreskin may result in great discomfort and may serve as the source of a rather penetrating odour. The balanitis or inflammation of the glans penis, which to some extent is always present in the uncircumcised, is eliminated by circumcision. So, too, is the often associated phimosis or narrowing of the external orifice of the penis relieved. It is noteworthy that in India the Hindus, who do not circumcise ritually, suffer far more frequently from cancer of the penis than the Muslims who practise ritual circumcision usually at the age of 10 to 12 years. Among the Jews, who perform the operation shortly after birth, cancer of the penis virtually never occurs.

In the western world the operation has been increasingly more widely practised as a hygienic procedure. In many hospitals it is routinely performed upon the newborn unless there is some objection. It has been felt by some authorities that circumcision of the newborn may be a psychologically traumatizing experience to the infant, and that therefore the operation should be delayed until the child is much older. It is, however, a question whether the operation would be less traumatic to the older child.

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(M. F. A. M.)

CIRCUMSTANTIAL EVIDENCE is a kind of indirect evidence. If something happens in the presence of witnesses who observe it, their evidence is direct evidence of the occurrence. If, however, there is no such direct evidence of the event, then it is necessary to rely on indirect evidence, if any. Such indirect evidence usually consists of certain circumstances surrounding the event or in some way connected with it. By piecing these circumstances together one may obtain an intelligible, coherent account of the whole course of the event or events in question. This piecing together of the data is a kind of hypothesis, and there may be several rival hypotheses to account for the facts. But as in all cases of the use of hypotheses, the hypothesis which gives the most adequate and consistent explanation is usually accepted. Inference from circumstantial evidence resembles ordinary induction to the extent that it involves the use of hypotheses and their verification, but it is unlike ordinary induction inasmuch as it does not aim at a generalization, being concerned only with some particular event. The systematic character of inference is perhaps most obvious in the case of inference from circumstantial evidence, for it manifests most clearly the process of the imaginative construction of a coherent system out of fragmentary evidence. The most familiar occasions for the exercise of inference from circumstantial evidence are criminal cases. Criminals naturally take precautions against the possibility of direct evidence, and are often betrayed by circumstantial evidence. *See* EVIDENCE: *Proof of Facts.*

CIRCUS. Although many historians have traced the origin of the modern circus to the circuses of ancient Rome it would seem more logical to assume that the circus, as it is known today, was derived from the Roman amphitheatre. Its shape, if not its size, is similar and the first modern circus was even called an amphitheatre. Both the Roman circuses and amphitheatres, however, were designed for horse racing or spectacles intended to end fatally for either man or beast, the antithesis of the displays of skilful co-operation that were the essence of the circus in the second half of the 20th century.

ROMAN ORIGINS

The Roman Circus.—The Roman circus was built on the model of the Greek hippodrome (*q.v.*). The first and largest was the Circus Maximus in Rome, which was rebuilt in the time of Julius Caesar and held perhaps as many as 150,000 seats, situated on three sides of the course. It was enlarged by succeeding emperors and at its greatest, under Constantine, it must have measured about 2,000 by 600 ft.

Although nothing but the site of the Circus Maximus remains, vestiges of the Circus Maxentius (A.D. 309), which followed a similar plan, can still be seen. References to the circuses of Flaminius, Caligulas, Dominitian and Sallust can also be found, although the Sallust, like the Circus Florae, may have been imaginary.

The arena (Lat. *arena*, "sand," or "beach") was divided longitudinally by a wall (*spina*) decorated with obelisks and shrines and set obliquely to give more room at the beginning of the race. Horses and chariots lined up in the stalls (*carceres*), which were arranged at a slight angle along one end to ensure a fair start. At the other end, the barrier flanking the track made a semicircular turn, the whole forming a U-shaped course. Chariots were drawn by two, four (occasionally three), and sometimes more, highly trained horses. The drivers, who were often slaves, wore helmets and were wrapped in lengths of reins. They carried knives to cut themselves free if the chariots collided or overturned. The competing teams bore different colours: red and white at first, later green, blue, purple and gold. Four, six, eight or even twelve chariots raced at a time and the course consisted of seven laps, the distance traveled and the progress of the competitors being signaled from each end of the *spina*. Admission was free, though the wine merchants and pastry cooks plied their wares inside the circus while bookmakers and prostitutes solicited custom.

Spectacles other than chariot racing were sometimes produced. During Augustus' reign (27 B.C.–A.D. 14) 3,500 beasts are said to have been killed, and under Nero the torture of Christians was an added attraction at the Circus Caligulas. Most exhibitions of this sort, however, were presented in the amphitheatres.

The Roman Amphitheatre.—Although the circus owes its origin to the Greek hippodrome the amphitheatre is purely Roman. The largest was the Colosseum (*q.v.*), which was dedicated in A.D. 79, and is estimated to have held between 45,000 and 50,000 persons. There the public paid for admission, and, although the arena was sometimes flooded for nautical pageants, the dominant theme was the slaughter of animals and men. Gladiators, who had first appeared in 264 B.C. and were outlawed in A.D. 404, were among the most popular performers: 2,000 gladiators and about 230 wild animals were billed to die in celebration of Rome's 1,000th anniversary. Until Constantine repealed the law in A.D. 326, a man could be condemned to the wild beasts in the arena. The "hunting" of wild animals in the Colosseum continued until A.D. 523.

Other Roman amphitheatres were built at Pompeii (*c.* 80 B.C.), Verona (A.D. 290), Pozzuoli, Capua and Pola in Italy; Syracuse in Sicily; at Arles and Nîmes in France; at El Djem, near Carthage in north Africa; and at Dorchester and Caerleon in England. (*See* also Games, Classical and Roman Architecture: *Types of Building: Theatres, Amphitheatres, Circuses.*)

THE MODERN CIRCUS

Beginnings in England.—The modern circus came into being in 1768, when Philip Astley (1742–1814), a former sergeant major turned trick rider, found that if he galloped in a circle while standing on his horse's back, centrifugal force helped him to keep his balance. In doing so he traced the first ring.

Circumstances were favourable for the development of the circus. During the second half of the 18th century a number of trick riders were appearing in the pleasure gardens of London and elsewhere. Many of them were riding masters turned showmen, though, as they were accustomed to the traditional rectangular manège, none thought of riding in a circle until Astley led the way. At this same time the fairs were going into decline. Due partly to rowdyism and partly to the jealousy of the theatre licensees, the run of many of the most famous fairs was curtailed and some of the main attractions were banned. Many showmen, looking for new outlets, found it in the circus, as did ropedancers, acrobats, jugglers and others whose performances were based on dexterity, agility and strength, and who discovered that their performances were better appreciated in the ring, where it could be seen clearly that nothing was faked.

In 1769 Astley moved his ring about a half-mile westward to a site at the Surrey end of Westminster bridge, London. First he fenced the boundary and built a covered stand, then he roofed in the whole establishment and later painted the ceiling above the ring with foliage, christening the establishment the Royal Grove. The name circus was first used in 1782 when the Royal circus was set up a half-mile to the southeast of Astley's; this was a rival enterprise started by Charles Hughes, one of Astley's horsemen.

Introduction to Continental Europe and America.—In 1772 Astley went to France to present his "daring feats of horsemanship" before the king and the French court, and he found that there, too, many showmen were ready to forsake the fairgrounds. Ten years later he returned to Paris and opened the amphitheatre, which he leased to the Franconis at the outbreak of the Revolution. Antonio Franconi (1738–1836), a member of a noble Venetian family, had been forced into exile after a fatal duel. He became first a showman and later a trick rider, but it was as a director that he excelled. He joined forces with Astley and, in Astley's absence, continued on his own. His sons, Laurent and Henri, continued in his footsteps and the Franconi family became the founders of the French circus. They are reputed to have standardized the diameter of the ring at 13 m. (or 42 ft. approximately in U.S., U.K. and other English-speaking countries), a size that is still recognized.

Astley's journeys did not stop at Paris. In 1782 he traveled as far as Belgrade, visiting Brussels and Vienna on the way, and during his life he built 19 permanent circuses. It was Hughes, however, who first introduced the circus to Russia. He added a company of trick riders to the stud of horses he had been commissioned to deliver to Catherine the Great in 1793 and he was rewarded with a private circus in the royal palace in St. Petersburg. The Russian circus was later developed by a Frenchman, Jacques Tourniaire (1772–1829).

In 1793 John William Ricketts opened circuses in Philadelphia, Pa., and New York city, the first seen in the new world. At the same time Benito Guerre was presenting his feats of horsemanship in Spain, and a cut on a contemporary handbill shows a rider leaping through a paper hoop—a scene that still epitomizes this form of entertainment. By the turn of the century the circus had spread throughout Europe and was firmly established in America. Performances were given mostly in permanent or semipermanent buildings. The greatest hazard was fire, from which Astley and Ricketts suffered particularly: Astley's amphitheatre burned down three times in the first 62 years of its history, and Ricketts lost his circuses in both New York and Philadelphia in the same way.

The traveling showmen of the fairgrounds were quick to adopt this new form of entertainment, first in an open enclosure with canvas walls and later in a tent. Like a number of other innovations in the traveling circus, the tent is said to have been invented in America. The first show to have used a circus tent, or "big top," may have been that of Turner in 1826, though in the same year Quick and Mead had a 50-ft. tent, four wagons, nine horses and a hurdy-gurdy to provide the music. It seems more likely that the tent originated in the European fairgrounds booth.

Theatrical Influence.—Meanwhile, in the permanent circus buildings in Europe, the true circus had become adulterated through a misalliance with the theatre. The tiers of encircling seats were broken to accommodate a proscenium arch and stage behind the ring. Equestrian drama, with plots based on battles and sieges, became the rage. The French public, who had generally shown a deep appreciation of the true circus spectacle, soon tired of the intrusion and applauded horsemanship without histrionics, but in England this hybrid form of entertainment continued. *Richard III* and even *Il Trovatore* were performed on horseback at Astley's, where the theatrical influence could still be seen at the end of the 19th century in the zoological pantomines produced by "Lord" George Sanger. Throughout this period the traditional circus performance was kept alive by the "Scenes in the Circle," which were also included in the bill. Even here, however, the influence of the theatre was apparent in the riding acts, for scenes such as "The Sailor's Return" were enacted on the back of a horse, caparisoned to represent a man-of-war, with gun ports down its flank.

Equestrian Influence.—The greatest exponent of trick riding was an Englishman, Andrew Ducrow (1793–1842), who, after achieving notable success on the Continent, ran Astley's amphitheatre from 1824 until his death. The characters he portrayed, such as the Chinese enchanter, the Tyrolean shepherd and the Indian hunter, could never mask his brilliant riding; and one of his acts, "The Courier of St. Petersburg," was still seen in the circus in the latter half of the 20th century. In this act, a rider straddles two cantering horses while other horses, bearing the flags of those countries that a courier would traverse on his journey to Russia, pass between his legs.

During the first 80 years of its history the circus was dominated by the horse. Many of the proprietors were riders and trainers who founded dynasties, such as Renz in Germany, Salamonsky in the Baltic states, Carré in the Netherlands and Schumann in Scandinavia. Other proprietors who were also famous riders were the Cookes, Clarkes, Fossetts and Ginnetts in England; and the Franconis, Loyals and Rancys in France. A number of the great U.S. riders and trainers, such as Levi North, Charles Fish, James Robinson, Robert Stickney and Spencer Q. Stokes, became proprietors or managers. When Richard Sands' circus visited England in 1842, the "Company of American Horseman" and the "Stud of Highly Trained American Horses" topped the bill.

Equestrian acts of the 20th century could be divided into three main groups: voltige, in which a rider vaults on and off a horse's back; trick riding, in which the rider spends more time turning somersaults, pirouettes and balancing on a horse's back; and high school, which is a spectacular form of dressage. The Schumann family, directors of the permanent circus in Copenhagen, are excellent high school riders and in the early 1960s were the greatest horse trainers in the world.

Zoological Influence.—Although horses were the mainstay of the program (and for many years provided the motive power for the traveling shows), there was still room for other acts. One of the most famous U.S. performers, whose fame extended far beyond his own country, was the wild animal tamer Isaac Van Amburgh (1801–65). He first appeared in New York at the Zoological Institute, a name that was the forerunner of the high-sounding American titles of the mid-19th century, for example the Equescurriculum, the Hippolymiad and the Cirqzooladon. Although Van Amhurgh is reputed to have been the first man to put his head in a lion's mouth, he was not the first wild animal tamer. Tamers and trainers had been seen on the fairgrounds of Europe for centuries, and the first great tamer to appear in the circus ring was Henri Martin (1793–1882), a Frenchman. Both he and Van Amburgh appeared in theatrical productions, such as *The Lions of Mysore* and *The Brute Tamer of Pompeii,* as well as at the circus.

Menageries were later incorporated into a circus. A program made up of individual specialist acts was expensive and it was a great economy to present animals in the ring which could also be exhibited at an extra charge in the menagerie or sideshow. C. Hagenbeck, an animal dealer in Hamburg, Ger., had pointed the way in his own circus in 1887 and thereafter an increasing number of menagerie proprietors forsook the fairground for the circus: Krone in Germany; Kludsky in Czechoslovakia; Bouglione, Amar and Spessardy in France; and Chipperfield in England.

Wild animal acts can be divided into two groups: those presented *en douceur* and those presented *en ferocité*. Often it is the less ferocious looking act that is most dangerous. There have been many famous trainers in the history of the circus, including Togare, Kaden, Damoo Dhotre (a pupil of Alfred Court), Gilbert Houcke and Vojtek Trubka.

The Influence of Acrobats.—In 1859 the invention of the flying trapeze by J. Léotard (1838–70) and Charles Blondin's crossings of Niagara falls on a tightrope rekindled the public interest in the work of the aerial gymnast and acrobat. Although the trapeze had never been seen before, ropedancing can be traced back to ancient Greece. By the turn of the century acrobatics had had an extensive influence although they never usurped the supreme position of the horse. About 1900 the Scheffers, Craggs, Hanlon-Voltas, Sandow, Lauck and Fox, Cinquevalli, Caicedo and the Potters were the most prominent European and American acrobats and gymnasts. Later the Concellos and Codonas on the flying trapeze, Con Colleano on the tightwire and Enrico Rastelli, the juggler, captivated audiences with their skill and daring.

Managerial and Technical Developments in the 19th Century.—From 1840 onward, circus combines and amalgamations became widespread in the United States and partnerships were made and broken with bewildering frequency. On several occasions between 1843 and 1856 "General" Rufus Welch (1801–56) joined his company with that of Lewis B. Lent. Welch at one time toured the Mediterranean countries, and Lent had been Sand's partner on his tour of England as well as being associated with the Flatfoots (so named because they put their feet down flatly against competition in what they considered their territory), Van Amburgh, Howes and Barnum. The forming and reforming of such aggregations and combines continued throughout U.S. circus history until 1929, when the Ringling Brothers, who already controlled Barnum and Bailey's "Greatest Show on Earth" and five others, bought out the Circus Corporation of America, bringing a total of 11 major circuses under one direction. This was never the case in Europe, where families tended to split up rather than combine, so that more than one circus may bear the name Pinder, Fossett, Ginnett or Sanger.

The mid-19th century was a period of great technical development in the United States. Spencer Q. Stokes invented the derricklike apparatus for training trick-riders which still goes by the name of the American Riding Machine. At one time his circus traveled by river boat, though he did not give performances on a showboat as did "Dr." Gilbert Spaulding (1811–80). This former chemist from Albany, N.Y., is said to have invented quarter poles (which support the canvas roof of the big top between the central king poles and the side poles) and was also one of the first men to transport his circus by rail. Railroads were more frequently used in the U.S. than in any other country. In Europe this method of transport was never very popular, and, although one or two attempts at traveling by rail were made, it was not until the second quarter of the 20th century that it was regularly used, and then only by Bertram Mills. In Latin America and the far east it was used, when available, after 1900. In 1852 Dan Rice, the famous U.S. clown (1823–1900), tried lighting his circus by electricity but gave up the experiment because of the injurious effect it had upon "persons predisposed to pulmonary complaints" and upon "the tender brain of children." Although P. T. Barnum's name is linked with the circus in the mind of the public, his success was largely due to his partner, James A. Bailey; Barnum's interest was kindled late in life by W. C. Coup (1837–95), who had spent many years with circuses. It was Coup who introduced the end loading of circus trains, bridging the gaps between the flatcars with fishplates. Circus wagons, when traveling by rail, have always been carried on flatcars. The easiest method of loading was, therefore to bridge the gaps between the flatcars and push each wagon down the length of the train. The contributions of the U.S. were not always on the managerial side. "Professor" Risley (1814–74) invented the acrobatic act in which children take part; it is still known as a "Risley act."

During the latter half of the last century the street parade grew in importance. This free attraction was developed by Seth B. Howes, who returned to the United States from England with a number of highly ornate parade wagons. These processions, which wound their way through the town back to the circus field ("lot" in the U.S., "tober" in the U.K.), were a great feature of British tenting circuses, particularly that of "Lord" George Sanger (1827–1911), who also owned Astley's amphitheatre from 1871 until it was demolished in 1893. Once he even tacked his parade on to the end of a military escort accompanying Queen Victoria across London. "Lord" George Sanger took his title because he was so incensed at Buffalo Bill's being referred to as the Honourable William Cody in the course of a law suit, that he said, "If Cody is an Honourable, then I am a Lord!" Queen Victoria later greeted him quizzically as, "*Lord* George Sanger?" to which Sanger replied, "If it so pleases Your Majesty." Astley's, although extremely popular, never became as fashionable as the permanent circuses on the Continent. At the Cirque d'Été the most exclusive club in Paris kept its own private box, and in St. Petersburg the stables were regularly scented for aristocratic visitors. Toward the end of the 19th century the Russian circus was dominated by the Cinisellis, who, like most Italian circus families, made their name outside their own country.

The Circus in the 20th Century.—At the end of the 19th and the beginning of the 20th century the circus was still spreading to many other countries. The British circus family of Harmston settled in the far east, and for years their only rival was the Russian circus, Isako. The Boswells forsook England for South Africa, where, from time to time, they met competition from Pagel, who was of German origin. Frank Brown, whose father had been a clown at Astley's, toured South America for many seasons. In Australia the circus prospered under the Wirths. The Lobes, from Budapest, made Persia their tenting ground and the Sidolis settled in Rumania. Foreign travel was, however, inhibited by the passport formalities, customs duties, quarantine restrictions and currency regulations that followed World War I, and for large companies with much equipment the difficulties were particularly acute. In order to evade inflation and crisis in Germany, Sarassani took his circus to South America in 1923 and 1934, but the last U.S. circus to tour Europe left the United States in 1896, and no British circus has left the British Isles since the early 1920s.

In the 1920s the circus in Britain declined. It was revived by Bertram Mills, a coachbuilder, who introduced the greatest international circus stars to the British public at Olympia, London, and ran the only tenting circus to travel by rail in England. Rastelli the juggler, Colleano the wire walker, the Codonas on the flying trapeze, the Schumanns and their horses and, later, Trubka the trainer of wild animals all appeared at Olympia.

After World War II the circus flourished in Europe. A large number of small family tenting shows sprang up and, in London, Tom Arnold took over the ice hockey rink at Harringay for a number of Christmas seasons, where the circus acts he presented recalled Mills' heyday at Olympia. The shape of the arena, however, led him to model his show on the American pattern. He surrounded the ring with a hippodrome track and included chariot races, production numbers and aerial ballets in his programs. The Christmas circus is essentially British. Attempts to introduce three rings into European circuses had not succeeded by the early 1960s. In the United States, and to some extent on the continent of Europe, performers who cannot find winter engagements in cabaret or variety retire to winter quarters to rehearse and break in new acts.

In the U.S. the combines and amalgamations led to bigger shows. In order to make these pay, tents that held up to 10,000 spectators would be erected for one day in each town on the circus schedule. The ring, traditionally 42 ft. in diameter, had to be flanked by other rings and intervening stages to suit the new and larger tents. The Ringling Brothers, Barnum and Bailey's "Greatest Show on Earth" at one time had three rings and five stages surrounded by a hippodrome track. This altered the type of show, which could no longer be confined to single acts but had to include spectacular processions and aerial ballets for mass effect. Traveling became more and more difficult and in 1956 increased freight rates and labour problems induced "The Greatest Show on Earth" to give up tenting and appear only in permanent buildings such as exhibition halls. Although about 30 circuses still toured the United States in the early 1960s, they were smaller, and most traveled by road instead of rail.

In the Soviet Union the circus became one of the most popular forms of entertainment and in the early 1960s boasted of more than 100 permanent and tenting shows. Each year approximately 22,000,000 people watched acrobats, riders, trainers and clowns trained in the state circus school. In the 1960s various Soviet circus companies appeared in the European capitals and audiences saw remarkably high standards achieved. The distinguishing features were the originality of the apparatus, the costumes and the presentation. In the high wire act of the Voljanskis, for example, the wire changed from being horizontal to an oblique angle, while the tension was maintained; the Koch sisters performed on a giant semaphore arm that revolved slowly as they balanced on the outside edge. Brilliantly designed circular carpets covered the sawdust, and drapes were used to decorate the ring fence. Safety lunges were used for all acts that involved a risk to human life.

A typical circus program might run as follows: (1) overture; (2) voltige; (3) strong man; (4) trained pigeons; (5) juggling act; (6) liberty horses; (7) clown entrée; (8) springboard act; (9) intermission; (10) wild animal act; (11) aerial act; (12) high school; (13) wire walker; (14) performing elephants; (15) trick riding; and (16) clown entrée. The choice, however, is large; springboard acts, perch performers, hand-to-hand balancers, artists on the rolling globe and many others would fit into the bill equally well.

The advent of television also affected the circus, for while it introduced the skill of the performer to a much larger audience, attendances at the actual performances fell. Circus directors reacted in two very different ways. Some stipulated that artistes should not appear on television for a certain period before and after their engagements, nor would they allow their shows to be televised. Others allowed parts of their programs to be televised, believing that a brief glimpse might whet the public's appetite much as a trailer advertises a film.

In spite of the various phases in its history, the circus remains essentially the same spectacle: a display of human endeavour in which man's agility, strength and ingenuity and his skilful management of animals are contrasted with the comic and sometimes tragic buffoonery of the clowns. Since such a spectacle needs no language to achieve its effect it is at home anywhere, regardless of the audience's race, creed, colour, age, rank, fashion, income and intellect.

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CIRENAICA: *see* CYRENAICA.

CIRENCESTER, a market town and urban district in the Cirencester and Tewkesbury parliamentary division of Gloucestershire, Eng., lies on the Churn river at the edge of the Cotswolds, 17 mi. S.E. of Gloucester by road. Pop. (1961) 11,836. Cirencester is an agricultural and hunting centre with twice-weekly markets and light industrial undertakings. It has many fine gray stone houses built by prosperous wool merchants. The great parish church of St. John Baptist, of Norman origin but mainly Perpendicular, has bells cast in Queen Anne's reign. The grammar school was founded in 1461.

Cirencester occupies the site of the Romano-British Corinium Dobunnorum, at the junction of Fosse way, Ermine street and Akeman street. Tombstones of Roman cavalrymen belong to a Claudio-Neronian fort. The walls enclosed a town of 240 ac., in which remains of a basilica and many well-appointed private houses were discovered. The town was the largest in Roman Britain after London, and probably the capital of Britannia Prima in the 4th century. Westward lay an amphitheatre, and numerous rich villas stood nearby. A fine collection of inscribed and sculptured stones, mosaic pavements and other relics is housed in the Corinium museum. The town was captured by the Saxons in 577, and later became a royal demesne. William the Conqueror granted the manor to William Fitzosbern, earl of Hereford, who built a castle which was later razed to the ground under King Stephen. A college of prebendaries, founded in Egbert's reign, was reconstructed by Henry I in 1117 as an Augustinian foundation. Henry II leased the manor to the abbot. In 1215 and 1253 the abbot obtained charters for fairs; the wool trade gave these great importance—William Camden records Cirencester as having "the greatest market for wool in England." In 1403 Henry IV rewarded the citizens for their help against the earls of Kent and Salisbury by granting them a guild merchant, but this was revoked by Henry V. Cirencester became a parliamentary borough in 1572, returning two members until 1885. The abbey was destroyed at the Dissolution, and an Elizabethan mansion (Abbey house) built on the site by Richard Master, the queen's physician. Cirencester house, built at the same time by Sir John Danvers, became in 1690 the home of the Bathurst family, rebuilt by the first Earl Bathurst in 1718. South of the town lies the Royal Agricultural college.

See F. Haverfield, "Roman Cirencester," *Archaeologia*, vol. lxix, pp. 160–209 (1920). (W. E. W. L.; I. A. RD.)

CIRE PERDUE: *see* SCULPTURE TECHNIQUE.

CIRQUE, a French word used to denote a semicircular amphitheatre, with precipitous walls, at the head of a valley in a glaciated mountain region (Lat. *circus*, "ring"), generally resulting from basal sapping and erosion beneath the bergschrund of a glacier. The bergschrund is a large crevasse, in the form of a great symmetrical arc, parallel to the head of the névé (*see* GLACIER); it lies at a short distance from the exposed rock surface and separates the stationary from the moving ice, and in early summer, when the glacier commences to move, it opens and exposes the rock at its base to diurnal changes of temperature. Frost action then causes rapid disintegration downward at its base and backward upon such part of the rock surface as is exposed in the bergschrund beneath the stationary ice, thus producing the characteristic form of the cirque. The formation of cirques has played an important part in the development of the scenery of glaciated mountain tracts. Arêtes (sharp ridges) are formed by the intersection of two cirques, and pyramidlike peaks such as the Matterhorn and Snowdon are remnants left by the recession of three or more cirques. Cirques frequently contain lakes, for, as a result of the action of the bergschrund, the floor slopes toward the mountain mass. W. D. Johnston first recognized the processes giving rise to cirque formation by actually descending a bergschrund on the glacier of Mt. Lyell in California. Hollows of similar shape to cirques occur in limestone regions which may not have been glaciated. These are formed by aqueous solution and are not true cirques.

CIRRIPEDIA, the scientific name for a subclass of Crustacea that comprises the barnacles, marine animals completely sedentary as adults and showing little external resemblance to other crustaceans. Some are parasitic on other marine animals. *See* BARNACLE; CRUSTACEA.

CISTERCIANS, later known as WHITE MONKS and sometimes as BERNARDINES, took their name from Cîteaux (*q.v.*), a locality in Burgundy (Côte d'Or), southwest of Dijon, France. The founding fathers were a group of monks of the Benedictine abbey of Molesme who, according to the traditional account (questioned but possibly correct) were dissatisfied with the relaxed observance of their abbey, and persuaded the abbot, St. Robert, to lead them (1098) to a desert place where they might live a solitary life and observe the rule of St. Benedict "to the letter." When the monks at Molesme demanded Robert's recall, the "new monastery" of Cîteaux was confirmed as an abbey under St. Alberic (d. 1109); he was succeeded by another of the original group, St. Stephen Harding, an Englishman from Sherborne (d. 1134). The beginnings were hard, with want and illness reducing the monks almost to despair, but the tide turned with the arrival of St. Bernard in 1112 or 1113.

At some time before 1119, when Urban II gave papal approval, and probably under Abbot Stephen, the outlines of the three essential Cistercian documents took shape: the account of the foundation (*Exordium parvum*), the constitutional summary known as the *Carta caritatis* ("Charter of Charity") and the regulations (*Consuetudines*) governing the life. The two former were probably in part at least the work of Stephen, the last was made up of early abbatial decisions augmented by the decrees of subsequent general chapters. There were at the time, and had been before, numerous attempts to remodel the traditional monastic life; the success of the Cistercians was due partly to the determination and logical realism of the group of founders, and partly to the genius of Stephen Harding and others in composing brief but comprehensive constitutional documents. They rejected absolutely all clothing, diet, etc., unauthorized by the rule, emphasized the absolute community of life and cut off every kind of possession that implied contact with the society around them. They reintroduced manual work for monks, making it a principal feature of their life, and they cut out almost all accretions to the office and liturgy and chant save for the daily conventual and private Masses. In order to implement the new venture, they adopted and transformed the practice of using lay assistants for building and farm work, and catered for large numbers of lay brothers or *conversi*, living under a different regime in separate quarters.

When, after a difficult beginning, Cîteaux began to flourish and "swarm," the three outstanding constitutional features imposed briefly and firmly by the *Carta caritatis* were: (1) Uniformity; all monasteries were to observe exactly the same rules and customs, with identical service books and an identical arrangement of buildings (*see* MONASTERY: *Cistercians*). (2) General chapter; the abbots of all the houses were to meet in annual general chapter at Cîteaux. (3) Visitation; each daughter house was to be visited yearly by the founding abbot, who should ensure the observance of uniform discipline. The whole body was thus bound together vertically by the close connection from top to bottom of mother and daughter, and horizontally by the legislative and administrative authority of all abbots meeting on an equal footing for the common good. Thus the individual house preserved its internal autonomy, and the individual monk belonged for life to the home of his profession, while the system of visitation and chapter provided external means of maintaining standards and enforcing legislation and sanctions.

The Cistercians might have remained a relatively small family, like the contemporary reforms of Savigny and Tiron, had not the fortunes of the order been changed by St. Bernard, who joined Cîteaux as a novice, along with about 30 relatives and friends, in 1112 or 1113. In 1115 he was sent out as founding abbot of Clairvaux, and thenceforward the growth of the order was spectacular. No other religious body before or since has increased so greatly in so brief a space. At St. Bernard's death the total number of Cistercian abbeys was 338, of which 68 were direct foundations from Clairvaux, and the order had spread from Sweden to Portugal and from Scotland to the Levant. The first English houses were at Waverley (Surrey) in 1128 and Rievaulx (Yorkshire) in 1132. In 1147 the Cistercians absorbed the whole family of Savigny in France and England. Nor were the Cistercian communities small, though the founding body normally consisted of 12 monks and 6 lay brothers with an abbot. Cîteaux in St. Bernard's later years had a total population of 700; at Rievaulx under St. Aelred there were 140 choir monks and 600 lay brethren. (*See* also BERNARD, SAINT).

As a result of this expansion and the fame of St. Bernard the spiritual centre of gravity of the church shifted from Cluny to Cîteaux-Clairvaux; it was commonly said that the whole world had "gone Cistercian," and for the remainder of the 12th century the White Monks occupied the places that the Cluniacs had held in the previous century in the Roman Curia and as legates and bishops. In a very different sphere, that of economic life, the White Monks made an even greater mark. With compact broad estates and with a large, disciplined, unpaid labour force, the Cistercians were able to develop all branches of farming without the hindrances of manorial customs. In reclaiming marginal land and in increasing production, especially that of wool in the large pastures of Wales and Yorkshire, the Cistercians played a large part in the economic progress of the 12th century and in the development of the techniques of farming and marketing.

The reasons for their unparalleled success were many. Foremost was the appeal made in the virile, expanding Europe by the simple, pioneering, well-balanced life of the early Cistercians, which exactly suited the temper of an age of spiritual endeavour, conditioned to monasticism by the Gregorian reform. More particularly, there were the energy, the charm and the clarion call of St. Bernard, who added to his qualities of leadership and eloquences those of the saint and the mystic, thus attracting the finest spirits of the time. Further, the institution of the lay brotherhood opened the monastic life to a class hitherto neglected, and that in an epoch of rising population. Finally, the foundation of a Cistercian abbey in marginal or waste land, and the preparation of the site and buildings by the lay brethren, made the establishment of new abbeys relatively inexpensive and simple for both landowners and monks.

The Cistercians, in addition to their own expansion, had immediate and lasting influence. Founders such as St. Norbert (Premonstratensians), St. Gilbert of Sempringham (Gilbertines) and the early Knights Templar took counsel and even orders from St. Bernard. The papacy used two of the main instruments of Cistercian government, the general chapter and visitation, as instruments of reform throughout the religious orders. In a less tangible way, St. Bernard and his disciples and imitators opened a new phase of devotion and spiritual teaching, with a more human and personal approach to the Blessed Virgin, the Holy Family, St. Joseph and the guardian angels, and with a more experimental and less formalized description of the higher stages in the spiritual life.

The golden age of the White Monks was the 12th century. Even before its close many abbeys were breaking some of the most essential statutes by accepting churches, villeins and tithes, and by commercial transactions in wool and grain. Moreover the phenomenal expansion of the order put a severe strain upon a constitution framed for a small regional group of abbeys. Thus the annual visit to chapter was a physical and moral impossibility for abbots in Sweden, Scotland and the Levant, and they were allowed exemption. Similarly, the abbot of a mother house with distant foundations—such as the English Kirksted with a daughter house in Norway—could not make the annual visitation or preside at elections. In the 13th century wealth accumulated and discipline declined; the Cistercian pope Benedict XII attempted a moderate reform in 1335 and directed the White Monks to the universities, but the decline continued. Wars and the Great Schism favoured regional independence; economic changes made the lay brotherhood a liability, and the *conversi* vanished altogether in England and elsewhere. At the Reformation the monks disappeared in northern lands; in France, where the White Monks were most numerous, a movement of reform led to the formation of two groups, those of the strict observance and those of the common observance, which lasted till the Revolution. Besides these there were two important reforms, the Feuillants and the Trappists.

Feuillants.—The Feuillants owed their origin as a separate order to Jean de la Barrière (1544–1600), who began a return to primitive observance in his abbey, Les Feuillans, in the Garonne district of France. The reform spread widely and was approved by Sixtus V in 1589; it became a fully independent congregation in 1592. The Feuillants, who counted among their number the celebrated liturgical scholar Cardinal Giovanni de Bona, disappeared at the French Revolution along with their sister order of nuns.

Trappists.—The Trappists (Ordo Cisterciensium Reformatorum seu Strictioris Observantiae; O.C.R.; O.C.S.O.) were founded by the converted courtier Armand de Rancé (1626–1700), who had held in *commendam* the Cistercian abbey of La Trappe in France, which he transformed (1662) into a community practising extreme austerity of diet, penitential exercises and absolute silence; he became its regular abbot in 1664. For more than 30 years the abbey, under his forceful sway, was one of the wonders of France; but his rigidity of mind, the physical and psychological demands he made upon his followers and his outspoken criticism of the ways of those less austere than himself provoked many to hostility and led him into a vexatious controversy with Jean Mabillon. Only two Trappist monasteries were founded in the 18th century, both in Italy. In 1792 the monks were ejected from La Trappe and a number of them, led by Dom Augustine de Lestrange, settled at Val-Sainte in Fribourg, Switz., where they adopted an even more rigid life and made several foundations before their expulsion in 1798. Long years of wandering in Russia and Germany were followed in 1814 by a return to La Trappe; they were the first religious order to revive after the Revolution, and at the death of Lestrange in 1827 numbered 700, divided in allegiance between the rule of De Rancé and that of Lestrange. Their increase has never ceased, and by the 1960s there were about 70 abbeys, including several in England, Scotland, Canada, the United States, Australia and South Africa. The three existing congregations of Trappists were united by Pope Leo XIII as the independent Reformed Cistercians of the Strict Observance; they follow the primitive custom of Cîteaux with an emphasis on silence and austerity but without the rigid regulations of the early Trappists. After World War II their growth was particularly notable in France and the U.S., where the abbey of Our Lady of Gethsemani (Kentucky), the largest in the whole order, alone comprised eight foundations.

The life of the reformed Cistercians is physically most austere, though its well-balanced regime of prayer, reading and manual work gives it a wider applicability than that of the more solitary and less active Carthusians. The monks sleep, eat and work in common, but in silence unbroken by any set periods of recreation. They practise total abstinence from flesh, fish and eggs, living on bread, vegetables, fruit and a little cheese and milk. Their clothing and bedding are simple and rough; they wear a white tunic and black scapular and hood, with a white cowl. De Rancé and some of his imitators eschewed intellectual work and were inclined to regard ugliness or squalor as a part of poverty. The Trappists have since returned to the beauty of simplicity and have encouraged scholarship in the realms of history and theology; they publish learned periodicals of high reputation, such as the *Collectanea* and *Analecta* of their order, while the spiritual writings of Dom Vitalis Lehody and Thomas Merton in the 20th century have attained a wide celebrity.

Cistercians of Common Observance.—Meanwhile, the original order, now known as the Cistercians of Common Observance (Sacer Ordo Cisterciensis; S.O. Cist.), has continued with a quiet prosperity to increase, forming eight congregations with about 50 monasteries, chiefly in continental Europe, though with houses in the United States and Canada. Some of these differ little in their practices from the Reformed, and in both orders there has been a notable mid-20th-century revival of literary work, particularly critical historical work of a high quality on topics common to all Cistercians.

Cistercian Nuns.—Communities of nuns adopting the Cistercian customs were found as early as 1120–30, but they were excluded from the order until about 1200 when the nuns began to be directed, spiritually and materially, by the White Monks, though many convents all over Europe transferred their allegiance to and fro between Black and White. Both Benedictines and Cistercians have claimed among their saints the group at the convent of Helfta (founded 1258 in Saxony), which included the two Gertrudes and the two Mechtilds. After the catastrophes of the Reformation many reforms were initiated, among them that of the celebrated abbey of Port-Royal in France and its daughters, which was originally a reform on strict Cistercian lines. There are Cistercian convents mostly in Spain and the German-speaking lands. There are also nuns of the reformed observance, known sometimes as Trappistines; they follow the customs of the monks, and have houses at Stapehill (Dorset), in Ireland, the United States and Canada. *See* Monasticism; Orders and Congregations, Religious; *see* also references under "Cistercians" in the Index volume.

Bibliography.—M. Heimbucher, *Orden und Kongregationen,* vol. 1, p. 330–376 (1933–34); L. J. Lekai, *Les Moines Blancs* (1957); M. D. Knowles, *The Monastic Order in England* (1940). (M. D. K.)

CISTUS, the rockrose, a genus of the family Cistaceae, containing about 20 species and many interspecific hybrids. They are low spring-flowering shrubs, mostly from the western Mediterranean, where they grow in full sun, in rocky to chalky soil, and are resistant to prolonged summer drought conditions.

The plants are distinguished by the leaves being in pairs, and the showy flowers in terminal clusters with each flower having five separate, often crinkly, petals. The fruit is a woody capsule. The seeds are many and are borne in five rows on the inside of the capsule wall. They are prized as garden subjects in regions where the ground rarely freezes. The most common are *C. villosus* with rose-purple flowers about 2½ in. across, and *C. ladaniferus* with white flowers 3–4 in. across. Hybrids are frequently encountered. (G. H. M. L.)

CITADEL: *see* Fortification: *Permanent Fortifications.*

CÎTEAUX (Lat. Cistercium), a famous site in the *département* of Côte-d'Or, Burgundy, France, 16 mi. S.S.E. of Dijon. Its great abbey, mother house of the Cistercian order, was founded in 1098 by St. Robert, abbot of Molesme. In the 12th century, largely due to the activities of St. Bernard of Clairvaux, it became the headquarters of a vast order with, at St. Bernard's death, 338 abbeys scattered all over Europe. The order disappeared during the Revolution. (*See* also Cistercians.) Of Cîteaux's great past there remains only a part of a Gothic cloister and some 18th-century buildings that were restored and occupied again by the Grand Chapter of the Cistercian order when the abbey was restored to it in 1898. The order's archives, including 12th-century illuminated manuscripts, are kept among the archives of Dijon *département.* (L.-N. L.; L. Pe.)

CITHAERON (modern Kithairon), a mountain range (4,623 ft.) in Greece, separating Boeotia from Megaris and Attica. Its western end reaches the Corinthian gulf; eastward it is separated from Mt. Parnis by the pass through Panactum and Phyle (modern Kastro). It was famous in Greek mythology. There Actaeon was changed into a stag, Pentheus was torn to pieces by the Bacchantes and the infant Oedipus was exposed. It was the scene of the mystic rites of Dionysus, and the festival of the Daedala in honour of Hera. The road from Athens to Thebes traverses the pass of Dryoscephalae (modern Drios Kefalae, "Oak-heads"), guarded on the Attic side by the ruined fortress of Gyphto Kastro ("Gipsy Castle"). Plataea is situated on the northern slope, and the strategy of the battle of 479 b.c. (*see* Greco-Persian Wars) was affected by the necessity for the Greeks to keep open the passes of Dryoscephalae, and the roads farther west from Plataea to Athens and to Megara.

CITHARA, the lyre, principal stringed instrument of the ancient Romans, corresponding to the *kithara,* the professional lyre of the Greeks (*see* LYRE). In Latin writings of early Christian Europe, the word denotes the Germanic harp and was variously applied to the early western harp as well as to surviving forms of the lyre. With the decline of the lyre in the middle ages cithara became a term to identify the minstrel's harp and King David was consequently portrayed as a harper, not, more accurately, as a lyre-player. Many common instrument names are ultimately derived from cithara, including guitar and zither.

(A. C. BA.)

CITIUM (Gr. KITION), the principal Phoenician city in Cyprus, situated on the southeast coast at the north end of modern Larnaca (*q.v.*). Converging currents from east and west greatly facilitated ancient trade. To south and west the site is protected by salt lagoons. The earliest remains go back to an Aegean colony of the Mycenaean age (*c.* 1400–1100 B.C.), but in historic times Citium is the centre of Phoenician influence in Cyprus. The biblical name Kittim, representing Citium, is, in fact, used quite generally for Cyprus as a whole; later also for Greeks and Romans in general. In a list of the allies of Ashurbanipal of Assyria in 668 B.C. a king, Damasu, of Qarthadasht (Phoenician for "Newtown") occurs where Citium would be expected. A Phoenician dedication to "Baal of Lebanon," found at Citium, suggests that it may have belonged to Tyre, and an official monument of Sargon II indicates that Citium was the administrative centre of Cyprus during the Assyrian protectorate (709–*c.* 668 B.C.). During the Greek revolts of 500, 386 *et seq.*, and 352 B.C., Citium led the side loyal to Persia and was besieged by an Athenian force in 449 B.C. It remained a considerable city even after the Greek cause triumphed with Alexander the Great. It suffered repeatedly from earthquakes, however, and in medieval times its harbour became silted and the population moved to Larnaca, on the open bay. Harbour and citadel have quite disappeared, the latter having been used to fill up the former shortly after the British occupation; some gain to health resulted, but an irreparable loss to science. There are traces of the circuit wall and many tombs. *See* also CARTHAGE.

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CITIZENSHIP is a relationship between an individual and a state originating under terms prescribed by the law of that state and giving rise to certain duties and rights which such law attaches to "citizenship." Citizenship also denotes the individual's status of being thus related to a state, that is, of being its citizen. International law attaches to such status certain rights and obligations of the given state vis-à-vis other states.

The original English meaning of citizen referred to membership of a borough or local municipal corporation, while the word "subject" was used to denote a man's relation to the monarch or the state. Subject is the key word appearing in English common-law usage and nationality legislation. In continental Europe citizenship (*droit de cité, cittadinanza, ciudadanía, Bürgerrecht*) also reflects the historical notion of a relationship to a city, imparting certain liberties. The term came to stand for a status of freedom. In Rousseau's doctrine of social contract, the *citoyen* ("citizen"), as participant in the formation of the general will, was contrasted with the *sujet* (the "subject"). In the ideology of the French Revolution *citoyen* denoted civic freedom and thus figured particularly in the Declaration of the Rights of Man and of the Citizen (1789). The American use of the term citizen is a Gallicism adopted to stress the Americans' republican emancipation from being subjects of the English king.

Nationality, though often used interchangeably with citizenship, is a broader term, also comprising relationships to a state which do not confer political rights but imply other privileges, particularly protection abroad. It is the term used in international law, denoting all persons whom a state is entitled to protect, *i.e.*, those enjoying a preferred municipal-law status as well as "United States nationals" who are not citizens, "British protected persons," French *ressortissants*, etc. Nationality also serves to denote the relationship to a state of entities other than individuals. Thus, corporations, ships and aircraft possess a nationality. Specific terminology varies from one legal system to another.

The basic status of legal affiliation to the United States is generally called citizenship of the United States. The Immigration and Nationality act of June 27, 1952, designates by "national of the United States" both a citizen and a person who, though not a citizen, owes permanent allegiance to the United States. The only remaining noncitizen nationals are the inhabitants of American Samoa, an outlying possession of the United States. They enjoy diplomatic protection and have a right of free entry to the United States but no political rights.

The constitution of the United States also has preserved citizenship in a state of the U.S., acquired by residence in the state (14th amendment, sec. 1). Thus, the privileges and immunities clause of the constitution (art. iv, sec. 2) proscribes discrimination by a state against a citizen of another state. The Judicial code confers upon citizens of a state, including territories, the District of Columbia and the Commonwealth of Puerto Rico, the right to bring certain actions in, or remove such actions from a state court to, a federal court, where the opponent is a citizen of another state or a foreign country ("diversity of citizenship" jurisdiction). For this purpose state-created corporations are treated as having state citizenship.

The British Nationality act, 1948, introduced a concept of citizen having a dual meaning: (1) "British subject" and "commonwealth citizen" are used interchangeably to convey the notion of a comprehensive status which incorporates (2) citizens of member countries of the commonwealth. Any person who, under the provisions of that act, is a citizen of the United Kingdom and colonies (constituting for this purpose one country of the commonwealth) or who, under the law of any other country of the commonwealth, is a citizen of that country, is by virtue of such citizenship a British subject. (*See* COMMONWEALTH OF NATIONS: *Nationality and Citizenship.*)

In the Code of French Nationality, 1945, an individual's legal affiliation with the French republic is called *nationalité française, qualité de français*, and the bearer of such status is called *Français, Française.* In French terminology, *citoyen français* ("French citizen") denotes a distinctive status in the former French colonies, importing enjoyment of greater rights than those possessed by the "French subject," who was governed by special penal laws and had fewer civil and political rights. French citizenship was granted to all *ressortissants* of French overseas territories in 1946. The constitution of the fifth republic, 1958, introduced the notion of "citizenship of the community" (comprising the French republic and other member states of the community). The implications of such citizenship are equal protection and certain political rights as regards agencies of the community.

Common principal grounds for acquiring citizenship (apart from international transactions such as transfer of territory or option) are: birth within a certain territory, descent from a citizen parent, marriage and naturalization (regarding the latter, *see* NATURALIZATION LAWS). There are two systems of attributing citizenship as of the time of birth: *jus soli*, whereby citizenship is acquired by birth within the territory of the state, regardless of parental citizenship; *jus sanguinis*, whereby a person, wherever born, is a citizen of the state if, at the time of his birth, his parent is one. The countries of the Commonwealth of Nations and the United States adopt the *jus soli* as basic principle; they also recognize acquisition of nationality by descent but subject it to strict limitations. Other countries generally adopt the *jus sanguinis* as basic principle, supplementing it by provisions for acquisition of citizenship in case of combination of birth and domicile within the country, birth within the country of parents also born there, etc.

Acquisition of citizenship by a woman through marriage to a citizen was the prevailing principle in modern times until the era following World War I. Under the system of "unity of nationality within the family," the wife and children share the nationality status of the husband and father as head of the family. Modification of this system, where it results in the woman's and child's statelessness, was promoted by the Hague conference of 1930. Under the impact of the idea of equality of men and women, there developed a new system whereby a woman's nationality was not affected by marriage. Resulting mixed-nationality marriages created complications, particularly as regards the nationality status of children, since descent from a citizen mother has also gained recognition as an acquisition ground. Thus, various mixed systems have been devised, all stressing the woman's and child's freedom of choice.

Expatriation provisions, frequently punitive, and the lack of uniformity of rules on citizenship acquisition and loss have produced statelessness. Provisions of nationality laws which overlap often result in dual nationality; a person may be a citizen of two countries, which may result in conflicting citizenship duties. Efforts are being made, particularly on an international level, to remedy the incident hardships.

Generally, political rights, such as suffrage and the right to hold public office, are predicated upon citizenship. Usual incidents of citizenship are allegiance and military duty. Otherwise, the significance of citizenship varies in accordance with the relevance attributed to it in various countries. Thus, in civil-law countries, issues, such as personal capacity (*e.g.*, capacity to contract marriage, to make a will), legitimate or illegitimate descent, family status, the civil consequences of marriage, succession to movable property, are governed by the law of the state of which the person concerned is a citizen. In common-law countries such issues are usually determined by the law of the person's domicile. In criminal matters, citizenship plays a nationally varying role, *e.g.*, as regards extradition, penal jurisdiction or treason legislation.

See also NATIONALITY; ALIEN; LOYALTY.

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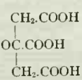
CITOLE: *see* CITTERN.

CITRANGE, the hybrid tree and its fruit produced by crossing any variety of sweet orange (*Citrus sinensis*) with the hardy trifoliate orange (*Poncirus trifoliata*). From 1892, U.S. scientists endeavoured to produce some form of citrus or a relative which would thrive in a winter temperature subnormal for oranges. Plants raised from cross-fertilized fruits, using these two species as parents, are generally much hardier than oranges. About a dozen varieties have been named—all produce fruit that is highly acid, juicy and of value mainly for flavouring drinks or for culinary use. They are too acid and bitter for eating out of hand. Since they are hardier than oranges, lemons or limes, they are of interest in areas that are somewhat cold for other kinds of citrus.

Some varieties of citrange are used for rootstocks for other kinds of citrus fruits. They are generally vigorous and disease resistant as well as hardy. As rootstocks, they tend to dwarf slightly the grapefruit, orange or lemon tops worked on them.

Citrangequats, trigeneric hybrids made by crossing a kumquat (*Fortunella margarita*) with a citrange, are cultivated as novelties in the United States. (J. R. MAG.)

CITRIC ACID, $C_6H_8O_7$, 2-hydroxypropane-1:2:3-tricarboxylic acid, with structural formula:



$$\begin{array}{l}\mathrm{CH_2.COOH}\\ \quad|\\ \mathrm{HOC.COOH}\\ \quad|\\ \mathrm{CH_2.COOH}\end{array}$$

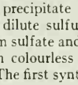
(citric acid)

is one of the commonest plant acids.

Distribution.—The acid was first isolated in a pure form from lemon juice by Karl Wilhelm Scheele in 1784. It occurs as the free acid in many other acid fruits and usually as a salt in most other parts of plants. Almost all plant materials that have been tested with the delicate modern methods have been found to contain some citric acid or citrate, some only a few milligrams per kilogram, others, such as lemons, up to 50 g. per kilogram. It is also a constituent of many animal tissues and body fluids. Milk contains up to 1.2 g. per litre, bone (wet) and teeth about 3 g. per kilogram, semen about 5 g. per litre, blood serum about 0.025 g. per litre, human urine between 0.2 g. and 1.2 g. per litre.

Preparation.—Citric acid has been prepared commercially from the juice of lemons and limes, but this method was largely superseded by the mold fermentation process: C. Wehmer discovered in 1893 that citric acid can be obtained from sugar solutions on which the mold *Citromyces* has been allowed to grow. In 1916 C. Thom and J. N. Currie found that some strains of *Aspergillus niger* produced much more citric acid than Wehmer's organism. This was the starting point of the modern fermentation method. The fermentation is a complex oxidative process; the sugar is probably first broken down to small units such as pyruvic acid, acetaldehyde, acetic acid and carbon dioxide, which recombine to form citric acid. It is usually carried out in shallow vessels which allow free access of air. About ten days after spore inoculation and incubation at 30° to 32° C. the process is completed. Yields as high as 87% of the weight of the sugar used have been reported; usually, however, about 60% can be recovered; sucrose gives the best yields, but cheaper sources like molasses are also satisfactory raw materials. A deep tank fermentation process of the type used in the manufacture of penicillin has been developed in the United States, using *Aspergillus wentii*. The mold fermentation process is used in many countries. Pure citric acid is usually prepared by way of the calcium salt. The crude solution of the acid, after heating and filtration, is neutralized with lime and chalk and boiled. The precipitate of calcium citrate thus obtained is decomposed with dilute sulfuric acid; the solution is filtered to remove the calcium sulfate and concentrated in vacuum pans. The acid crystallizes in colourless rhombic prisms of the composition $C_6H_8O_7+H_2O$. The first synthesis of citric acid was accomplished by L. E. Grimaux and P. Adam in 1880.

Properties.—Citric acid dissolves readily in water and is also soluble in ethyl alcohol and in ether. On heating, the crystals soften between 70° and 100° C. and lose water. On further heating the substance again becomes dry and finally melts at 153° C. At about 175° C. it loses a molecule of water and is transformed into (trans)-aconitic acid ($C_6H_6O_6$) or propene-1:2:3-tricarboxylic acid:



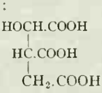
$$\begin{array}{l}\mathrm{CH_2.COOH}\\ \quad|\\ \mathrm{C.COOH}\\ \quad\|\\ \mathrm{CH.COOH}\end{array}$$

(aconitic acid)

Above 170° C. carbon dioxide and an oily distillate which yields crystals of itaconic acid ($C_5H_6O_4$) are formed. When citric acid is heated in dilute sulfuric acid, aconitic acid is formed; fuming sulfuric acid produces acetone dicarboxylic acid ($C_5H_6O_5$), water and carbon monoxide.

As a tribasic acid, citric acid forms three series of salts. The salts of the alkaline metals are readily soluble in water. The neutral salts of the alkaline earths are only moderately soluble. Calcium citrate is less soluble in hot water than in cold.

Uses.—Citric acid plays an important part in the metabolism of animals, plants and microorganisms. Most animal tissues, many plants and some microorganisms convert citric acid reversibly into cis-aconitic acid and isocitric acid (1-hydroxypropane-1:2:3-tricarboxylic acid):



$$\begin{array}{l}\mathrm{HOCH.COOH}\\ \quad|\\ \mathrm{HC.COOH}\\ \quad|\\ \mathrm{CH_2.COOH}\end{array}$$

(isocitric acid)

Aconitic acid has been found in the leaves of monkshood (*Aconitum napellus*) and of mare's-tail (*Equisetum*), but it is not certain whether the cis- or trans-form is present. Isocitric acid is the chief acid of the blackberry and occurs in relatively high concentration (up to 12% of the dry matter) in the leaves of various Crassulaceae; *e.g.*, *Bryophyllum*, *Sedum*, *Sempervivum*. The dry matter of foxglove leaves contains between 1% and 3% isocitric acid. The reversible interconversion of citric, cis-aconitic and isocitric acids is brought about by the enzyme aconitase. The three acids are assumed to be intermediary stages in the oxidative breakdown of foodstuffs in biological material. By way of a complex series of reactions they can arise from carbohydrate as well as from fat and from protein. They are readily oxidized in the living cells. The significance of the relatively high concentration of citrates in milk, bone, teeth and seminal fluid is not yet clear; since these materials are all relatively rich in calcium, it has been suggested that citrate plays a special role in metabolism of calcium. Citric acid produced commercially is mainly used for medicinal purposes—as a purgative, and in the treatment of gout—and for the manufacture of foods and beverages.

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CITROËN, ANDRÉ GUSTAVE (1878–1935), French engineer and industrialist who introduced Henry Ford's methods to the European automobile industry, was born on Feb. 5, 1878, and graduated from the École Polytechnique. At the outbreak of World War I he convinced the French army of the necessity for mass-producing shells. After the war he mass-produced a small car, the Citroën, which won great popularity. Citroën aided in financing the 1932 Georges-Marie Haardt expedition, which traveled by car from Beirut to Peking, and also sponsored the Citroën Central African expedition. Refusing to retrench during the depression, Citroën in 1934 introduced the "Seven"—the only popular front-wheel drive car of its time. La Société André Citroën went into liquidation in Dec. 1934 and was later reorganized. Citroën died in Paris on July 3, 1935. (M. J. Bi.)

CITRON, a species of *Citrus* (*C. medica*) belonging to the subfamily Aurantioideae; the same genus furnishes also the orange, lemon, lime, shaddock (pummelo) and grapefruit. The citron is a small evergreen tree or shrub growing to a height of about ten feet; it has irregular, spreading spiny branches; large pale green, broadly oblong, slightly serrate leaves, with wingless petioles, and generally perfect flowers. The acid varieties such as the Diamante have flowers purplish without and white within, while the sweet varieties such as the Corsican have creamy white flowers throughout. The fruit is oval or oblong, protuberant at the tip, from five to six inches long, furrowed; rind adhesive, the inner portion thick, white and fleshy, the outer, thin, greenish-yellow and very fragrant. The pulp is firm, either acid or sweet, and is used only for by-products. The thick peel has an agreeable flavour when candied. There are many varieties of citron but the two commonly grown for production of candied peel are Corsican and Diamante. The fruit of the Etrog citron is used only for ceremonial purposes in religious rites of the Hebrew people. It has a pronounced protuberant tip with persistent pistil even on the ripe fruit. Candied citron is highly esteemed as a confection. Supplies come from the Mediterranean countries and Puerto Rico. Citron peel must be cured in brine or sea water prior to being candied.

The citron tree may be grown in the various countries of the world where lemons and limes are grown, as it is only slightly less resistant to frost injury than they are.

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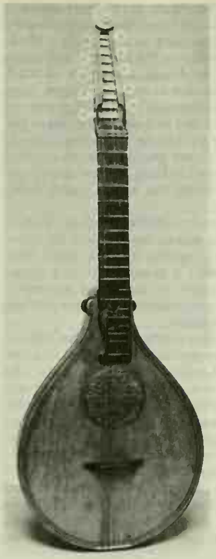
CITTÀ VECCHIA: *see* MOINA.

CITTERN, a small wire-stringed instrument, plucked by a plectrum or by the fingers, which originated in the middle ages but attained its greatest popularity during the 16th and 17th centuries. It had a flat, shallow, pear-shaped body, the depth of which uniquely decreased toward the bottom end. This spatulate form derives from the medieval gittern, one of the earliest of the European types of this family of instruments. Another curious and early feature of the cittern is the assymetric neck, consisting of a semicircular spar and set off-centre to the treble side, but with a wide fingerboard overhanging beneath the lower strings, forming a section resembling the letter P.


BY COURTESY OF THE TRUSTEES OF THE VICTORIA AND ALBERT MUSEUM, PHOTOGRAPH, P. F. MACDONALD

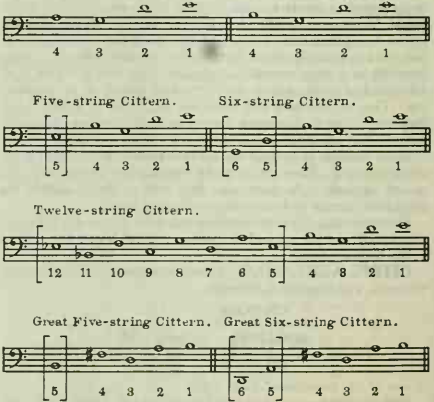
16TH-CENTURY GERMAN CITTERN

The cittern was the first instrument on which fixed metal frets were used, in contrast to the adjustable gut frets of the lute and viol.

The basic arrangement of the strings was four unison pairs, brass for the lower and steel for the upper courses. The instrument was made in two main sizes, tuned a fourth apart in pitch, the lowest notes of which were respectively G and D below middle C. Additional courses of strings were common but were in the nature of diapasons as on the lute and were used for reinforcing the basses of chords *ad libitum*. The strings pass over a pressure or violin-type bridge set fairly high up the belly and are hitched to pins at the lower end. The tuning of the main strings is peculiar (*see* below) and resembles that of the modern ukulele; the tuning arrangement is designed to facilitate the fingering of simple chords. The instrument was played from music noted in tablature. (*See* LUTE).

Cittern Tuning

(after M. Praetorius, *Organographia,* 1619)



The additional strings (diapasons) are shown in brackets.

Early specimens sometimes reveal a high degree of artistic decoration and craftsmanship, suggesting aristocratic patronage.
(E. Ha.)

CITY, a name given to certain urban communities in English-speaking countries by virtue of some legal or conventional distinction; it also refers to a particular type of community, the urban community and its generic culture.

In the United States, a city is an urban area incorporated by special or general act of a state legislature. Its charter of incorporation prescribes the extent of municipal powers and the frame of local government, subject to constitutional limitation and amendment. In common usage, however, the name is applied to almost every urban centre, whether legally a city or not, and without much regard to actual size or importance. In Australia and Canada, city is a term applied to the larger units of municipal government under state and provincial authority respectively. New Zealand has followed British precedent since the abolition of the provinces in 1876; the more populous towns are called boroughs under the Municipal Corporations act of 1933 and earlier legislation. In the United Kingdom itself, city is merely an official style accorded towns either in their historical identity as episcopal sees or as the beneficiaries *honoris causa* of a special act of the crown (the first town so distinguished was Birmingham in 1889). Except for the ancient City of London (about 673 ac. under the lord mayor), the title has no significance in local government in the United Kingdom: cities do not enjoy greater corporate powers than those of county boroughs (as defined in the Local Government act of 1888 and Municipal Corporations act of 1882).

City government is almost everywhere the creation of higher political authority, state or national. Indeed, some European countries have adopted general municipal codes which permit centralized administrative control over subordinate areas through a hierarchy of departmental prefects and local mayors. In English-speaking countries, however, devolution of powers occurs through legislative acts which delegate limited self government to local corporations.

As a type of community, the city may be regarded as a relatively permanent concentration of population, together with its diverse habitations, social arrangements and supporting activities, occupying a more or less discrete site, and having a cultural importance which differentiates it from other types of human settlement and association. In its elementary functions and rudimentary characteristics, however, a city is not clearly distinguishable from a town or even a large village. Mere size of population, surface area or density of settlement are not in themselves sufficient criteria of distinction, while many of their social correlates (division of labour, nonagricultural activity, central-place functions and creativity) characterize in varying degree all urban communities from the small country town to the giant metropolis.

While many cities have been deliberate foundations by potentates or colonizers, others have "just grown." During their 7,000-year history, cities have been populated by clans, families and individuals; they have been patterned in rectangular, oval and irregular forms. Cities have variously functioned as temples, fortresses, capitals, markets and factories, and have provided a locus for agricultural, commercial, manufacturing and a host of specialized service activities. As a consequence, city life has given rise to a variety of social structures and personality-types. The changing institutional order of the city has embraced any and all of these social phenomena and has assimilated something from each. The city and its hinterland are usually interdependent: the countryside focuses its life and activity upon that of a central city which, in turn, encompasses the diversity of the hinterland.

Origins of Cities and City Culture.—The early evolution of urban communities occurred between the 6th and 1st millenniums B.C. in widely separated parts of southern Asia. Their origins seem rooted in a Neolithic transformation which resulted in the introduction of cereal agriculture (wheat and millet) some time after 10,000 B.C. Dependence on crops required a more orderly and permanent mode of settlement under comparatively restricted conditions of environment. A stable community of stone-using people eating a semicultivated wheat, but without pottery or metallurgy, existed at Jarmo in east-central Mesopotamia about 5000 B.C. A social-architectural prototype with houses and walls was situated at Jericho in Palestine at about the same time. The subsequent transition from agricultural villages to larger cities (as revealed by radiocarbon dating) was quite rapid. By 3000 B.C. urban populations were distinguished by literacy, technological progress (notably in metals), social controls, political organization and emotional focus (formalized in religious-legal codes and symbolized in temples and walls). Such places, dated by historical means, existed on the Sumerian coast at Ur and in the Indus valley at Mohenjo-daro during the 3rd millennium, and before 2000 B.C. had also appeared in the Nile and Wei-ho valleys. Cities proliferated along overland trade routes from Turkestan to the Caspian and then to the Persian gulf and eastern Mediterranean. Their economic base in agriculture (supplemented by trade) and their political-religious institutions had made for an unprecedented degree of occupational specialization and social stratification. From central vantage points, cities already gave some coherence and direction to life and society in their hinterlands.

The growth of cities, however, was by no means the inevitable outcome of a succession from barbarism to civilization. As S. Piggott has pointed out in "Role of the City in Ancient Civilizations" (in *Metropolis in Modern Life,* ed. by E. M. Fisher [1955]), an alternative, and in some ways inimical, type of community had arisen in the steppe-lands of Asia based upon animal husbandry: the nomadic encampment. Like their urban contemporaries, the nomads were no longer "primitive" men. In addition to pastoralism, they had developed great oral traditions, abstract art styles, and numerous crafts albeit no formal architecture. Led by warrior chiefs, these self-sustaining migratory peoples encroached upon the settled agricultural-trading areas to the south.

During the 2nd millennium the Indus civilization was engulfed by an onslaught of Aryan nomads, while other peoples, using horses and chariots, penetrated the urban heartland from Mesopotamia to Egypt. In these circumstances of prolonged upheaval, survival required the perfection of warlike arts and predatory supply systems which transformed the urban communities into paramilitary states; *e.g.,* the Hittite, Egyptian and Mycenaean empires. Citizenship, though still a ceremonial service, was increasingly associated with the bearing of arms. After 1200 B.C. even the city-empires (a city-camp hybrid) lapsed into chaos and disorder until the lifting of the Hellenic "dark ages" during the 8th century B.C. and the transplanting of the syncretic city-state beyond the eastern Mediterranean by Phoenicians and Greeks.

Autonomous and Dependent Cities.—The heterogeneous peoples that created the Greco-Roman world inherited a technological and nonmaterial culture from southwestern Asia which helped mollify barbarism and nourish the growth of cities. Their trading colonies, from the Crimea to Cadiz, eventually brought the entire Mediterranean within the orbit of civilization. It was in the Greek city-state (*q.v.*) or *polis,* however, that the city-idea reached its peak. Originally a devout association of patriarchal clans, the *polis* came to be a small self-governing community of citizens in contrast to the Asian empires and nomadic hordes. For citizens, at least, the city and its laws constituted a moral order symbolized in magnificent buildings and public assemblies. It was, in Aristotle's phrase, "a common life for a noble end." When the old exclusive citizenship was relaxed, and as new commercial wealth surpassed that of the older landed citizenry, social strife at home and rivalry abroad gradually weakened the common life of the city-republics. The creativity and variety of the *polis* gave way before the unifying forces of king-worship and empire epitomized by Alexander the Great and his successors. To be sure, many new cities were planted between the Nile and the Indus through which the amenities and forms of city-culture were carried back to the east, but the city itself ceased to be an autonomous body politic and became a dependent member of a larger political-ideological whole.

The Romans, who fell heirs to the Hellenistic world, transplanted the city into the technologically backward areas beyond the Alps inhabited by pastoral-agricultural Celtic and Germanic peoples.

But, if Rome brought order to civilization and carried both to barbarians along the frontier, it made of the city a means to empire (a centre for military pacification and bureaucratic control) rather than an end in itself. The enjoyment of the imperial Roman peace entailed the acceptance of the status of *municipium:* a dignified but subordinate rank. Initiatives passed to the centre and, in the east, the culture of provincial cities became imitative, their politics trivial. They contributed little to the larger economic life beyond the needs of their social elites and the payment of taxes; they tapped the surpluses created by local agriculture and trade in rents and tribute. As Roman citizenship became more universal and formal, the idea of public duty gave way to private ambition. Municipal functions atrophied and, except for their fiscal duties, it was in a passive role that the city survived into the Byzantine era.

Medieval Cities: From Fortress to Emporium.—In Latin Europe neither political nor religious reforms could sustain the Roman regime. The breakdown of public administration and the breach of the frontier led to a revival of parochial outlook and allegiance, but their focus was not upon the city. Community life now centred on the fortress (*burgum*) or castle (*castellum*) and the term city (*civitas*) was attached to the precincts of the episcopal throne, as in Merovingian Gaul.

Early medieval society was a creation of camp and countryside to meet the local imperatives of sustenance and defense. With Germanic variations on late Roman forms, communities were restructured into functional estates each of which owned formal obligations, immunities and jurisdictions. What remained of the city was comprehended in this feudal-manorial order, and the distinction between town and country was largely obscured when secular and ecclesiastical lords ruled over the surrounding counties (*comté, Grafschaft*) as the vassals of mock emperors or barbarian kings. Social ethos and organization enforced submission to the common good of earthly survival and heavenly reward; the true city, *civitas Dei*, was not of this world. The attenuation of city life in most of northern and western Europe was accompanied by provincial separatism, economic isolation and religious other-worldliness. Not before the cessation of attacks by Magyars, Norsemen and Saracens did urban communities again experience sustained growth.

Recovery after the 10th century was not confined to the city nor to any one part of Europe. The initiatives of monastic orders, seigneurs or lords of the manor, and merchants alike fostered a new era of increased tillage, enlarged manufacture, money economy, the growth of rural population and the founding of "new towns," as distinguished from those "Roman" cities that had survived from the period of Germanic and other encroachments. In almost all the medieval towns the role of the merchant was central: his needs and aspirations had a catalytic effect and, largely as a consequence of mercantile enterprise in the long-distance staple trade, cities were to flourish once more. Under commercial stimulus, feudal obligations were relaxed and European society was made over anew by the city and the market place in pursuit of self-government and economic gain.

Before the year 1000 contacts with rich Byzantine and Islamic areas in the Levant had revitalized the mercantile power of Venice, which commanded the profitable route to the Holy Land during the crusades. Meanwhile, merchant communities had attached themselves to the more accessible castletowns and diocesan centres in northern Italy and on the main traveled routes to the Rhineland and Champagne. They later appeared along the rivers of Flanders and northern France and on the west-east road from Cologne to Magdeburg.

It was no coincidence that the 12th and 13th centuries, which saw the founding of more new towns than any time between the fall of Rome and the Industrial Revolution, also witnessed a singular upsurge toward civic autonomy. Throughout western Europe towns acquired various kinds of municipal institutions loosely grouped together under the designation "commune"; the term, however, encompasses significant regional differences, and for a comprehensive discussion of these institutions *see* COMMUNE (MEDIEVAL). Broadly speaking, the history of the medieval towns is that of the merchant elites seeking to free their communities from lordly jurisdiction and to secure their government to themselves. Wherever monarchical power was strong, they had to be content with a municipal status but elsewhere they created city-states. Taking advantage of renewed conflict between popes and emperors, they allied with local nobility to establish communal self-government in the larger cities of Lombardy, Tuscany and Liguria. In Germany the city councils sometimes usurped the rights of higher clergy and nobility; Freiburg im Breisgau obtained its exemplary charter of liberties in 1120. The movement spread to Lübeck and later to the net of Hanse towns on the Baltic and North seas, touching even the Christian "colonial" towns east of the Elbe-Saale rivers. In the 13th century the "Great Towns" of Bruges, Ghent and Ypres, creditors of the counts of Flanders, virtually governed the entire province. In France revolutionary uprisings, directed against nobility and clergy, sometimes established free communes, but most communities were perforce content with a franchise from their sovereign more limited than those enjoyed by English boroughs under the Norman conquest. Finally, the corporate freedom of the towns brought emancipation to individuals. When bishops in the older German cities treated newcomers as serfs, the emperor Henry V affirmed the principle *Stadtluft macht frei* in charters for Speyer (or Spires) and Worms; "new towns" founded on the lands of lay and clerical lords offered freedom and land to settlers who took up residence for more than "a year and a day." In France the *villes neuves* (*e.g.,* Lorris) and *bastides* (*e.g.,* Montauban) likewise conferred rights on servile persons.

In the 14th century, the urban movement subsided as Europe entered on a period of political anarchy and economic decline that did not much abate before the 16th century. At a time when local specialization and interregional exchange required more liberal trade policies, craft protectionism and corporate particularism in the cities tended to hobble the course of economic growth. The artisan and labouring classes, moreover, now challenged the oligarchical rule of the wealthy burghers and gentry, disrupted local government and ultimately destroyed the basis for civic autonomy: prolonged social warfare led to "popular" despotisms and fiscal bankruptcy. Visitations of plague, fanatical crusades against heresy, and Turkish encroachments on the routes to Asia worsened conditions in town and country alike. Europe turned inward upon itself and, except for a few large centres, activity in the market place was depressed: the cities surrendered their liberties and their population. These centuries of decline were relieved only by the slow process of individual emancipation and the cultural efflorescence of the Renaissance, which laid the intellectual basis for the great age of geographical and scientific discovery exemplified in the new technologies of gunpowder, mining, printing and navigation. Not before the triumph of princely government, in fact, did political allegiance, economic interests and spiritual authority again become centred in a viable unit of organization, the absolutist nation state.

The City and the Nation State.—The virtue of absolutism in the early modern period lay in its ability to utilize the new technologies. Through the centralization of power, economy and belief it brought order and progress to Europe and provided a framework in which individual energies could once more be channeled to a common end. While the nation stripped the cities of their remaining pretensions to political and economic independence (symbolized in their walls and tariff barriers), it created larger systems of interdependence in which territorial division of labour could operate. Though new mercantilist policies built up national wealth, they did not necessarily foster the growth of cities. All too often the wealth of nations was dissipated in war. Much of the income produced in town and country went to bolster the monarch's power and advertise his fame; the splendour of court life and the baroque glory of palaces and churches were paid for by merchant enterprise and the toil of peasants and craftsmen. Only in colonial areas, notably the Americas, did the age of expansion see the planting of many new cities and it is significant that the capitals and ports of the colonizing nations experienced their most rapid growth during these years. Under absolutist regimes, a few large political and commercial centres grew at the expense of smaller outlying communities and the rural hinterlands.

By the 18th century, the mercantile classes were increasingly disenchanted with monarchical rule. They resented their lack of political influence and assured prestige. They objected to outmoded regulations which hindered their efforts to link commercial operations with the systematic improvement of production. Eventually, they would unite with other dissident groups to curb the excesses of absolutism, erase the vestiges of feudalism and secure a larger voice in the shaping of public policy. In northwestern Europe, where these liberal movements went furthest, the city populations and their bourgeois elites played a critical role out of all proportion to their numbers. Elsewhere, as in Germany, the bourgeois were more reconciled to existing regimes or, as in northern Italy, had assumed a passive if not wholly parasitical role.

With the exceptions of Great Britain and the Netherlands, however, the proportion of national populations resident in urban areas nowhere exceeded 10%. As late as 1800 only 3% of world population lived in towns of more than 5,000 inhabitants. No more than 45 cities had populations over 100,000 and of these less than half were situated in Europe. Asia had almost two-thirds of the world's large-city population and Edo (Tokyo), with 1,400,000 residents, was the largest 18th-century city, larger than ancient Rome or medieval Byzantium at their peaks. Clearly, the mere presence of large cities or merchant elites anywhere in the world did not ensure the development of a dynamic social economy: the decisive factor was industrialism.

Industrial Cities.—Before 1800, innovations in agricultural and manufacturing technique had permitted a singular concentration of productive activity close to the sources of mechanical power—water and coal. A corresponding movement of population was accelerated by the perfection of the steam engine and the superiority of the factory over pre-industrial business organization. From the standpoint of economy, therefore, the localization of differentiated but functionally integrated work processes near sources of fuel was the mainspring of industrial urbanism. Under conditions of belt-and-pulley power transmission, urban concentration was a means of (1) minimizing the costs of overcoming frictions in transport and communications; and (2) maximizing internal economies of scale and external economies of agglomeration. While the intellectual and social prerequisites for industrialization were not uniquely present in any one European nation, an unusual confluence of commercial, geographic and technological factors in Britain led to far-reaching changes in such strategic activities as textiles, transport and iron. Britain became "the workshop of the world" and London its "head office." Differentiation went so far that the cotton, woolen and iron districts became more specialized and productive, each proceeding within its own cycle of technical and organizational change. By the mid-19th century, similar if less comprehensive industrial organization was evident in parts of France, the Low Countries and the northeastern United States.

The concentration of the manufacturing labour force in "mill towns" and "coke towns" gradually undermined traditional social structures and relationships. Age-old problems of public order, health, housing, utilities, education and morals were aggravated by the influx of newcomers from the countryside. High rural birth rates combined with the industrialization of agriculture to release not only the country's foods and fibres but its children as well. Though the lowering of mortality in the 19th century was later offset by declines in fertility, the population of the more industrialized nations boomed into the 20th century and the greater part of the increment migrated to the larger towns. The outcome was rural depopulation and the urbanization of society. Local institutions, often of medieval origin, were unable to cope with conditions that exaggerated poverty, disrupted family life and complicated personal adjustment. Piecemeal reforms did little to improve the new milieu since, in the last analysis, the "city problem" arose not so much from the lack of public authority as from an unwillingness to pay the costs of social planning and improvement. Generations of urbanites experienced a continuing disorganization of their lives and work before the rising productivity of machines and increasing popular pressures on government could arrest the worst effects of this profound transformation. Slowly and painfully, the city's population adapted to its norms and enjoyed its satisfaction. New economic and cultural opportunities in the city evidently compensated for its congestion and strain.

In the century after 1850 world population doubled and the proportion living in cities of more than 5,000 inhabitants rose from under 7% to almost 30%. Between 1900 and 1950 the population living in large cities (100,000 plus) rose by 250%, the rate of increase in Asia being three times that of Europe and the United States. Nevertheless, the pattern of industrial urbanism (an overwhelmingly nonagricultural economy organized in a hierarchical system of different-sized cities ranging from one or more metropolitan centres at the top to a broad base of smaller-sized cities underneath) was still largely confined to the economically advanced areas: Europe, North America and to a lesser extent Australasia. Meanwhile, industrial urbanism had entered on its metropolitan phase. The widespread use of cheap electric power, the advent of rapid transit and communications, new building materials, the automobile and rising levels of per capita personal income had led to some relaxation of urban concentration. City dwellers began moving out from older downtown areas to suburbs and satellite communities where conditions were thought to be less wearing on nerves and bodies. Rising central area land values, traffic congestion, increased taxation and festering slums reinforced the exodus. At the city's core the composition of the resident population came to include growing proportions of the aged, minority groups and the very poor.

In the reshaping of the 20th-century city, advantages for residence and consumption probably played a more decisive role than advantages for production. Thus, while its advantages for manufacturers have diminished somewhat, the city remains the only feasible locus for the mass of specialized service activity which forms so large a part of the modern economy: the city offers maximum access to people. The spread of the city, however, has further weakened the vitality of local government: the difficulty of defining appropriate administrative boundaries has been added to the older problems of powers and finance. The task is to find viable forms of government for vast metropolitan districts, sometimes identified as conurbations, which sprawl across the countryside without unity or identity. *See* CITY GOVERNMENT; CITY PLANNING; ECOLOGY, HUMAN; SOCIOLOGY, URBAN; *see* also references under "City" in the Index volume.

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CITY GOVERNMENT. The governments of modern cities bear little resemblance to the governments of ancient or medieval cities. But as the walled medieval town often left its impression at the heart of the modern European metropolis, so too did obsolete governmental patterns linger on to complicate the administration of modern municipal services. This lag was evident in world-wide efforts to cope with the suburban overflow from great metropolitan centres. It also appears in many other ways and suggests the starting point for understanding modern city government; *i.e.*, the continuing struggle to keep pace with the problems of rapid urbanization.

Early municipal governments evolved to meet the limited demands of small towns serving rural populations. The Industrial Revolution converted the cities into workshops. The accompanying revolution in communications made them the commercial, cultural and intellectual centres of their respective countries. Thus economic drawing power combined with the attractions of a more sophisticated urban culture to bring about a world-wide migration from rural areas into cities.

With the urban migration came a need for new public services. Crime, fire, poverty and pestilence grew in seriousness with the size of the city. Polluted wells yielded to public water supply; open sewers gave way to sanitary waste disposal; contagious diseases came under public health regulations; industrial unemployment required new forms of public assistance; fire and health hazards dictated more stringent building regulations; growing congestion impelled attention to better planning of streets and open spaces. The services provided by city governments became increasingly important to the urban citizen. But each step required new legal powers, more specialists and additional funds. The pressure began to crack the shell of outmoded institutions.

Cities in England.—As the Industrial Revolution spread over England, the European continent, the United States and finally Japan in the 19th century, it brought marked changes in the structure of city government. In England, Elizabethan poor laws collapsed early under the impact of industrial unemployment. The revised Poor law of 1834 set the pattern for early efforts to adjust traditional local institutions to changing needs by creating new governmental areas (poor-law unions). It provided for locally elected governing boards, a paid professional staff and central government supervision of these local authorities. This use of *ad hoc*, or single-purpose, authorities to carry out new municipal functions spread in England until a hopeless confusion of jurisdictions, tax rates and organization forced a series of reforms. Consolidation began as early as 1871, but not until the acts of 1929 and 1933 was a more rational system of local government areas and authorities created.

By mid-20th century most of the larger cities in England, Wales and Northern Ireland operated as county boroughs. These all-purpose authorities are combined city-county governments enjoying the powers of both. The area outside the county boroughs is divided into administrative counties, which are further subdivided into boroughs (called noncounty boroughs), urban districts and rural districts. Most noncounty boroughs and urban districts are cities between 5,000 and 50,000 population, although a few are larger. Whether he lives in a county borough, noncounty borough or urban district, the urban dweller elects a council as his principal governing body. One-third of the members retire each year. Both the county borough and noncounty borough councils select aldermen, up to one-third the number of councilors, for six-year terms. The aldermen sit and vote as members of the council. The council also elects the mayor who presides over the council but has no important executive duties. Administration is supervised by council committees appointed for each important department of government. The committee selects the professional head of the service and provides close policy guidance for his activities. There is no single chief executive, although the borough clerk is a connecting link between departments. (*See* also BOROUGH.)

The Local Government Boundary commission was appointed in 1945 to continue the rationalization of local areas. The Local Government act of 1948 made important changes in the system of government financing and property valuation for tax purposes, in part because the services undertaken by local governments under the National Health Service act of 1946 and the National Assistance act of 1948 outran local tax resources. These acts provided extensive health services and augmented aid to the aged and infirm. The Local Government act of 1948 provided a system of equalization grants from the national government to help underwrite the new functions.

Cities in the United States.—In the United States, both national and state governments were slow to face the emerging urban problems of the 19th century. The cities, reflecting the traditional American suspicion of government, were governed through an ineffectual system of two-chamber city councils, mayors without power and a multitude of elected officials. The legal status of the city as a corporation, operating within the strict bounds of specified powers delegated from the state governments, was another major handicap. Cities often lacked the legal powers needed to exercise necessary controls over private action. Rurally dominated state legislatures were either indifferent to urban problems or meddled directly in local affairs to get special privileges. When new municipal functions were authorized, state laws usually required that they be administered by semi-independent commissions detached from the administration of the mayor. In the resulting confusion, local officials shielded by dispersed responsibility often took advantage of the opportunities for corruption in awarding franchises for public utilities, enforcing building codes, constructing public works, etc.

By the end of the 19th century, municipal corruption had become a national scandal in the United States and several reform movements gathered momentum. Among them were drives for greater home rule for cities, a shorter ballot, more stringent enforcement of tenement-control laws, reform of police systems, city planning and stronger executive control over city government. The National Municipal league, organized in 1894, became the educational centre for changes in the structure of government. It advocated and provided legal guidance for strengthening the position of the mayor, reducing the size of city councils, dispensing with superfluous elected officials and abolishing many independent boards and commissions. With public sentiment for reform growing, many states adopted municipal home-rule laws. These permitted a range of experimentation and local initiative that raised U.S. city government from disrepute to advanced professionalization within a generation.

Three patterns of city government attracted attention in the U.S. during the first half of the 20th century. One—the commission form—is now only a matter of historical interest. It was launched in Galveston, Tex., in 1901, and later widely imitated. The members (usually five) of a small council served as the administrative heads of a group of services. The mayor was simply the presiding member of the council and had no special powers. With time, the dispersal of responsibility in the scheme revealed serious weaknesses, and the commission form gradually dwindled away. The two forms of government growing in importance by mid-century were the strong-mayor type and the city-manager (*q.v.*) type. Under the strong-mayor form a popularly elected chief executive is given substantial authority to make appointments, initiate the budget, supervise government departments, propose public policy and veto council actions. This became the dominant pattern in the larger cities. Sixteen of the 21 cities with more than 500,000 population in 1960 operated under some form of mayor-council government. Most of these cities had established some kind of general managerial assistance for the mayor in the form of a chief administrative officer. The powers of the mayors varied widely, however, and the trend to centralized administrative authority was restricted by the continuing tendency for state legislatures to place new functions under semi-independent boards. Smaller cities moved more slowly toward a strong executive than did the larger. Many continued at mid-century to operate under strong-council, weak-mayor forms with the council and its committees the dominant element.

The city-manager plan enjoyed startling success after its first introduction at Sumter, S.C., in 1912 and Dayton, O., in 1913. It follows the corporation pattern: the council is essentially an elected board of directors which appoints a professional manager to direct the city's administration. The council is usually small and nonpartisan, with the members elected at large. The manager recommends policy, prepares the budget, makes appointments and exercises direction over the administrative departments. He does not, in contrast with the strong mayor, play an active part in political action designed to get his recommendations adopted. This is left to the council. The system worked well and spread rapidly. At mid-century about half of all cities in the United States with more than 25,000 population had the council-manager form of government. Of towns and cities with more than 5,000 population about one-third operated under the manager plan, about one-half under some form of mayor-council government, about one-eighth under the commission form and the remainder under a form of town meeting.

In the United States, as in England, the growth in governmental services accelerated after 1930. Much of the burden of administering and financing these services fell on local governments. Population shifts during and after World War II meant increased pressure for utilities, schools, improved streets and related local services. Inadequate local tax sources brought appeals for state assistance. Meanwhile the state and federal governments were looking to local governments to help administer new programs in public health, education, housing, urban redevelopment and other social services. Financial aid to local governments, therefore, expanded and principally took the form of grants subject to state or federal standards of performance and related supervision. The net result was not unlike the pattern that developed in England, although the confusion created by overlapping jurisdictions and special districts was not tackled with comparable vigour. The problem of federal-state-local relations, including the allocation of tax resources, was the subject of many studies by federal and state commissions.

Continental European Patterns of Centralized Control.—While England and the United States were struggling to adapt traditions of local autonomy and limited government to modern urban living, other countries were bringing local governments under strict national supervision. Adequate legal authority was provided by broad grants of power from the central government under general municipal laws. The administration of these powers, however, was held under much tighter central rein than in England or the U.S. France established a pattern of this type which had far-reaching influence in Europe, Latin America and Japan.

In France, the citizens elect a city council, which in turn selects a chief executive, the *maire*. Once selected, the latter becomes in many respects an official of the central government. He exercises extensive police powers independently of the council and is solely responsible for the conduct of city administration. His activities are, however, subject to close national supervision through the prefect of the *département*, or, in small towns, the subprefect of the *arrondissement*. The prefect may annul acts of a city council that conflict with national laws; he must approve the budget and numerous other kinds of local enactments; he may write into the budget any obligatory items that are omitted; and he may suspend the city council under certain conditions. After World War II the constitution of the fourth republic (1946) and the constitution of the fifth republic (1958) set the stage for greater decentralization of local government in France. The preoccupation of the fourth and fifth republics with national and international problems, however, often delayed carrying decentralization plans into effect.

German cities first broke the feudalistic mold with the reforms of Baron vom und zum Stein in 1808, and between 1871 and World War I German municipal administration reached impressive heights of efficiency. Local councils were elected under restricted suffrage which gave one-third of the council seats to a small group of large taxpayers, one-third to a group paying the next-highest taxes and only the remaining third to the mass of voters. This council selected an executive board (*Magistrat*) consisting in part of unpaid citizens, in part of salaried professionals. The chairman of this board was the *Bürgermeister*, a well-paid professional civil servant enjoying great prestige and authority and, normally, long tenure. This combination set a new standard in effective municipal administration. Although the *Bürgermeister* was subject to a series of higher authorities ending with the ministry of the interior, he had the authority and administrative competence necessary to good government. The Weimar republic established after World War I democratized the councils but made few basic changes in the structure of municipal government. The Hitler regime, on the other hand, altered the pattern drastically in the 1930s. The *Bürgermeister* and other principal local officials were named by the Nazi party delegate and wielded virtually all the powers of city government. After the Nazi collapse in May 1945, local community elections led the return to self-governing institutions, and city elections were held throughout occupied Germany in 1946 and 1947. Division of the country in the postwar years prevented the emergence of any consistent pattern of local administration.

Municipal government in Italy strongly resembles the French structure. Before the advent of Mussolini in 1922, centrally appointed prefects exercised extensive powers over local affairs in the provinces. The towns and villages (*comunes*) were governed by a locally elected council and mayor, known as the *sindaco*. Committees of the councils played a somewhat larger part in running local affairs than in France, but the detailed supervision by the prefects was comparable. In Italy, as in Germany, fascism brought extreme centralization under party control. Perhaps as a reaction, the Italian constitution of 1948 decentralized administration. New regional governments, each under a regionally elected council and centrally appointed commissioner, were given extensive powers to legislate for city matters. The principle that regions are normally to exercise their administrative functions by delegating them to the provinces and *comunes* or by using local officials was clearly intended to give municipal governments a new dignity and importance, while continuing to use them to carry out national and regional programs.

In Russia after the Communist Revolution the responsibility for local government became primarily that of the republics and regions. As a result, many different forms developed. The basic pattern, however, vests general authority in a locally elected council (soviet), which in turn administers local affairs through its committees. In the larger cities the soviet selects a committee (presidium) to be the directing and co-ordinating executive. The party and youth organizations are active in selecting candidates, shaping policy and helping to carry out local programs. Popular participation in local government seems to be more active in the U.S.S.R. than it was under the fascist dictatorships of Germany and Italy.

Latin America.—In Latin-American countries local administration has been strongly influenced by continental Europe. Regional administrative areas are commonly designated provinces or departments, and central controls over local affairs are frequently strong, as in France. Constitutional provisions vary widely from extreme centralization to substantial local autonomy. The municipalities (*municipios*) in Latin America are not necessarily cities. They sometimes embrace sizable rural tracts around modest towns. The tendency, in general, is to treat the municipality as an administrative area for the national or regional government, and despite constitutional variations a high degree of centralized control over local affairs predominates.

Japan.—During the late 19th century, and down to the end of World War II, Japan followed the continental system of centralized administration. German advisers after the Meiji restoration of 1868 helped shape the administration of local affairs, although the result was perhaps more French than German. This was encouraged by a basic step in the revolution itself which had replaced provincial feudal lords with centrally appointed governors. The powers of the prefectural governors largely obscured local governmental institutions. The Local Autonomy law of 1947, however, drastically reversed the prewar pattern. Elected prefectural governors and assemblies were provided, while detailed provisions were made for the government of cities, towns and villages. The law provided essentially self-governing status for "special cities" over 500,000, but the opposition of rural prefectures blocked putting this section of the law into effect. The government proceeded, however, with a vigorous program of amalgamating small towns and villages into larger entities capable of assuming important governmental functions. An elected mayor and assembly are the essential organs of local administration, with much of their time devoted to national and prefectural programs.

Major Trends in City Government.—The governments of the cities of the world show certain marked similarities and a number of common problems. A locally elected council is virtually universal. There is usually a single chief executive, and the trend has been to strengthen his administrative position. England and the U.S.S.R. are exceptions, with committees of the council playing a strong role in guiding professional department heads. The appointed professional chief executive, originating first in Germany, assumed major importance in the United States in the modern form of the city manager and city administrative officer. Elsewhere in Europe and in Japan the elected local executive continued to predominate.

Central and state or regional governments came to rely increasingly on local governments for the administration of their programs. This was a natural development in the centralized continental systems, but it also became evident in Britain and the United States. In both countries financial grants and technical supervision of services by higher authorities emerged as a definite pattern. In both countries, also, expanded services rendered local tax resources insufficient, even for traditional local services. Thus the tendency was to seek further financial aid, and with it to receive closer supervision. Meanwhile France, Italy and Japan were stressing decentralization. The trend, therefore, was toward removing some of the earlier distinctions between the traditional self-government of Anglo-U.S. cities and the more centralized continental systems.

Another distinct trend was the increasing professionalization of municipal services. Cities began to organize into national associations, such as the American Municipal association in the United States, and both national and international conferences of municipal officials became common. Likewise, a growing number of specialists—city managers, finance officers, personnel officials, town planners, etc.—set up national international professional associations.

A final trend to be noted was the growing concern over the problems of metropolitan areas. The great cities of the world do not fit into generalized local governmental patterns. They have spread out to engulf, socially and economically, areas far beyond their political boundaries. Many of them are the metropolitan hubs of their respective countries. These facts have encouraged the consolidation of the larger metropolitan areas under distinctive governmental arrangements. The London Government act 1963 abolished the counties of London and Middlesex and the 28 metropolitan boroughs on April 1, 1965, and formed a new and bigger administrative area of Greater London divided into 32 London boroughs, with the City and the Temples, which were unchanged. The broad powers of the London City council were transferred to the Greater London council which consists of a chairman, aldermen and councillors. (*See* LONDON.) Paris has an over-all municipal council of 90 members, but subdistricts of the city (*arrondissements*) are grouped into nine sectors, each with its own mayor. Metropolitan Tokyo was consolidated into one large governmental district with prefectural powers in 1943. In 1953, Toronto, Ont., and 12 suburban municipalities were consolidated into one metropolitan district with authority to carry on a broad range of common functions.

Metropolitan government remained a major unsolved problem in the United States. Numerous studies of metropolitan regions were undertaken but adoption of adequate programs of reorganization followed at a much slower and more uncertain pace. Among the many attempts to develop remedies for the complex problems of metropolitan government were the Dade county (Miami), Florida, metropolitan government; the city-county consolidations at Baton Rouge, La., and at Atlanta, Ga., and metropolitan special district governments performing limited functions, such as the Seattle, Wash., metropolitan district. In general, however, the central city, its satellite towns, and a variety of special districts remained a chaos of overlapping and competing jurisdictions. There was no metropolitan-wide authority competent to carry on the functions of planning, land-use control, transit, recreation, prevention of water and air pollution, and other activities that demand attention on an area basis. Because local jealousies and rivalries block the consolidation of metropolitan governments, it seemed probable that only new kinds of multipurpose districts, able to carry on area-wide functions while leaving local matters to community determination, were likely to relieve the situation. Certainly the metropolitan region remained a major challenge to students of government throughout the world.

Additional information on city government may be found in the articles dealing with specific countries and some of the large cities. *See* also CITY; CITY PLANNING; HOME RULE (MUNICIPAL).

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CITY MANAGER. The city manager is the principal executive and administrative officer of a municipality under the council-manager form of local government, which spread widely in the United States and Canada after Dayton, O., became the first large city to adopt it in 1913. Following World War I, some cities and counties in Ireland, Norway and Sweden provided for the appointment of administrators whose duties closely resembled those of the city manager in the United States and Canada. Finland in 1931 required its municipalities to appoint managers, and two states in Germany, North Rhine-Westphalia and Lower Saxony, in 1946 provided for city and county managers.

Under the council-manager plan, the voters elect only the city council, which appoints a city manager to administer municipal affairs under its supervision. The members of the council, usually five to nine in number, may be elected either at large or by wards. The mayor is a member of the council and serves as its presiding officer. He may either be designated to this position by the council or elected as such by the voters. The council acts only collectively, and its individual members, including the mayor, have no administrative functions. The city manager serves at the pleasure of the city council. Subject to its general supervision, he is in full charge of the administration of municipal affairs. He prepares the budget, appoints and dismisses personnel and directs the work of the municipal departments. He attends all council meetings, presents recommendations on municipal business and usually takes an active part in the discussions.

Origin and Spread of Plan.—The council-manager plan was devised and first advocated in the U.S. by the National Short Ballot organization, an association which proposed to improve state and local government by reducing the number of elective offices in order to fix responsibility on a few officials. This organization, of which Woodrow Wilson was president and Richard S. Childs, a young New York advertising man, was the secretary and active promoter, undertook first to support the commission plan of municipal government. Under that plan, all municipal powers were vested in a commission, the members of which collectively served as a legislative body and individually administered the departments.

Since the dispersion of administrative functions proved to be a serious weakness of the commission plan, Childs's attention was attracted by the news that the city council of Staunton, Va., had appointed a general manager and delegated to him the function of directing the municipal departments. He seized on this idea as a means of overcoming the weakness of the commission plan, and the National Short Ballot organization formulated and began to promote the commission-manager plan, which in all essentials was the plan later known as the council-manager or city-manager plan.

Sumter, S.C., adopted the plan in 1912, and was followed by several other small cities. The greatest impetus to its spread came with its adoption in 1913 by Dayton, which had suffered a severe flood that required emergency action by its local authorities.

The National Municipal league, the principal organization in the United States for the promotion of municipal reform, had previously concentrated its efforts on strengthening the authority of the mayor and eliminating partisan patronage. After the early success of the council-manager plan, it adopted the plan in 1915 as the basis of its model charter for municipal governments. This charter added to the essential features of the council-manager plan provisions to establish a civil service system, to forbid members of the council to interfere with the city manager's administrative work or appointments and to forbid municipal employees to engage in political activity. (Three-fourths of the cities that have adopted the plan elect their councils at large.)

While it generally proved impractical to write into law a precise definition of the respective functions of the council and the city manager, in view of the fact that the city manager serves at the council's pleasure, the principal objectives of the plan were achieved in most of the cities that adopted it. The plan spread rapidly from 1918 to 1923, as many cities undertook programs of public works and municipal improvements and realized their need for more efficient administration.

The council-manager plan also continued to grow rapidly in both America and Europe after the end of World War II. In the United States and Canada one-half of all the cities operating with this plan in 1958 had adopted it during the years following that war. At the beginning of 1958 it was in effect in more than 1,550 cities, towns and counties in the United States and Canada. Nearly one-half of all the United States cities with populations of more than 25,000 had the council-manager plan.

All cities and towns in Finland as well as one-fifth of the rural municipalities had appointed managers by 1958, and so had all the counties in Ireland, while in Sweden all counties and about 10% of the cities and towns had managers. In Norway 85% of all towns had managers. In two states in Germany all cities, towns and counties had managers. Thus by 1958 these five European countries had 1,534 council-manager municipalities, almost as many as the United States and Canada.

Advantages of the council-manager plan are that it provides for a short ballot with only members of the city council elected by the people; that it unifies authority and political responsibility in the council; and that it centralizes administrative responsibility in an administrator appointed by the council. It is argued by some that a disadvantage of the plan is that the manager generally comes from outside the city and is not familiar with its local problems. Another disadvantage is that too much power is placed in the hands of one man. But a good manager must have more than just a knowledge of local affairs. A manager has no "power" because the elected council makes all policy decisions and the council can remove the manager at any time.

Legal and Political Basis.—The legal basis of the plan in the United States varies with state law. In states which permitted municipal home rule, cities established the plan by adopting by popular vote charters drafted by local reform groups, often following the model charter or the advice of expert consultants. Some adopted by popular vote an optional council-manager plan provided by state law. Some had their state legislatures enact special council-manager charters for them. And in others the city council adopted the plan by municipal ordinance without submitting it to popular vote.

Characteristics of Managers.—In the United States more city managers have had training or experience as engineers than in any other occupation. But following the end of World War II city councils tended to prefer men with training and experience in public administration rather than men with specialized training. Four-fifths of the managers had attended college and two-thirds of this group completed their college work. One-half of those who obtained bachelors' degrees continued their education for a higher degree, usually a master's degree, and one out of every five managers held a graduate degree.

While city managership had no definite training requirements, a young man who planned a career in this profession usually obtained a master's degree in public administration and served as an intern and as an assistant to a manager for several years before becoming a city manager. Nearly one-half the city managers appointed each year were promoted from one city to another or were former managers who received new appointments. Less than 10% of the managers came from nongovernmental positions.

City managers, with rare exceptions, refrained from taking part in local political campaigns, even when they were personally attacked by opposition factions. On the other hand, many took the lead in public discussions of municipal policy. Some of the most successful managers were extremely active as public speakers and as public advocates of improving or extending municipal services.

City managers looked on their work as a professional career, but at the same time they never expected to hold their positions except at the pleasure of their city councils. Their professional society, the International City Managers' association, always took the position that the city manager was subject to dismissal by the council and refused to support proposals that he be removed only by more than a simple majority vote of council members. Similarly, it admitted to membership any city manager duly appointed by a city council and never sought to establish any criteria of its own for recognition or membership in the profession.

The association did a great deal not only to stimulate a professional attitude among its members, but also to advance the general level of municipal administration. It sponsored research in municipal administration; published the *Municipal Year Book*, an annual encyclopaedia of factual and statistical data on all cities in the United States; and conducted courses of training in various branches of municipal management.

The city-manager movement had effects beyond the sphere of municipal affairs. In the United States, city managers often went from municipal government into state and national administration and did much to help develop administrative systems in which federal, state and local agencies co-operate in the management of national programs. *See* also LOCAL GOVERNMENT.

See International City Managers' Association, *The Municipal Year Book* (annually), *City Management, a Growing Profession* (1957).
(D. K. PE.; C. E. RY.; O. F. N.)

CITY PLANNING is the guidance of the growth and change of urban areas. As such, it is aimed at fulfilling social and economic objectives which go beyond the physical form and arrangement of buildings, streets, parks, utilities and other parts of the urban environment. City planning takes effect largely through the operations of government and requires the application of specialized techniques of survey, analysis, forecasting and design. Thus city planning may be described as a social movement, as a governmental function, or as a technical profession. Each aspect has its own concepts, history and theories. Together they fuse into the effort of modern society to shape and improve the environment within which increasing proportions of humanity spend their lives: the city.

In many countries, city planning has been broadened to cover larger areas as the need for orderly development of the entire physical environment has been recognized. In some small countries where usable land is scarce, such planning may extend to the whole country. In Great Britain this broader approach is termed "town and country planning"; in the U.S. the usual term is "city and regional planning." (*See* also REGIONAL PLANNING.)

SOCIAL MOVEMENT

Early History.—There are examples from the earliest times of efforts to plan city development. Evidence of planning appears repeatedly in the ruins of cities in China, India, Egypt, Asia Minor, the Mediterranean world and South and Middle America. There are many signs: orderly street systems, rectangular and sometimes radial; divisions of a city into specialized functional quarters; development of commanding central sites for palaces, temples and what would now be called civic buildings; and advanced systems of fortifications, water supply and drainage. Most of the evidence is in smaller cities, built in comparatively short periods as colonies. Often the central cities of ancient states grew to substantial size before they achieved governments capable of imposing controls. In Rome, for example, the evidence points to no planning prior to late applications of remedial measures.

For several centuries during the middle ages there was little building of cities in Europe. There is conflicting opinion on the quality of the towns that grew up as centres of church or feudal authority, of marketing or trade. They were generally irregular in layout, with low standards of sanitation. Initially, they were probably uncongested, providing ready access to the countryside and having house gardens and open spaces used for markets and fairs or grazing livestock. But as the urban population grew the constriction caused by walls and fortifications led to overcrowding and to the building of houses wherever they could be fitted in. It was customary to allocate certain quarters of the cities to different nationalities, classes or trades, as in cities of the far east at the present day. As these groups expanded, congestion was intensified.

During the Renaissance there were conscious attempts to plan some aspects of city form. Military concerns dictated certain features, such as logistically practical circulation patterns and encircling fortifications, which forced overbuilding as population grew. As late as the 1860s Baron Haussmann's radial boulevards in Paris had military as well as aesthetic purposes. The grand plan, however, probably had as its prime objective the glorification of a ruler or a state. From the 16th to the end of the 18th century many small cities, and parts of large cities, were laid out and built with monumental splendour. The result may have pleased and inspired the citizens, but it rarely contributed to the health or comfort of their homes or to the efficiency of manufacturing, distribution or marketing.

Early U.S. History.—The planning concepts of the European Renaissance were transplanted to the new world; familiar examples are Williamsburg, Va., and Washington, D.C. In particular, Pierre l'Enfant's plan for Washington (1791) illustrated the strength and weakness of these concepts; it was a plan ably designed to achieve monumentality and grandeur in the siting of public buildings, but in no way concerned with the efficiency of residential, commercial or industrial development. More prophetic of the layout of U.S. cities was the rigid gridiron plan of Philadelphia, Pa., by William Penn (1682), with a layout of streets and lots (plots) adaptable to rapid changes in land use, but wasteful of land and inefficient for traffic. The gridiron plan traveled westward with the pioneers, since it was the simplest method of dividing surveyed territory. Its special advantage was that a new city could be planned in the eastern offices of land companies and lots sold without buyer or seller ever seeing the site.

The New England town also influenced later settlement patterns. The central common, initially a cattle pasture safe from marauding Indians, provided a focus of community life and a site for meetinghouse, tavern, smithy and shops. It showed up as the square in county seats from the Alleghenies to the Pacific, still the focus of urban activity. Also from the New England town came the tradition of the freestanding single-family house. Set well back from the street and shaded by trees, it had an ornamental front yard and a working back yard, and became the norm of American residential development. This was in contrast to the European town house, with its party wall and tiny fenced back yard, examples of which are found in some large U.S. cities.

19th Century.—In both Europe and the U.S., the surge of industry during the 19th century was accompanied by rapid population growth, unfettered individual enterprise, great speculative profits and remarkable lapses of community responsibility. During this era sprawling giant metropolitan cities developed, offering wealth and adventure, variety and change. Their slums, congestion, disorder and ugliness provoked the beginnings of the modern housing and city-planning movements. Reacting against the slums of 19th-century industrial cities, housing reform was the first demand. Industrial slums in European and American cities were unbelievably congested, overbuilt, unsanitary and unpleasant. The early regulatory laws enacted against these conditions set standards which improved upon the slums of the time, but seemed a century later to be impossibly low. Progress was very slow, for the rent-paying ability of slum dwellers did not make it profitable to invest in better housing for them. Housing improvement as an objective, however, recurred continually. Early significant improvements in public health resulted from engineering improvements in water supply and sewerage, which were essential to the later great growth of urban populations.

Toward the end of the 19th century, another effort to improve urban environment emerged from the recognition of the need for recreation. Parks were developed to provide visual relief and places for healthful play or relaxation. Later, playgrounds were carved out in congested areas, and facilities for games and sports were established not only for children but also for adults, whose workdays gradually shortened.

Concern for the appearance of the city had long been manifest in Europe, in the imperial tradition of court and palace, the central plazas and great buildings of church and state. The resurgence of this tradition had a counterpart in the "city beautiful" movement in the U.S. following the Chicago world's fair of 1893, as widely expressed in civic centres and boulevards, contrasting with and in protest against the surrounding disorder and ugliness.

In the course of the 19th century, a number of utopian and religious groups contributed ideas for more satisfactory urban forms, though their experimental communities met with indifferent success. The garden-city movement in England developed from the writings of Ebenezer Howard in the 1890s, and was a great and continuing influence on efforts to improve the urban environment.

20th Century.—Early in the 20th century, during the sprawling growth of industrial cities, factories invaded residential areas, tenements crowded in among small houses and the first skyscrapers overshadowed other buildings. To preserve property values and achieve economy and efficiency in the structure and arrangement of the city, the need was felt to sort out incompatible activities, to set some limits upon height and density and to protect established areas from despoilment. Zoning (*q.v.*) was the result.

As transportation evolved from foot and horse to street railway, underground railway or subway, elevated railroad and automobile, the new vehicles made possible tremendous territorial urban expansion. Workers were able to live far from their jobs, and tremendously complex systems of communications developed. The new vehicles also rapidly congested the streets in the older parts of cities. By threatening strangulation, they dramatized the need to establish orderly circulation systems of new kinds.

Metropolitan growth so intensified these and other difficulties that the people living in cities—who for the first time outnumbered the rural population in many countries—began to demand an attack upon all of these problems. In response, city planning by mid-century aimed not at any single problem or reform, but at the improvement of all aspects of the urban environment. An important concept was that all these problems were related, and could not be attacked successfully in isolation. It became apparent that the planning of the urban environment could not be separated from the planning of the whole metropolitan area. This introduced issues of national planning and in many countries brought city planning into the field of planning the nation's economic and social resources as a whole. (*See* MODERN ARCHITECTURE; APARTMENT HOUSE; REGIONAL PLANNING.)

As it developed, city planning laid stress on those aspects of the urban environment that in the common interest should be improved and that required protection and promotion through government action. Countries varied in the relative importance which they attached to these aims—some stressing the government function in promoting planning, some the role of individual enterprise, with government playing a subsidiary role as the protector of the public from the adverse effects of the actions of others.

Goals of Modern City Planning.—The ultimate goals were social, although the plans themselves related to physical things. They were deeply involved with intermediate economic objectives. The expression of the goals was, of course, coloured by the culture of the society seeking them. In the U.S. and countries following western European traditions, the ideal urban environment would reconcile the maximum opportunity for individual choice with protection for the individual from the adverse effects of the actions of others. Within this philosophy, city planning would probably seek: (1) the orderly arrangement of parts of the city—residential, business, industrial, etc., so that each part could perform its functions with minimum cost and conflict; (2) an efficient system of circulation within the city and to the outside world, using to the maximum advantage all modes of transportation; (3) the development of each part of the city to optimum standards, as of lot size, sunlight and green space in residential areas, and parking and building spacing in business areas; (4) the provision of safe, sanitary and comfortable housing, in a variety of dwelling types to meet the needs of all families; (5) the provision of recreation, schools and other community services, of a high standard of size, location and quality; (6) the provision of adequate and economical water supply, sewerage, utilities and public services.

In any community, these goals might be supplemented by special goals, such as the preservation of a historical area, or the protection of property values, or the efficient conduct of government. On occasion, the goals of some powerful special interests might be inconsistent with those of others; *e.g.*, the preservation of slum property values and the provision of adequate housing. Furthermore, the statement of ideal goals required the use of relative terms, such as "adequate," "high standard," etc., which are relative rather than absolute, and change from time to time. Therefore inherent in the concept was the recognition that an ideal is not a fixed objective, but itself will change; that the ideal city can be striven toward, but never achieved.

GOVERNMENT FUNCTION

As a normal and identifiable function of government, city planning has been recognized in Europe and the U.S. since the early years of the 20th century. The year 1909 was a milestone. It saw the passage of Britain's first Town Planning act and, in the U.S., the first national conference on city planning, the publication of the Burnham plan for Chicago and the appointment of Chicago's plan commission (the first official planning agency in the U.S. was in Hartford, Conn., in 1907). Germany, Sweden and other European countries also developed planning administration and law.

City planning as a government function involves the co-ordination of all governmental activities that bear upon community growth and change, especially those that influence private development, so that they all work toward comprehensive objectives. In its early form emphasis was on preparation of a single and authoritative plan. In time, it was realized that the future was not precisely predictable and that the plan must be flexible. More emphasis was placed upon "planning" than "the plan," and upon the administrative arrangements needed to bring study to bear upon each governmental decision. It was also realized that governmental influence on private activities must be primarily negative, and that many of the decisions that resulted in significant growth and change in cities were made by private agencies, such as industries, banks or land developers, especially in the parts of the world that permitted private economic activity. Accordingly, planning was broadened to include the measures needed to foster a realization by business and civic leaders of their stake in city development, and of their opportunities to capitalize on it. In European countries the planning powers of central as well as local government were strengthened in order that the community, through government, might take more positive action to accomplish planning objectives.

The place of the city-planning function in the structure of urban government has developed in different ways in different countries. On the continent of Europe, where municipal administration was strongly centralized, city planning became the sphere of an executive department with substantial authority. In Great Britain the local planning authority was a local legislative body (the county or county borough in England and Wales, the county or burgh in Scotland), advised by a planning committee of local councilors and with a planning department to act in an executive and advisory capacity. In the U.S., with its tradition of tripartite government, it was recognized that decisions of importance to community development were made both by the executive branch (mayor) and the legislative (council). Rather than impinge on the authority of either, planning was allotted to a separate commission, advisory to both, with no authority beyond the right to be consulted before any action affecting the plan was taken.

After the late 1930s, especially where the city-manager (*q.v.*) form of municipal government had been adopted, there was a trend toward making city planning a staff arm of the executive, in line with a general trend toward the strengthening of executive powers, and to channel all advice to the council through his office. There was also, as municipal government became more complicated, a trend toward formalizing the planning of administrative operations, budgeting and other executive functions, which led to some confusion between this kind of planning and city planning as discussed in this article. (*See* City Government.)

Zoning and Subdivision Controls.—The regulation of the use of land and buildings, of the density of population and of the height, bulk and spacing of structures began long before the development of modern city planning. As a tool deliberately used to put into effect a comprehensive scheme for land use, however, it is generally dated from the adoption of New York city's first comprehensive ordinance in 1916. Though zoning was used in Britain and other European countries, it was developed furthest in the U.S. The first ordinances were simple regulations, intended primarily to protect existing property values and preserve light and air. As planning itself broadened its objectives and evolved its techniques during the 1930s, zoning developed into a more precise and sensitive tool. There were successively broader court interpretations of this use of the police power (*i.e.*, the power to regulate private actions in the interest of the public health, safety, morals and general welfare), and zoning was employed more and more to give legal effect to planning policies for land use. The control of land use was thus related to the development plan, or master plan, prepared by the local planning authority. Such a plan was approved by the central government in Britain where applications for permission to develop land or change its use were considered in relation to the provisions of the plan.

Paralleling the evolution of zoning in the U.S. was the development of subdivision controls: subjecting the initial laying out of vacant land to public regulation. It was realized, after bitter experience with suburban land speculations in the 1920s, that the interest of the owner and developer of raw land is sometimes temporary and purely financial, while the urban community must live with his product for generations after. Subdivision regulations in many U.S. cities specified that new streets conform to the over-all city plan and that new lots be properly laid out for building sites. Some required the developer to give the land needed for streets, playgrounds and school sites, and pay all or most of the cost of development.

Zoning and subdivision control offered adequate controls over the growth of new parts of cities, where they were used by enlightened legislative bodies. (They were also used in some places for such objectives as the exclusion of low-income families or the assignment of special privilege to favoured property owners.) It was realized, however, that they were insufficient to correct past mistakes, and especially to bring about the rebuilding of the obsolete parts of cities. (*See* Zoning.)

Large-Scale Development.—In order to clear slums and to provide decent housing for slum dwellers unable to afford private standard structures, publicly owned and subsidized housing was developed. (*See* Housing.) It was used first in Europe, especially in the 1920s, and was supplemented by co-operatives and other forms of limited-profit or publicly aided housing, particularly in Scandinavia. Public housing with federal aid became government policy in the U.S. in the 1930s. Most states authorized their cities to condemn and clear slums and build public housing. In Great Britain and Europe in the 1920s and 1930s public housing was also built in suburban vacant areas, in some cases on such a scale as to almost constitute new towns. This was a result of the recognition that all slum dwellers could not be rehoused in the same areas without repeating the slum congestion. Though such action was legal in the U.S. after the 1930s, it was rarely employed.

All over the western world, in the first half of the 20th century, new towns were built, constituting a very small part of the total of urban growth but serving as experiments and as examples of what could be done. This was largely the product of England's garden-city movement, which proposed preplanned new cities, on land held by the community, limited to 30,000 population, complete with business services and employment centres and surrounded by permanent green belts of rural land. The initial experimental cities were undertaken in England by private initiative, motivated by a spirit of reform; Letchworth was started in the early 1900s, and Welwyn Garden City in the 1920s.

The concept had substantial influence in the U.S. Kingsport, Tenn., was a new city built by industrial interests. Some of the design ideas were used in suburban real-estate developments, outstanding being Radburn, N.J., which pioneered the super block scheme as the "town for the motor age." U.S. examples, however, omitted the community-ownership feature, and almost all omitted employment centres, balanced income groups and effective greenbelts. The federal government undertook a few large-scale housing developments for in-migrant industrial workers during World Wars I and II, as make-work projects during the depression of the 1930s and as examples of sound urban design (*e.g.*, the greenbelt towns outside Washington, D.C., Cincinnati, O., and Milwaukee, Wis.).

Also during the 1930s a number of European countries, especially France, the Netherlands, Germany and the U.S.S.R., undertook the building of new towns as governmental enterprises. Most of them (except in the U.S.S.R.) were residential suburbs rather than complete urban units. During the period following World War II many European countries made strides in the regulation of new growth and in planned rebuilding of bomb-torn city centres.

After World War II Great Britain embarked on a bold program. It reorganized the planning districts of the country; it established sweeping new powers over private land use, almost nationalizing the right to develop undeveloped land; and it undertook to build new towns to receive population and industry from congested great cities, which were planned for rebuilding at lower densities. By 1960, 15 new towns were under way, but the national program had suffered reverses. At first economic exigencies interfered with the relocation of industry suggested by long-range environmental planning, and some of the controls over private land development, which appeared to impede investment and construction, had to be relaxed. Nevertheless most of the new towns had become centres of rapid industrial and population expansion and constituted important new work in city plan effectuation.

In the U.S. the 1940s saw an increasing concern with planned rebuilding of obsolete areas. This interest was paralleled in countries that had sustained extensive war damage. In the endeavour to rebuild devastated cities several European countries, notably Britain, France and the Netherlands, strengthened public powers to acquire land and redevelop it according to a new layout. Notable examples are Coventry in England and Rotterdam in the Netherlands. Toward the end of the decade many states of the U.S. granted urban redevelopment powers to their cities, which began to clear slums not only for public housing but also for any other public or private re-use that fitted a comprehensive plan. New private uses were made possible by selling or renting the cleared sites at much less than it cost to buy and demolish the slums, the difference being partly paid for with federal aid.

In the U.S. urban redevelopment—*i.e.*, large-scale clearance of completely obsolete areas—was supplemented with federal aid for an attack upon the intermediate areas, obsolescent but not obsolete. The term urban renewal was applied to this concept. Upon all parts of a city, all of the powers of government were brought to bear, under a comprehensive plan including private and civic groups, to rehabilitate run-down areas, to conserve good areas and to check blight as well as correct its results by clearance.

One more device had been developed during the 1930s and 1940s in the U.S., largely by planning agencies. Capital-improvement programing became a normal practice of city government; expenditures for public works were scheduled according to a plan and to priority criteria. Most other effectuation measures had attempted the guidance of private development. Capital-improvement programing and the mandatory reviewing by the planning agency of municipal acts affecting physical environment were devised to guide the complex operations of the municipal government itself.

Planning Jurisdictions.—Where a single municipal government included all of an urban area, tools for planning and effectuation seemed, in the second half of the 20th century, to be approaching adequacy. This condition, however, was exceptional. In Europe and the Americas the metropolitan area was the typical urban form, composed of many independent municipalities, with overlapping jurisdictions of counties, school districts and special authorities.

In the U.S. efforts were made toward metropolitan planning, not to replace city and suburban planning agencies but to supplement them on a broader scale. In the 1920s these efforts were largely voluntary, outstanding being the private Regional Plan Association of New York, whose work had much influence. By the 1940s many public metropolitan planning agencies had been set up; they were, however, purely advisory, with no authority to give effect to their planning recommendations. As late as the early 1960s metropolitan planning efforts in the U.S. were still largely ineffective. Planning agencies had little voice in the decisions of not only the separate cities and suburbs but also larger public agencies, such as state highway departments, sewer and water supply authorities and port and airport authorities. The U.S. planning movement had not yet evolved the governmental machinery for reconciling in a democratic way the conflicting interests of all of the constituents of a metropolitan area.

During this same period European countries were also groping toward solutions of the metropolitan planning and development problem, with some progress in Great Britain, Scandinavia, Germany (Ruhr) and the Netherlands. In the 1950s a limited metropolitan government was established for Toronto, Ont., with planning as an integral function.

In Asia the emerging industrial economies of the post-World War II period produced cities following many of the patterns of the west. These rapidly developing countries, however, are still preoccupied with political and economic problems and have made little progress in establishing an environmental planning function in city or metropolitan government effective enough to prevent the mistakes made earlier in western cities. There are a few outstanding examples of planned new cities in such widely scattered places as India, Israel and South America. There are also signs of increasing concern in Puerto Rico, India, Indonesia and elsewhere for regional development programs.

Similarly, there was increased emphasis in Europe and America on the role of the city within the larger region, specifically in the Ruhr valley in Germany and with the TVA and other regional planning work in the U.S. during and after the 1930s.

THE PLANNING PROFESSION

As the popular demand for the results of city planning brought increasing official activity and as the city-planning function was accepted as a government operation, planning developed into a separate profession. Until the 20th century, city planning was done by architects, landscape architects or civil engineers. In Europe city planning is generally considered to be a branch—though a specialized branch—of architecture or engineering. This attitude had been modified to some extent, however, as the relevance of economists, sociologists and geographers to the planning team has come to be accepted.

In the U.S., however, city planning is regarded as a profession in its own right. Architecture, civil and traffic engineering, geography, sociology, economics, law and public administration all contribute to city planning, and city planners are trained to be familiar with the subject matter and techniques of each of these fields. The core of their specialized professional concern, however, is not within the competence of any of the older professions: "the unified development of urban communities and their environs . . . as expressed through determination of the comprehensive arrangement of land uses and land occupancy and the regulation thereof" (from the constitution of the American Institute of Planners, the U.S. society of the profession established in 1917).

The earliest university training for city planners in the U.S. was offered at Harvard in the late 1920s and at the Massachusetts Institute of Technology, Cambridge, in the early 1930s. By the second half of the century more than 20 U.S. schools gave degrees in planning, the master in city planning degree (M.C.P.) being the standard professional degree. The field, however, had far outgrown the number of graduates, and jobs in planning agencies could be filled only by in-service training of personnel from related professions. Special education for planners also developed in other countries, but the total number of schools in the rest of the world was no greater than the number in the U.S. In most other countries, training was offered only to students previously qualified in architecture or engineering, a limitation generally absent in the U.S. However, qualifications for planning courses had undergone modification in some other countries in accordance with a broader conception of the planner's functions.

The fact that U.S. city planners were not necessarily competent in the design of three-dimensional forms gave rise to a new area called urban design. Practitioners of urban design could be considered either as specialized architects or as specialized city planners. They worked on a scale larger than the single building but smaller than the entire urban area (except for very small municipalities), and also at a shorter time range than most city planning. An important distinction was that urban design worked toward the completion of three-dimensional projects, whereas city planning, based on a concept of perpetual change, guided change toward desirable objectives (which themselves would also change), rather than toward fulfillment of a specific design. Thus urban design, like architecture and other professional disciplines, was an activity essential to longer-range, larger-scale city planning, but distinct from it. Urban design in European countries received a great stimulus where large-scale development, such as new towns or city centres, was undertaken by public authorities.

City planning, in the second half of the 20th century, was still in flux. It had gradually been equipped with some of the tools of science, drawing heavily upon the social sciences for insights into the social and economic functioning of urban communities, upon technology for solutions to problems such as traffic and transportation and for innovations in housing, industrial or shopping-centre development. However, it was still underequipped with scientific knowledge, and research efforts began on a broad scale during the 1950s in the U.S. and to a much smaller extent elsewhere. It was also underequipped with a knowledge of what people would need and an insight as to what they would want for the future urban environment. Though less subject to research, this was the challenge to city planning and to all related professional disciplines, for as the population of the world was growing annually by greater numbers than ever before, its cities were growing even more rapidly.

See also references under "City Planning" in the Index.

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CITY-STATE, the name given to the political form which crystallized during the classical period of Greek civilization. Its ancient name, *polis,* was derived from the citadel (*acropolis*) which marked its administrative centre, and the territory of the *polis* was usually so limited that the citizens (*politai*) were fully acquainted with one another. City-states differed from tribal or national systems in size, exclusiveness, patriotism and passion for independence. The origin of city-states is disputed. It is probable that earlier tribal systems broke up during a period of economic decline and the splintered groups established themselves between 1000 and 800 B.C. as independent nuclei of city-states which covered peninsular Greece, the Aegean islands and western Asia Minor. As they grew in population and commercial activity, they sent out bands of emigrants who created similar city-states on the coasts of the Mediterranean sea and the Black sea, mainly between 750 and 550 B.C.

The thousands of city-states that sprang into existence during these centuries were remarkable for their diversity. Every variety of political experiment from monarchy to communism was practised, and the fundamental principles of political life were formulated by their philosophers. The vigour and intensity of the citizens' experience were such that they made unparalleled advances in all fields of human activity, except industry and technology, and laid the basis of Greco-Roman civilization and modern "western" civilization. The particularism of city-states was their glory and their weakness. Incapable of forming any permanent union or federation, they fell victim to the Macedonian kingdoms and the Roman empire, under which they lived on as dependent privileged communities (*municipia*). For Rome, which began its republican history as a city-state, shaped its foreign policy to the annihilation of the city-state as a political form in the ancient world.

See also GREECE: *History;* ATHENS: *History;* SPARTA; ROMAN HISTORY. (N. G. L. H.)

CIUDAD BOLÍVAR, capital of Bolívar state, Venez., and an important river town (pop. [1961] 64,133) on the southern bank of the Río Orinoco 260 mi. from the delta. In the past (but recently to a lesser extent) it was the commercial centre of the llanos, the huge, sparsely settled grassland region drained by the Orinoco. The limited commerce of this region could at the most be concentrated in a few river ports, and the chief of these was Ciudad Bolívar. The principal exports include gold, diamonds, cattle, horses, hides, skins and some timber. The growth and prosperity of Ciudad Bolívar and the area it serves were expected to be accelerated after the 1950s by the iron ore development in the lower Orinoco valley south from Puerto Ordaz and Palua (*see* CERRO BOLÍVAR). Its population increased about 25% in the 1940s and was still growing in the early 1960s. The city is situated well above the swamps of the lower Orinoco and despite a tropical location is quite healthful. It is connected by road with Caracas 450 mi. distant.

The town was founded by Moreno de Mendoza in 1764 as San Tomás de la Nueva Guayana, but its location where the Río Orinoco narrows to a width of less than half a mile gave it the popular name Angostura, the Spanish for "narrows." This name was used until 1846, when that of the Venezuelan liberator was bestowed upon it in recognition of the city's close identification with him. In 1819 the town was the meeting place of a congress at which Simón Bolívar (*q.v.*) declared the independence of Gran Colombia from Spain. For a time Ciudad Bolívar served as the headquarters of the revolution during the struggle for independence. It suffered severely during the fighting and the later political disorders. (L. WE.)

CIUDAD JUÁREZ, formerly EL PASO DEL NORTE, a northern frontier town of Mexico, in Chihuahua state, 1,221 mi. by rail and 1,285 mi. by road N.N.W. of Mexico city. Pop. (1960) 262,119; altitude 3,117 ft. It is on the right bank of the Río Bravo del Norte (Rio Grande), opposite El Paso, Tex., with which it is connected by two bridges. It is a northern terminus of the National Railways of Mexico and has a large transit trade with the United States.

Ciudad Juárez contains the Guadalupe mission, built in 1659, and many modern buildings. The town's present importance is due to its border position and its function as the marketing centre for a growing cotton production. The El Chamizal border controversy, a frontier dispute between the U.S. and Mexico, was created by the meanders of the Río Bravo at Ciudad Juárez; this issue was settled in 1963 with the two countries exchanging small portions of territory. The city was the headquarters of Benito Juárez in 1865 during his struggle against the French and was renamed in 1888 in his honour. (R. B. McCK.)

CIUDAD REAL, one of the five Spanish provinces formed from the ancient kingdom of New Castile (*see* CASTILE), of which it is in the southern part. Pop. (1960) 583,948. Area 7,625 sq.mi. (19,749 sq.km.), the third largest province after Badajoz and Cáceres. Mean altitude 2,067 ft. The province is crossed by the railways from Madrid to Badajoz and to Alicante and by that to Andalusia. It is also crossed by roads from Madrid to Cádiz and Ciudad Real; Ciudad Real to Murcia; Córdoba to Tarragona and Valencia to Badajoz, via Almansa. In the east and centre high plains form part of the region known as La Mancha, rising on the southeast to low hills. Apart from the La Mancha region the province is mountainous, having in the north the Montes de Toledo (Sierras de Chorito and Pocito) and in the south the Sierra Morena

(Sierra de la Alhambra). The flat La Mancha area (the country of Don Quixote de la Mancha) extends also into neighbouring provinces, but it is there that it is most extensive. Most of it is a desolate steppe and forms the largest plain in Spain. The region of the Campo de Calatrava is less monotonous. The province has two river systems: that of the Guadiana (the more important) and its tributaries, the Záncara, Gigüela and Jabalón; and that of the Guadalquivir. In the valley of the upper Guadiana are the famous lakes of Ruidera.

Cereals, vines and olives are cultivated. Wine is the main product of the province, especially that of Valdepeñas. The construction of dams such as that at Gasset was undertaken to increase irrigation. For centuries the flocks from Soria, Logroño and Cuenca have grazed in La Mancha. There are mercury mines at Almadén which have been worked since antiquity, and coal mines at Puertollano, near which a modern industrial complex has been formed. Industrial development is slight, however, apart from that based on agriculture. Among popular crafts the lace and needlework of Almagro is well known. The windmills, immortalized by Cervantes, are still silhouetted against the skyline of La Mancha.

Apart from the capital, Ciudad Real, the principal towns are Valdepeñas, Tomelloso, Puertollano, Alcázar de San Juan and Manzanares.

Ciudad Real, the capital of the province, is situated in a fertile plain watered by the Guadiana and the Jabalón. Pop. (1960 est.) 35,539 (mun.). The city is spread out, with low-built houses. There are many spacious squares and wide streets. Outstanding among the churches are the Gothic Santa Maria, and those of San Pedro and Santiago. The city was formerly walled, but the walls were destroyed by the river. Ciudad Real was founded by Alfonso the Wise, who named it "Villa Real," in 1255. In 1420 John II gave it the status of a city. As a strategic site on the route through La Mancha to Andalusia it has been the scene of many battles throughout history. (M. B. F.)

CIUDAD RODRIGO, a city and episcopal see in the province of Salamanca, Spain, lies near the Portuguese border, on the national road from Burgos to Portugal and on the railway from Salamanca to Coimbra. Pop. (1950) 12,455 (mun.). The whole of the urban area within the walls has been declared a historic-artistic monument meriting protection and conservation by the state. Because of its frontier position it has the defensive appearance of a fortress, with walls, towers, gateways and a castle. It is crossed by two principal streets which intersect to form the Plaza Mayor. The streets have a medieval appearance; there are convents and *señorial* houses with heraldic crests. Much is in the plateresque or Spanish Renaissance style. The cathedral dates from the 12th century; it was completed in the 14th century and reconstructed in the 16th. The city was founded in 1150 by Count Rodrigo Fernández, from whom it took its name. Ferdinand II fortified it (*c.* 1190) and granted the bishopric. It has been the scene of meetings between kings, of the signing of treaties and of royal weddings. In the War of Independence it was taken by the French under Marshal Ney after a hard siege in 1810, but in 1812 Lord Wellington and the guerrilla leader Julián Sánchez retook it after another siege. Wellington was rewarded with the titles of duke of Ciudad Rodrigo and marquess of Torres Vedras in Portugal. (M. B. F.)

CIUDAD TRUJILLO: *see* Santo Domingo.

CIURLIONIS, MIKALOJUS KONSTANTINAS (1875–1911), Lithuanian composer and painter, who, in his representation of the secret of cosmic existence and fate, is considered to have expressed a profound and specifically Lithuanian feeling, was born in Varena on Sept. 10, 1875. He studied music in the school of Duke Oginski in Plunge (1888–93) and in the conservatories of Warsaw and Leipzig. As a painter he was self-taught. His most valuable works were created between 1904 and 1909. He died at the age of 35, on March 28, 1911, in an asylum near Warsaw.

In music Ciurlionis was a mystic, continually searching for an individual form. He composed for piano, orchestra and choir, his best-known works being his symphonic poems "In the Forest" and "The Sea" and his shorter compositions for piano. Not satisfied with music alone for the expression of his fantasy world, he started to "paint music." His best paintings—all tempera—are symbolic and abstract compositions such as "Sonata of the Sea," "Spring Sonata" and "Pyramid Sonata" and his cyclic compositions "Creation of the Universe," "Zodiacal Cycle," etc. Ciurlionis concentrated on the essential and universal; his reality is the everlasting process of life subject to the rhythm of the universe. The portrayed shapes lack material individuality; they are parts of the cosmic harmony, of Ciurlionis' spiritual mirage, of visions of unique beauty. He anticipated the abstract art of Europe, which, when he represented his ideas, had not yet been born. All his paintings are in a gallery in Kaunas, Lithuania. Because of his poverty, Ciurlionis used paints of poor quality and his pictures unfortunately are losing their colours. (Ma. G.)

CIVET (Civet Cat), several species of long-bodied, short-legged carnivores of the family Viverridae, found in Africa and in Asia from India to southern China. The length may be up to 2½ to 3 ft., the thickly furred tail being about half as much again. The ground colour is buffish-gray variously spotted and striped with black, with an erectile ridge of dark hair along the back; the ears are small and the snout is pointed. The perineal glands open under the tail into a large pouch in which a greasy, musk-like secretion accumulates. This secretion is used by the animal for marking out its territory and is deposited on tree trunks, stones and other objects; it may also serve to bring the sexes together at the breeding season. Civets kept in captivity provide the secretion, the civet of commerce, which is a valuable material in perfumery.

ZOOLOGICAL SOCIETY OF LONDON

AFRICAN CIVET (CIVETTICTIS CIVETTA)

Civets are usually solitary and live in hollow logs, among rocks and in similar places, coming out to forage by night. They feed on any small animals they can overpower and also eat vegetable matter. They are destructive to domestic poultry and young corncobs (maize). The litter consists of two or three young. *See* also Carnivore. (L. H. M.)

CIVICS is the name given, particularly in the United States in the late 19th and early 20th centuries, to the study of citizenship and government in secondary and sometimes in elementary schools. The term also was used for a time to include, in addition to its narrower meaning, curriculum materials derived from sociology, economics, geography, social psychology, international affairs, social ethics and the study of occupations. These areas of study, along with history, came to be known in secondary education as the social studies or the social sciences. Among the social studies still may be found courses devoted specifically to the organization and processes of governments and the rights and duties of citizens. Such courses may be called civics or they may be called government or citizenship or some yet different name. (K. A. B.)

CIVIDALE DEL FRIULI, a town in the Friuli-Venezia Giulia region of Italy, in the province of Udine, lies 16 km. (10 mi.) from the town of Udine by rail. It is 453 ft. above sea level. Pop. (1957 est.) 11,053 (commune). The town is situated where the Natisone river forms a charming ravine, spanned by the 15th-century Bridge of the Devil. The old Venetian element is still visible. The cathedral (16th century) contains a magnificent wrought-silver altarpiece (12th century) and in its treasury are many precious ornaments dating from the 9th to the 16th centuries. In the museum attached to it are the baptistery of Callixtus, the altar of Ratchis (both 8th century) and other works of early medieval sculpture. The national museum of archaeology contains a *lapidarium* dating from late Roman and early medieval times and a fine collection of Lombard objects and manuscripts. The oratory of Sta. Maria in Valle, also called the Tempietto Longobardo, has decorations in stucco and pictures of the 8th century. Industries include alcohol, paper, cement and furniture manufactures.

The town was founded by Julius Caesar in 52 B.C. and from him took its name, Forum Julii. It had the same name in 568 when it became the seat of the first Lombard duchy in Italy and gave the name Friuli to the whole region. Under Charlemagne, in 774, it was renamed Civitas Austriae, from which was derived the modern form Cividale. From 735 to 1222 it was also the official seat of the patriarch of Aquileia. The historian Paulus Diaconus was born there in about 720. In 1419 the town voluntarily joined Venice.

CIVIL DEFENSE, a term used in the United States and in some European countries to denote all the nonmilitary actions that can be taken to reduce the loss of life and property from enemy action. It embraces defense against all types of attack, including conventional explosive bombs or rockets, nuclear weapons and chemical or biological attacks. During the early 1960s civil defense posed challenging problems for all the major powers living in an atmosphere of cold war. The awesome destructive powers of modern weapons formed one aspect of the problem; the complexities of crowded urban life formed the other. Attitudes toward civil defense ranged from hopeless resignation in the face of the difficulties involved to a crusading zeal for national defense and human survival. Some peace organizations strongly opposed all measures of civil defense on the ground that they were futile and encouraged the acceptance of war as inevitable.

Historical Background.—In the early stages of World War I, Germany used rigid airships to attack England from the air and the Allies launched some counterattacks on Germany. However, it was not until World War II that the threat of aerial attack on cities became sufficiently great to call for organized civil defense planning. While a few special air-raid shelters were built in Great Britain and in Hawaii, civil defense tactics during the interwar years consisted principally of utilizing improvised shelters such as basements and subways. Germany built special bunkers for a small fraction of its population, and these proved to be very effective in saving lives. Other civil defense tactics (in Great Britain and along the coasts of the United States) consisted of blackouts to reduce the night glow from city lights that could have served as guides to enemy pilots. The British government provided gas masks for its people, and practically all the countries involved in the war trained citizens in the elements of fire fighting, rescue and medical first aid.

The major, perhaps critical, difference between the civil defense situation in World War II and that which confronted the world after 1950 was that the relatively small weapons in World War II afforded some "learning time." People could learn by experience that shelters were safer than ordinary buildings, and civil defense volunteers could be recruited and trained after the war had begun. But with weapons that can destroy whole metropolitan areas at one blow, no learning time is afforded; there is no opportunity to learn from repeated attacks because the first attack, in all probability, will accomplish its mission.

Weapon Size.—The increase in explosive power of weapons during the 1940s and 1950s was dramatic. The bomb exploded over Hiroshima in 1945 had about 10,000 times as much power as the largest conventional bombs then in use. Fusion or hydrogen weapons available in the 1960s had increased their destructive power as compared to World War II fission-type nuclear weapons by a factor of hundreds or thousands. These radical increases in the destructive force of weapons caused equally radical changes in civil defense policies. While almost any shelter provided reasonable protection against conventional bombs, nuclear weapons of the size developed in World War II required a policy of locating and marking sites that offered the best possible protection in the area. With the advent of hydrogen weapons, consideration was given to the evacuation of urban centres upon warning of attack. However, with the advent of shorter warning times and with better understanding of the radiation hazards of fallout, this policy lost its appeal except as a possible measure to be employed by an aggressor nation to precede its delivery of an opening strike.

Weapon Delivery Systems.—The method of attack affects civil defense primarily in the amount of warning it affords for protective action. During the 1950s it was calculated that piston-engine-driven aircraft afforded some U.S. cities from six to eight hours of warning. Jet-propelled aircraft and cruise-type missiles reduced the warning time to four to six hours. Seaboard cities everywhere could be attacked by ballistic or cruise-type missiles from offshore submarines with virtually no warning at all. Clandestine attack, as from weapons secreted aboard freighters in harbours, affords no warning time.

This situation made mass evacuation completely impractical and even cast doubt upon the possibility of using air-raid shelters, for the time required to empty a large building exceeds the probable warning time. The use of shelters as protection from fallout was still considered feasible because survivors of the initial bomb effects could move to shelters after the weapon had exploded.

Warning Systems.—Air-raid alerting in the U.S. originally was accomplished principally by means of outdoor sirens, but the fact that emergency vehicles also used sirens reduced the effectiveness of sirens for air-raid alerting purposes. Because persons in major cities are indoors most of the time, much effort was devoted to the development of indoor warning devices. One such device, called NEAR (national emergency alarm repeater), consists of an electrical relay that responds to a deviation in the frequency on the electric-power network. On the occasion of an alert, some multiple of the normal 60-cycle-per-second alternating potential would be superimposed nationwide on the utility power networks by means of special generators in the substations; the resulting change in power-line frequency would activate the relay and set off an alarm.

In Great Britain air-raid warning is effected by means of sirens; the siren signal is reserved exclusively for air-raid announcements, while emergency vehicles use bells. In both Nationalist China and Communist China air-raid warning is by means of whistles, and emergency vehicles use sirens. In the U.S.S.R. preliminary air-raid warning is by means of both whistles and sirens. When the initial warning is given in the Soviet Union, all persons are expected to pay continuous heed to the government-controlled radio and loudspeaker network, which serves every area. A follow-up radio notification, plus the ringing of gongs and bells, warns of attack by radiological, chemical or biological means.

Effects of Weapons.—The amount of energy released from a nuclear weapon is expressed in terms of tons of its TNT equivalent. Whereas the strength of the earliest nuclear weapons was measured in kilotons (thousands of tons) later weapon yields ran to megatons (millions of tons). Most of the energy of a nuclear burst occurs in the form of an explosive blast wave; some of the energy is released in the form of heat and light comparable to the radiation of energy from the sun; a small percentage of the energy is given off directly in the form of nuclear radiation; and a fair proportion goes into the production of radioactive fission products, from which in turn emanate beta and gamma radiations over an extended period of time.

The fireball of a megaton-type explosion lasts over ten seconds, and the radiation emanating during at least the first part of this period precedes the blast wave in arrival at any point because the radiation travels with the speed of light—nearly 200,000 mi. per second—while the blast wave travels at a rate of approximately ½ mi. per second, or more than 2,000 m.p.h.

When a nuclear weapon is detonated well above the earth's surface its fission products are deposited in the stratosphere. The particles may encircle the earth many times before gradually drifting to the ground over periods of months or years. When a nuclear weapon is detonated close to the ground, the heat from the fireball vaporizes a portion of the earth's surface several hundred feet in diameter. These vaporized particles of earth and other debris contain trapped within them much of the released fission material. This mixture of powdered debris and fallout material rises to high altitudes with the heated surrounding air.

The damage effects of nuclear weapons may be considered in terms of effects on man and effects on inanimate objects. The principal blast effects on man are injuries caused by crumbling structures and by flying debris. The direct thermal effects on man are burns resulting from the heat of the fireball. Secondary thermal effects on man arise from fires that are ignited by the radiant heat of the blast, or that originate through such blast effects as overturned stoves or shorted electrical circuits. In some cases the fire may be caused by a combination of heat radiation and blast destruction. In general, the initial radiation emanating from the exploding bomb can be neglected because it causes few casualties that are not compounded by blast and thermal effects. However, fallout radiation can contribute a significant danger to man over hundreds of square miles downwind from the bursting point of the bomb and well outside the range of other casualty effects. Even noncombatant countries may be affected by it. The intensity of the fallout radiation decays with time, decreasing to one-tenth its original value in seven hours.

Nuclear radiation has little effect on inanimate objects, although the presence of radiation in the vicinity of a building can render it uninhabitable for some time. On the other hand, buildings are directly vulnerable to blast and to thermal effects. For large nuclear weapons, the area of fire destruction is expected to be several times the area of blast destruction.

With a ten-megaton explosion, wooden frame houses can be expected to suffer severe blast damage up to distances of about 6 or 7 mi. from the detonation point; and, in general, under nuclear-strike conditions (disrupted water mains, unavailability of professional fire-fighting equipment) this type of house can be expected to burn to the ground at any location within a radius of about 15 mi.

From a ten-megaton burst a man could expect to receive second-degree burns at a distance of about ten miles. A ten-megaton weapon with a 15-knot wind could cause sufficient radiation at points as far as 150 mi. downwind to kill half of all exposed persons in the area. Crops and animals would, of course, also be destroyed by nuclear bursts.

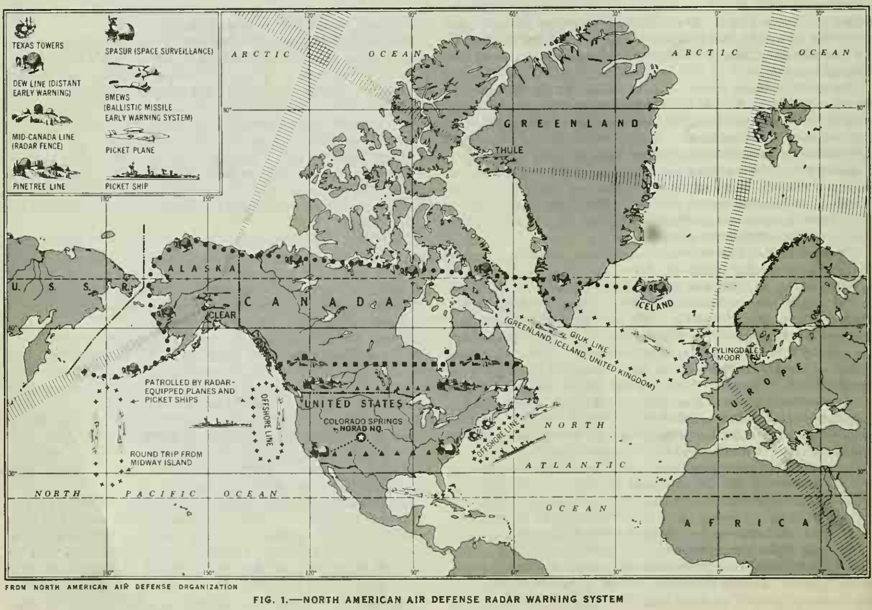
Civil Defense Measures.—The protective measures of civil defense may be considered in four categories: (1) measures taken during peacetime; (2) measures taken just prior to an actual attack; (3) measures taken during an attack; and (4) measures taken following an attack.

In the peacetime category the following are the most important: reinforcement of existing structures and provision of shelters within existing structures; construction of new shelters; construction of underground living and working quarters; reduction of fire hazards by the maintenance of general cleanliness and by the safe enclosure of stored combustibles; dispersal of cities by the removal of major industries to less populous areas; modification of building codes and of general urban planning to incorporate such features as increased structural strengths and fireproofing of buildings, duplicate and emergency public utility services, community shelters, and wide streets and adequate parks to provide firebreaks; stockpiling of first-aid materials and of vital resources; secure storage of important records.

Protection of property from the effects of extreme pressures and the protection of personnel go hand-in-hand, for a building that can withstand such pressures can also protect its occupants. A few specially reinforced windowless structures were built in the U.S. The Baltic countries, especially Sweden, placed a large proportion of their vital industry underground. No adverse effects on production or morale were reported.

Dispersal of facilities by erecting new industries or by moving existing industries a distance from the assumed aiming points has the ultimate effect of also dispersing population. Dispersal is restricted to nations with sufficient land area, such as the U.S. and the Soviet Union.

In the preattack period there are certain governmental measures and certain individual measures that may be taken. Some of the principal governmental measures are the sounding of a widespread alert and the declaration of a state of emergency. During this preattack period the government would continually advise the populace by every available means of communication. In the U.S. a special communications system known as Conelrad (control of electromagnetic radiation) was adopted to shut down all radio and television broadcast stations with the exception of certain AM stations which regulated their operation to deny electromagnetic


TEXAS TOWERS
SPASUR (SPACE SURVEILLANCE)
DEW LINE (DISTANT EARLY WARNING)
BMEWS (BALLISTIC MISSILE EARLY WARNING SYSTEM)
MID-CANADA LINE (RADAR FENCE)
PICKET PLANE
PINETREE LINE
PICKET SHIP
ARCTIC OCEAN
ARCTIC OCEAN
GREENLAND
THULE
ALASKA
U.S.S.R.
CANADA
CLEAR
ICELAND
(GREENLAND, ICELAND, UNITED KINGDOM) GIUK LINE
FYLINGDALES MOOR
EUROPE
PATROLLED BY RADAR-EQUIPPED PLANES AND PICKET SHIPS
OFFSHORE LINE
UNITED STATES
COLORADO SPRINGS NORAD HQ.
OFFSHORE LINE
ROUND TRIP FROM MIDWAY ISLAND
NORTH PACIFIC OCEAN
NORTH ATLANTIC OCEAN
AFRICA

FROM NORTH AMERICAN AIR DEFENSE ORGANIZATION

FIG. 1.—NORTH AMERICAN AIR DEFENSE RADAR WARNING SYSTEM

navigational aid to approaching enemy aircraft. To an aircraft navigator the radiation intensity pattern observed from an isolated identified station under normal conditions can be employed as a beacon; however, the pattern observed from the collective Conelrad transmissions is too broad to be useful in the same manner. The scheme could be particularly effective against aircraft carrying kiloton bombs. However, the advent of ballistic missiles, megaton bombs and dependable alternative navigation methods cast doubt upon its value as a passive defense measure, particularly in view of the reduction in coverage of broadcast advice to the public that it entails.

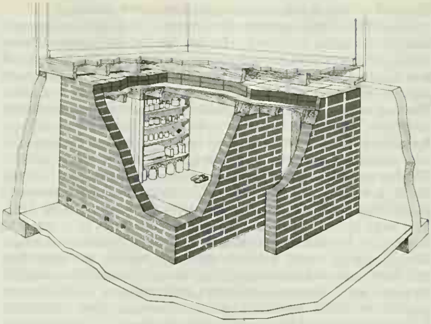
Another passive defense proposal was the employment of oily smoke over cities as a means of attenuating the radiant thermal energy from a nuclear fireball. This technique, called TRAC (thermal radiation attenuating clouds), required a warning period longer than might be available; hence, the concept did not gain wide acceptance.

For the individual, preattack measures include waking any sleeping members of the household; assisting sick and infirm persons; shutting off utilities; moving away from windows and other frangible items; gathering emergency supplies and rushing to the nearest structurally strong shelter; and being attentive to official advice.

During an actual attack, for persons who are fortunate enough to be inside adequate shelters, there is little further protective action that can be taken. It is probable, however, that for some individuals the first warning would be the brilliant light-and-heat flash from the fireball of an exploded weapon. For these persons, depending upon each individual's location at the time, the following alternative actions are available: falling into any convenient ditch or culvert; dropping to the floor of an automobile; or hiding behind anything that could serve as a blast-and-heat barrier. In the absence of any shielding, a prone body in contact with the ground offers less resistance to wind-drag forces than does an upright body; also, the prone body offers a smaller target for debris flying with the blast wave.

Immediately following an attack there are complex restrictions on measures that can be taken effectively. It is important that personnel rescue and first aid be executed as promptly as possible, for in many instances the saving of lives would be dependent upon the speed of action. However, such work would be hampered by the simultaneous requirement of fighting fires and by the general state of temporary shock induced by the unprecedented sudden destruction. Small blazes, unattended, could grow to continuing fires within about a quarter of an hour, and these, in turn, could merge into conflagrations shortly afterward. After the first hour or so, more than fleeting outdoor exposure to fallout by any living being could be exceedingly dangerous. It could force persons for tens of miles downwind from a ground burst to remain in shelters for days or possibly for weeks. Because of the anticipated high ratio of casualties to trained medical first-aid personnel, it has been proposed that emergency first aid be preceded by a classification of casualties into three groups: (1) too severely injured to be salvaged with existing facilities; (2) capable of survival with assistance from available facilities; or (3) able to bear their injuries without assistance. Treatment would then be confined to those in the second category.

Organization for Civil Defense.—In the U.S. civil defense exists at the national, state and local levels. The Federal Civil Defense act of 1950 created the Federal Civil Defense administration (FCDA). This act gave the FCDA extremely broad powers in time of war, but its peacetime activities were largely restricted to relaying the air-raid warning from the point of detection to the local level; conducting research on matters of interest to civil defense; developing and co-ordinating plans; training civil defense officials and volunteers; stockpiling certain critical equipment, such as medical supplies; and administering the "matching funds" program, whereby state and local civil defense organizations could obtain needed supplies at reduced cost. Seven civil defense regions (their boundaries corresponding roughly to the six U.S. army areas) were established for purposes of co-ordination; however, actual civil defense operations were to be at the state, county and municipal level.



FROM OFFICE OF CIVIL AND DEFENSE MOBILIZATION

FIG. 2.—BASEMENT CONCRETE-BLOCK FALLOUT SHELTER

The Office of Defense Mobilization (ODM) was made responsible for stockpiling critical materials, administering the program for the dispersal of vital industry, assessing potential in supplies and manpower, and applying electronic computers to determine what facilities might survive certain sizes and types of enemy attack. In 1958 the two offices, FCDA and ODM, were combined into the Office of Civil and Defense Mobilization (OCDM). In 1961 the department of defense was assigned responsibility for an expanded program to be carried out through its newly created Office of Civil Defense (OCD). To the OCDM (renamed the Office of Emergency Planning), under the executive office of the president, was assigned over-all co-ordination of the nonmilitary defense program.

In the U.S. the actual civil defense operations (rescue, fire fighting, first aid, radiation monitoring, etc.) are carried out by the normal branches of local government augmented by volunteers. This is also true to some extent in Britain and in Germany. Great Britain's four civil defense organizations, the Civil Defence corps, the Industrial Civil Defence service, the Auxiliary Fire service and the National Hospital Service reserve, enroll part-time, unpaid recruits, both men and women. These services divide among themselves the rescue and care of casualties and the homeless, the protection of offices and factories, fire fighting and nursing. They are supported by the warning and monitory organization, the Women's Voluntary Service for Civil Defence, the police, fire and ambulance services and the armed forces. In Sweden, Denmark, Norway and Switzerland training in civil defense is compulsory. Training in civil defense measures is also compulsory in the U.S.S.R., where the training doctrine is oriented toward chemical and biological as well as toward nuclear attack. In Canada, civil defense planning at the national level is an army responsibility. Operations, as in the U.S., are at the province and local levels. Many major nations (France and Italy, for example) have no civil defense laws or organizations.

Organizations created for ameliorating the effects of enemy action have also proved effective against natural disasters such as tornadoes and floods.

Civil and Active Defense.—Judging on the basis of appropriations of public funds in all countries, there is considerably more public support for active defense than there is for civil defense. One attractive feature of active defense is that while civil defense is aimed principally at saving lives, active defense can prevent losses of property as well. Any known weapons system, however, can be saturated; there is a limit to the number of aircraft that an air defense system can engage in a given period of time. If the number of attacking aircraft exceeds this saturation number, the remainder of the attack force will penetrate to the target city. Furthermore, unless the nuclear bomb is destroyed high in the air along with the aircraft, the explosion of the weapon upon contact with the earth could produce serious results. Most experts agree that civil defense is a necessary adjunct to active defenses.

Unsolved Civil Defense Problems.—Civil defense presents many challenging problems. In the missile era, short warning times preclude many civil defense measures, such as getting people into appropriate air-raid shelters. The behaviour of sheltered populations under extreme stress situations is largely unknown. The cost of an adequate civil defense is enormous, probably in the vicinity of $1,000 per sheltered occupant. The desire of military forces to keep secret the effects of new weapons and the desire of civil defense agencies to make these effects public are in conflict. The fire hazard from nuclear attack is largely unexplored; for example, a nuclear burst between an envelope of clouds above and snow below could increase the thermal effect (and resulting fires) by a large factor. There are inherent uncertainties as to when an attack may begin and when it may end. The detection of a fleet of approaching enemy bombers does not preclude the possibility of a simultaneous missile attack, nor does it preclude the possibility that enemy submarines may be lurking offshore, both alternate possibilities conveying threats with short warning times. Similarly, the explosion of a single nuclear weapon cannot be interpreted as the end of the attack for any specific area. More weapons may be in the offing at the very time that the desire to emerge from shelters to fight fires and attempt rescue work is at its peak. *See* also AIR DEFENSE; ATOMIC ENERGY; BIOLOGICAL WARFARE; CHEMICAL WARFARE; GREAT BRITAIN: *Defense: Civil Defense;* ROCKETS AND GUIDED MISSILES. (JO. BA.; T. J. WA.)

CIVILIS, GAIUS JULIUS (1st century A.D.), the Batavian leader of a rebellion on the Rhine frontier of the Roman empire in A.D. 69–70. He commanded a cohort of his own tribe and had been suspected of disloyalty by the party of Aulus Vitellius (*q.v.*) when the latter was acclaimed emperor in Jan. 69. Later that year Antonius Primus, a supporter of Vespasian (*q.v.*), urged Civilis to prevent German reinforcements from reaching Vitellius; Civilis therefore induced the Batavi, followed by German tribes across the Rhine, to attack the Roman legions. He secured control of all the country north of Vetera (near modern Xanten), and in that camp two legions were besieged for several months. Meanwhile Vitellius had died, but the revolt continued against Vespasian. It was joined by certain Gallic tribes, who proclaimed an *imperium Galliarum* under the *praefectus alae* (commander of the auxiliaries) Julius Classicus, a noble of the Treveri, Julius Tutor of the same tribe and Julius Sabinus of the Lingones. Vetera now fell, and was burned along with all Roman camps north of Moguntiacum (Mainz): some legionaries were forced to swear allegiance to the new regime, others were massacred. At this point, however, large Roman reinforcements arrived under Q. Petillius Cerialis who first entered Mainz and then won a decisive battle outside Augusta Treverorum (Trier). Civilis, Classicus and Tutor were gradually pushed northward and made their last stand on the Batavian "island" across the Vahalis (Waal) river. Finally Civilis came to a conference and was given terms apparently favourable to his countrymen; his fate is unknown.

Civilis' story is known only from the vivid account by Tacitus who attributes too much "barbarism" to the fighting methods and general outlook of a rebel who was himself a high Roman officer leading auxiliary troops of the Roman army. The movement clearly was a result of genuine dissatisfaction with Roman rule.

See Tacitus, *Histories*, books iv and v; H. Nissen, "Der Batavische Krieg," *Bonner Jahrbücher*, vol. 111/112, pp. 60–89 (1904); G. Walser, *Rom, das Reich und die fremden Völker in der Geschichtsschreibung der frühen Kaiserzeit*, p. 86 *et seq.* (1951). (G. E. F. C.)

CIVILIZATION AND CULTURE. The following article by James Harvey Robinson, which first appeared in the 1929 edition of the *Encyclopædia Britannica* under the title "Civilization," has been retained because of its interest as a statement of permanent value. For a discussion by later authors on the concepts of civilization and culture and a summary of modern views, see *Concepts of Civilization and Culture* and *Culture and Humanity* below. (X.)

This encyclopaedia is in itself a description of civilization, for it contains the story of human achievement in all its bewildering developments. It shows what men during hundreds of thousands of years have been learning about themselves, their world and the creatures which share it with them. They have reached out into remote space and studied nebulae whose light reaches them after a million years; they have, on the other hand, dissected atoms and manipulated electrons as they might handle pebbles. In the present magnificent series of volumes man's inventions are reviewed from the rudest chipped flint to the most delicately adjusted microscope; his creation of multiform beauties of design, colour and word, his ways of dealing with his fellows, his co-operations and dissensions; his ideals and lofty aspirations, his inevitable blunders and disappointments; in short, all his gropings, disheartening failures and unbelievable triumphs are recalled.

Several thousand contributors have been brought together to do each his special part in writing millions of words on what mankind has hitherto done and said. It might therefore seem at first sight superfluous, and indeed impossible, to treat civilization itself as a separate topic in a few pages. But there is danger that owing to the overwhelming mass of information given in these volumes certain important underlying considerations may be lost sight of. There are highly significant questions concerning the nature and course of human development, the obstacles which have lain in the way of advance; the sources of success and frustration, which could hardly be brought together in dealing with any of the special aspects of human culture. Accordingly an attempt will be made under this caption to scan civilization as a single, unique and astonishing achievement of the human species.

To begin with, it is a startling fact that civilization, which sets off man in so astounding a manner from all other animals, should only lately have begun to be understood. We are immersed in it from infancy; we take it for granted, and are too near it to see it, except in this detail and that. Even today, with all our recently acquired knowledge, those who strive most valiantly in imagination to get outside civilization so that they may look upon it dispassionately and appraise it as a whole, are bewildered by its mysteries. As for the great mass of intelligent people, they still harbour many ancient illusions and misapprehensions from which they can only be weaned with great reluctance.

The object of the present article is to describe the newer ways of viewing civilization, its general nature, origin, progress, transmission and chief developments, in the light of information which has been accumulating during the past 50 or 60 years. The study of man himself has been revealing quite as many revolutionary facts and hypotheses during the past half century as the scientific investigation of the world in which he lives. The history of human achievement has been traced back, at least in vague outline, hundreds of thousands of years; man's original uncivilized nature and equipment have been studied and compared with the behaviour of his nearer relatives; new conjectures have emerged in regard to the functioning of speech and the nature and origin of human reasoning; careful investigations of primitive civilizations have cast great light on more complicated ones; the tremendous importance of childhood and its various implications in the development of civilization have been elaborated.

These and many other discoveries conspire to recast our conception of civilization, its past progress and its future possibilities.

It is instructive to note that the word civilization is by no means an old one. Boswell reports that he urged Johnson to insert the term in his dictionary in 1772, but Johnson refused. He preferred the older word "civility." This, like "urbanity," reflects the contempt of the townsman for the rustic or barbarian; it is an invidious term, although in a way justified by the fact that only where cities have grown up have men developed intricate civilizations. The arduous and dispersed tasks of the hunter, shepherd and peasant folk do not afford the leisure, or at least the varied human contacts, essential to the generation of new ideas and discoveries. But modern anthropologists have pointed out that peoples without cities, such as the tribes of Polynesia and the North American Indians, are really highly "civilized," in the sense that upon sympathetic examination, they are found to have subtle languages, ingenious arts, admirably suited to their conditions, developed institutions, social and political; religious practices and confident myths, no better and no worse substantiated than many that prevail today among the nations of Europe. All these betoken and presuppose a vastly long development. Among English-speaking people the first to point this out clearly was E. B. Tylor, who published his famous *Primitive Culture* in 1871, the same year in which Darwin's *Descent of Man* appeared. These two books would alone have served, by different approaches, to give the word civilization a far more profound meaning than it had ever had before.

New Conception of Civilization.—There could be no real understanding of the fundamental characteristics of civilization until the fact was well established and digested that could we trace back man's lineage far enough we should find it merging into that of wild animals, without artificial shelters, clothes or speech; dependent for sustenance on the precarious daily search for food. It requires a considerable effort of the imagination to picture the human race without these seeming necessities of even primitive civilization. Without fire and tools men must have existed as did a wild girl discovered near Châlons-sur-Marne, France, in 1731. She possessed a monkeylike agility which enabled her to catch birds and rabbits; these she skinned with her nails and gobbled raw, as would a dog. She delighted to suck the blood from living pigeons, and had no speech except hideous screams and howls.

This conception of man's former animal existence is gradually supplanting the older one, based upon ancient Hebrew tradition, that the first man and first woman were special creations with fully developed minds, speech and reason, which enabled them forthwith to dress the garden in which they found themselves, to name its animal denizens, and to talk with one another, and with God himself in the cool of the evening.

The former assumption was that man was by nature endowed with a mind and with reason. These distinguished him sharply from the animals, which did wondrous things it is true, but not as a result of reason. Their behaviour was guided, it was argued, by instinct. Darwin says that "the very essence of an instinct is that it is followed independently of reason." But if we agree, as manifold evidence seems to force us to do, that long, long ago men behaved and lived like wild animals, are we not forced to ask if they did not live wholly according to what Darwin calls instincts? And if once upon a time our ancestors lived solely by their animal equipment, did they as yet have a mind and reason? May not the human mind be something that has very gradually developed as a result of man's peculiar animal make-up and capacities? May not his reason be but another name for his slowly accumulated knowledge and beliefs and his ways of dealing with them and building upon them? In any case the discovery that our ancestors once lived like wild animals raises entirely new and difficult questions as to the nature, origin and interpretation of those powers of his known as mind and reason, which have enabled him to seek out those inventions and come upon beliefs and practices which have produced in the aggregate civilization.

In short, it seems to be more and more apparent that mind and reason were not part of man's original equipment, as are his arms and legs, his brain and tongue, but have been slowly acquired and painfully built up. They are themselves inventions—things he has come upon. Like other inventions they are part and parcel of civilization—not innate in man but dependent for their perpetuation on education in the widest sense of that term. This is so novel an idea that many readers may find it difficult to grasp, but when grasped it alters one's whole estimate of human progress. We ordinarily think of civilization as made up of mechanical devices, books and pictures, enlightened religious ideas, handsome buildings, polite conduct, scientific and philosophical knowledge, social and political institutions, ingenious methods of transportation and the rest. We think that all these things are due to man's possession of a mind, which no animal has, and as a result of the exercise of reason. In a way this is true enough, only we must reconceive mind and reason and regard them just as truly a part of the gradual elaboration of civilization as a house of commons or a motorcar, and quite as subject to improvement. At the risk of a seemingly irrelevant philosophical digression, which is really essential to a modern understanding of civilization, something may be said of the newer conception of mind and its variant, reason.

The word mind was originally a verb, not a noun; it meant action, not a thing or agent. It was remembering and purposing, and taking note of—as for instance "I minded"—that is, remembered, or paid attention to, or was concerned by. But as time went on philosophers made a noun of the good old verb. It was conceived as that incorporeal substance which was the seat of a person's consciousness, thoughts, feelings, and especially of his reasoning. The body was set over against the mind whose orders it was supposed to execute. The Scottish philosopher of common sense, Thomas Reid, says explicitly that "we do not give the name of mind to thought, reason or desire; but to that power which both perceives and wills." Even John Stuart Mill says in his *Logic* that "mind is the mysterious something which feels and thinks."

Recently there has been a tendency to reduce the noun mind once more to a series of verbs—desiring, remembering, feeling, thinking, distinguishing, inferring, planning—and to regard the assumption of "a mysterious something" as unfounded, unnecessary and a serious embarrassment. Relieved of this embarrassment it is possible to begin to bridge the gulf between the original behaviour of the human race and that of mankind today. Descartes and all the older philosophers believed that man had always had a mind as good as theirs. They sought to tell him how to employ it in the pursuit of truth. Mind was to them a sort of divine instrument, conferred solely upon man, that could be sharpened and efficiently used by following the laws of logic; but they could not think of it as something accumulated, so to speak, through the many thousands of years since man made his first contributions to the upbuilding of civilization.

The way is now cleared for a new view of civilization which would not have been possible 50 or 60 years ago. Civilization is no longer contrasted with "rusticity," "barbarity" or "savagery," but with man's purely animal heritage. Modern men are still animals, they have to eat and sleep, protect themselves from the inclemencies of the weather, and defend themselves from attacks of their fellow creatures and other animals, and to rear a new generation, if the species is to be perpetuated. They closely resemble kindred animals in much of their physical structure, in their important organs, breathing, digestion and the circulation of their blood. All these peculiarities are hereditarily transmitted no matter how much or how little men may be civilized. On the other hand, civilization—language, religion, beliefs, morals, arts and manifestations of the human mind and reason—none of these can be shown to be handed down as biological traits. They can only be transmitted to a new generation by imitation or instruction.

All mankind today has a double heritage. The one comes to us without any effort on our part, as do the spider's peculiar characteristics or those of birds, or of any of our fellow mammals, come to them. It is secure and tends to remain the same for thousands of years. Civilization, on the other hand, is precarious; it must be assimilated anew by each one of us for himself in such a degree as circumstances permit. It can increase indefinitely but it may also fall off tremendously, as the history of man amply testifies. It is a legacy that can be lost as well as kept and increased.

To illustrate: it may be that before human beings had acquired any of this losable thing, civilization, they would pick up a stick to strike an assailant or hurl a stone at him. They might have found themselves riding astride floating tree trunks to cross a stream. Certain persons would occur, let us say, in each generation who would do all these things without ever having seen them done. These acts would be classed in man's animal heritage. But should we find traces of men who chipped a flint nodule into a hatchet head, and hollowed out their log with such a hatchet, or with fire, we should have to class these acts among the arts of civilization since they presuppose so much accumulated experience and ingenuity that they could not be inborn. The art of making a rude boat might consequently be wholly lost, as surely many inventions must have lapsed, if a single generation passed without constructing one.

It seems now an imperative fact that all civilization—the total social and traditional heritage—would fall away immediately and completely should a thoroughgoing forgetfulness, an overwhelming amnesia and profound oblivion overtake humanity. Only their natural equipment would be left. As Graham Wallas suggests, those least civilized would have a possible chance of surviving. It is only uncivilized man that might go on indefinitely. We are all by nature wild animals plus; and our taming weakens us for the ancient struggle in the forest, naked and barehanded.

Peculiar Items of Man's Bodily Form.—At this juncture the question arises, what was there peculiar in man's physical make-up that enabled him to initiate civilization and build up a mind which he could use to increase his resources so far beyond that of any other animal? Before proceeding we should recollect that the ways of all living creatures are manifold and astonishing. Even a single-celled organism can marvellously adjust itself to altered conditions. It seems to learn by experience, it appears to have a sort of memory, it is modified by happenings which interrupt its comfortable routine. It is ingenious in defending itself, in seeking food and reproducing. It is, in short, purposive in its conduct. The tiger and the frog are able to adjust themselves to very different modes of life, and so are the orioles and cacti. Before man began to accumulate civilization we are forced to assume that he too made terms with the daily need of adjustment which faced him, otherwise we should not be here to write the tale. These are the salient essentials of life, and man is a part of what Julian Huxley calls "the stream of life." All these possibilities lay behind the development of man's intelligence. They are the hinterland from which civilization emerged and to which it ever tends to retreat.

In order to begin and carry on the accumulation of civilization, man had of necessity to be so constructed physically that he could perceive more clearly than his predecessors, make more accurate distinctions and so remember and imagine better; for all these are essential to talking and thinking. The awareness of animals is of a low, vague type, and so must pristine man's have been. The one-celled animals behave in a purposive way, but they have no eyes or ears or noses. They must live in silence and darkness like a human blind deaf-mute. They will nevertheless take in certain food and reject other things. They perceive and act without, so far as we can see, being conscious of their actions. They make the necessary decisions without deciding in a human sense. They have no nervous system, but, as has lately been discovered, the promise of one. The creatures most like ourselves have eyes, ears and noses, and evidently see, hear and smell; and they have an elaborate nervous system. Of these resources they make constant use. But compared with man they are ill-qualified to make careful distinctions and discriminations and remember clearly. They take note of far fewer factors in their situation. They must act somewhat as our digestive system does. It is a sort of animal within us which performs wondrous feats when given food. It works purposively, as do our heart and blood circulation. We can become conscious of these unconscious achievements when we choke, because the switch is not thrown promptly enough to prevent a morsel from going down our windpipe instead of taking the route to the stomach. Palpitation of the heart is a conscious suggestion of the faithful pump, which rarely reminds us of its constant attention to business. Let it neglect two or three beats and we are dead.

The essentials of man's physical equipment for initiating and piling up civilization have been dwelt upon by many writers. He has sensitive hands, and (after he got securely on his hind legs) he could use them far more freely than if he had to employ them as auxiliary feet. His thumb can be readily placed against any one of his fingers. There is no such expert feeler and handler as he to be found among his kindred. He could learn much of shape and form, of softness and hardness, of weight, texture, heat and cold, toughness, rigidity and flexibility, which could be but vaguely sensed with hoof or paw. Had he had ears that he could turn about like a jack rabbit, and a prehensile tail, he might have been able to learn faster. And all these things were the beginning of knowledge. He could not only strike but hurl. His eyes were so placed that he was always looking through a stereoscope, so to speak, and seeing things in the round. His vocal organs promised a great range of delicate discrimination in the sounds he made. Then he was a helpless dependent for many years on his elders so that their acquired ways could become his.

Lastly there is man's brain with its complex cerebral cortex and its association paths, which develop astonishingly as a child grows up. The cortex is the prime correlator of impressions, and is modified through individual experience in a higher degree than any other part of the nervous system. Its functioning is still very mysterious, but no one doubts its essential role in the process of human learning and the increase of intelligence. Its operations are not, however, autonomous but closely associated with the experiences of the whole human organism and dependent on those singular capacities of mankind already mentioned.

So it becomes apparent that after hundreds of millions of years during which nature's experiments have been going on in physical structure and function, which have enabled creatures of the most diverse types to meet the absolute requisites of life—growing up and reproducing their species—a kind of animal finally appeared on the earth so constructed that he could become civilized. Man's biological make-up represents a unique combination of physical characteristics. Most of these, as we have seen, occur in other mammals. Even those which seem peculiar to him would not serve, however, as a foundation for the development of civilization except in a highly complex union. Cows might have a human cerebral cortex, foxes apposable thumbs, birds stereoscopic eyes, dogs vocal organs similar to ours, and yet civilization would be far beyond their reach. Man can teach all of them tricks. They themselves can learn something as their life goes on. Chimpanzees may under favourable circumstances make very simple, humanlike inferences; but none of them could initiate and perpetuate the arts and sciences as a heritage of their species.

Progress and Conservatism.—Such then was man's original equipment for getting civilized. He had, obviously, no means of foreseeing the enterprise in which he was engaged. His evolution as a civilized being was no more premeditated than his rise from earlier simian ancestors. There seems to be sufficient evidence that for hundreds of thousands of years changes in his mode of life were so gradual and rare as to pass unperceived. Each generation accepted the conditions in which it was reared without thought of betterment. Our modern hope of "progress"—an indefinite increase of human knowledge and its application to the improvement of man's estate—was practically unknown even to the Greeks and Romans. From the 13th century onward a few writers dwelt upon the promise of the future, but they were outclamoured by those convinced that human woes were attributable to a departure from ancient standards. The humanists strove to re-establish the wisdom of the classical writers, and the Protestants sought to revive the beliefs and practices of the early Christians. Only three centuries ago did Bacon unroll a program of aggressive search for the hitherto unknown, which had any very wide influence. In the 18th century the conception of reform and progress found illustrious spokesmen, and their anticipations of coming changes in the economy of human life were destined, as it proved, to be far outrun by the events of the 19th and early 20th centuries.

We can, however, still note on all hands illustrations of man's confidence in routine sanctified by ancient authorities; his suspicion of innovation in wide realms of belief and practice. This dogged obstinacy in clinging to his habits, and his general suspicion of the unfamiliar, are exactly what might have been anticipated when we consider his animal origin. This trait has served to slow down the process of change, but at the same time has greatly increased the security and permanence of each achievement. Here we find a possible explanation of the great role that the veil of sacredness has played in man's development. He has cast it over beliefs and practices and so hid them from pert scrutiny and criticism. The number of those who can tolerate somewhat critical thinking here and there, has, nevertheless, greatly increased of late, but they are still few indeed. What we call today a conservative or reactionary mood must have been characteristic of mankind from the beginning. It corresponds to animal inclinations.

Among animal proclivities there is, however, from the one-celled organisms upward, a lifesaving tendency to make random movements, extensions and contractions, to hasten hither and thither, in the pursuit of food and mates. This restlessness and groping are among man's legacies also. They offset his routine and static habits, and lie behind and back of the inventions and discoveries he has made. There is, too, especially obvious among the higher animals, something auguring what in man becomes curiosity. The danger of attack made preliminary scouting a valuable asset in survival. So men were by nature wont to pry and try and fumble, long before they scientifically analyzed and experimented.

There can be no doubt that hundreds of thousands of years were required for man to reach even the lowest degree of culture to be found among the simplest tribes today. The discovery of fossil skulls, teeth and bones at different geological levels shows that more or less apelike men have been on earth for from 500,000 to 1,000,000 years. Several species, such as the Java man, the Heidelberg man and the much later Neanderthal race are now extinct. The only vestiges of their handiwork consist in chipped flint tools, becoming better made and more varied as time went on. There is no way of telling what other arts, beliefs and practices were associated with a particular assortment of flint utensils. William Sollas, in his *Ancient Hunters*, sought to draw ingenious analogies between these prehistoric weapons and the civilizations of the Tasmanians, Australians, Eskimos, etc.

The so-called Cro-Magnon race had finely developed skulls quite as good as those of today. To them are ascribed the remarkable paintings and drawings found in caves of southern France and northern Spain. They are believed to be from 25,000 to 30,000 years old. Halving this period we come upon traces of ground and polished stone tools, coincident with the relinquishment of hunting as man's exclusive pursuit and a settling down to sow and reap, spin and weave. Halving it again, we get news of the use of copper, the precursor of the metals on which our civilization largely rests. This can but be a rough chronology subject to much revision as time goes on and the earth is more thoroughly searched for evidences of man's past.

To get the matter clearly before one, let us imagine, as the writer has suggested elsewhere, that 500,000 years of developing culture were compressed into 50 years. On this scale mankind would have required 49 years to learn enough to desert here and there his inveterate hunting habits and settle down in villages. Half through the 50th year writing was discovered and practised within a very limited area, thus supplying one of the chief means for perpetuating and spreading culture. The achievements of the Greeks would be but three months back, the prevailing of Christianity, two; the printing press would be a fortnight old and man would have been using steam for hardly a week. The peculiar conditions under which we live did not come about until Dec. 31 of the 50th year.

There is a school of anthropologists, the diffusionists, who would derive all the higher types of civilization—writing, metallurgy, the construction of imposing stone buildings—from a single region, Egypt. They have collected much evidence to show that through the commerce of the Phoenicians, Egyptian inventions spread eastward into India, China and Japan, then across the Pacific to form the basis of Maya culture in Central America. The merits of the "diffusionist" arguments cannot be considered here. G. Elliot Smith, one of the best known advocates of this theory, dwells on the common lack of inventiveness and the reluctance of mankind to adopt new ideas, his tenacious hold on old ones and "his thick armour of obstinacy." "To obtain recognition of even the most trivial of innovations it is the common experience of almost every pioneer in art, science or invention to have to fight against a solid wall of cultivated prejudice and inherent stupidity."

All anthropologists are well aware of this hostility to change, which we may regard, as shown above, as a natural trait of mankind. They also admit the wide dissemination of inventions through commerce and conquest. Nevertheless many maintain that the same or similar discovery has been made independently in different parts of the earth, as the result of similar needs and conditions. When we have examined the exigencies of successful inventions in the following section we shall see that however commonplace they are now, with the accumulation of the past to build upon and modern facilities to work with, they were beyond measure difficult at the start when mankind still led the life of an animal. When once made and adopted by some tribe it is far easier to think of them as being introduced to other peoples than to assume that their presence represents an independent discovery.

Civilization depends upon the discoveries and inventions man has been able to make, together with the incalculable effects these have had upon his daily conduct, thoughts and feelings. As knowledge and ingenuity increased he departed further and further from his original wild animal life. The manner in which he began to learn is a matter of conjecture, since the manufacture of tools and weapons, the invention of language and artificial ways of producing fire far antedate any written accounts of advances in man's education. The same may be said of the much more recent spinning, weaving and farming. As we have seen, it required hundreds of thousands of years to reach the degree of civilization represented by these achievements. Their importance, however, cannot be overestimated, since they formed the absolutely essential basis of all later developments. We may feel a certain pride in contemporary inventions, but let us remember that we owe to savage hunters and illiterate neolithic farmers the accumulation of knowledge and skill without which none of our modern experimentation would be possible. Where would we be without fire, speech, clothes and bread!

Since invention, discovery and the increase of knowledge are the stuff of which civilization is made, it is pertinent to our theme to consider how they occur. There is plenty of evidence available in the reports which discoverers now make of the manner in which they reach their conclusions. There is also evidence of how their results are received and acted upon by others. All explorers must be exceptionally curious and at the same time patient gropers. The curiosity observable in most children tends to die away, but survives in one form or another in rare instances through life. These exceptional persons possess a drive alien to their fellows. They may be the handyman of a village or a member of a highly endowed research staff. They avail themselves of what has already been found out; the village mechanical genius does not have to invent a monkey wrench or bit of insulating tape, nor does the biologist need to know much about the optical principles of his lenses, much less invent or manufacture them. The geologist before he makes any discoveries is familiar with hundreds of treatises on his subject. It would be generally conceded by investigators that their discoveries are seemingly accidental. They do not know what they are going to find, and quite commonly find what they were not looking for, even as Saul, chasing lost asses, came upon a kingdom. All this applies to every kind of increase of knowledge, whether it have to do with the operations of so-called nature or with novel suggestions in the realms of philosophy or art. All are the result of curiosity, patient examination and thought. At best they are no more than footnotes and glosses added to existing human knowledge. This is now so varied and voluminous that no single person can compass it except in this detail and that. Should he attempt to do so, all chance of adding to it would be excluded.

But an invention or discovery or the rectification of an ancient error does not become a part of civilization until it has been accepted by the tribe and been added to its habits of action and thought. Plenty of shocking tales could be recalled of professional and popular opposition to innovations on grounds which now seem grotesque. We owe discoveries to individual men and women, but new information and skill can only be propagated and disseminated in a favourable culture medium. Many instances could be cited of promising knowledge which has so far failed to get a footing in civilization.

The influence of particular discoveries and mechanical devices is by no means confined to their more immediate and obvious applications. It is impossible to foresee what wide-ranging effects they may ultimately exert on human life. Fire will cook a meal, harden an earthen bowl, keep a group of naked savages warm, frighten off prowling animals, soften or melt metals; it may also consume sacrifices to the gods, or form the central interest of a stately temple and be replenished by an order of vestal virgins. It may play its part in the symbolism of the theologian and the poet. The Indians of the North American plains were deeply affected by the introduction of the horse, and African tribes by firearms and whisky. The motorcar and telephone altered social relations. The perfecting of the steam engine revolutionized the transport of men and their wares; it promoted city life; further, it caused Marx to write a big book which became the gospel of a momentous social upheaval, which threatened the peace of mind of all nations.

The invention of clothes—quite material things, whether of linen, wool, silk or cotton—not only created great industries but enabled men by changing their hide artificially to establish social distinctions akin to biological genera and species. Through clothes entered in prudery and the pious horror of bare bodies which has wrought consternation and disaster among the dark-skinned folk. After World War I women's skirts were gradually shortened. The warmth of houses and vehicles permitted this. One of the conventional distinctions between girls and women was thus obliterated. The unveiling of women's faces in Islamic countries, the breaking down of purdah in India—all these material changes imply modifications of woman's life and of the attitude of the sexes to one another. They forecast further important changes in traditional civilization.

In view of these facts, and indefinitely more that each one can easily add for himself, it would seem that what are esteemed the "nobler" aspirations and creations of mankind, whether in art and literature or the pursuit of truth, are all not only dependent upon "material" inventions but so strangely interwoven with them and their effects that it is no easy thing to separate the higher and the lower, except in imagination. What is sometimes called "the higher life of man" arises from his more humble and practical knowledge and skill; accordingly the old distinction between the material and spiritual seems to be greatly attenuated as they are both seen to merge into the newer conception of civilization as a whole. This will become even more apparent when we come to deal with words.

Role of Childhood.—One of the essential conditions for the perpetuation of civilization is the long period of dependence through which the human child must pass before it gains sufficient bodily strength and intelligence to achieve merely animal self-sufficiency and make its own way. Without the constant and prolonged succour of adults it would speedily perish. This means that the extended period of helpless susceptibility to his surroundings makes it possible vastly to modify a child's original disposition. A mouse is sexually mature in six weeks and fully grown in three months. Calves and colts walk about shortly after birth. The gorilla, on the other hand, has a prolonged childhood, requires 10 or 12 years before it is able to breed, and goes on growing, like man, for a few years after. He lacks, however, in spite of his prolonged childhood, the other essential traits which have enabled mankind to initiate, increase and transmit civilization.

We are all born uncivilized and would remain so through life were we not immersed in civilization. There is a long time in which we may, according to the place where we are born, be moulded into a well authenticated Papuan, Chinese or Parisian. We cannot choose whether we shall find ourselves talking like a Hottentot, a Russian or a German. And we learn to do in all things as those do among whom we are brought up. We cannot but accept their respective customs, scruples, and ideas, for all these are imposed upon us before we have any choice or discretion. We must perforce follow the ways of our elders, who themselves were once children and gained their civilization before any discrimination or comparison with other than the prevailing habits was possible. This is the inexorable rule, and it accounts for many of the striking characteristics of civilization.

If the assimilation of culture is closely associated with the dependence and adaptability of childhood there need be no great surprise that accumulating evidence seems to indicate that when bodily maturity is once reached, the increase of knowledge and intelligence slackens or even almost ceases in many cases. By 13 or 14 the child has acquired an overwhelming part of the knowledge, impressions, cautions and general estimates of his fellow creatures and the world in which he lives, which he continues to harbour with slight modifications during his lifetime. When as a result of the participation of the United States in World War I it became necessary to test the competence of a great number of young men an unforeseen contribution was made to our insight into civilization. Of the 1,700,000 examined, 45% did not show themselves (to quote an eminent authority, Henry H. Goddard) "much above the 12-year-old limit." Those tested, it must be remembered, did not include idiots or "morons," but the average run of youths accepted by their fellows as normal. While tests may be as yet inadequate they but confirm the observable fact that the inculcation of culture is associated with bodily growth and especially with the strange changes in the cells of the forebrain and their intercommunications. These developments are tremendous from infancy to maturity in so-called normal cases.

Only in exceptional instances does mind building continue steadily after childhood and adolescence. We have had time before 13 to take over the standardized sentiments of our elders, to learn all that they know, to accept their views of religion, politics, manners, general proprieties and respectabilities. The common run of mankind can, however, be taught tricks as time goes on and acquire special expertness. But a great part of our childish conceptions retain a permanent hold on us. There is usually little encouragement to alter them. We leave most of them unrevised, though we have to make adjustments as the years elapse. Human beings seem on the whole easily subdued to routine and the routine is established, as it would seem, by the time we are grown up. That the ability to learn, however, falls off very slowly after adulthood was shown by E. L. Thorndike.

The experts in advertising, the publishers of "tabloid" newspapers and the contrivers of moving-picture films seem to conform to the supposition that what appeals to a 12- or 13-year-old child is admirably adapted to the intelligence and tastes of the multitude. This means that the overwhelming majority of men and women assimilate in childhood the common and familiar forms of civilization or culture in the midst of which they find themselves, but hardly outrun them as life goes on. Perhaps one in a hundred may allow his opinions to be altered by assiduous reading, or take pains to cultivate his insight into art and literature and scientific discoveries. But all these and other contributions to one's personal civilization are outside the range of the human animal in general. Indeed the mere upkeep of our present complicated culture must depend upon a very trifling percentage of the population. Were a few thousand carefully selected infants in the various progressive countries of the world to be strangled at birth not only would advances in industry, arts and letters cease but a decline would set in owing to the lack of those to make the essential readjustments in our industries and their financing; to keep up laboratories and books at their present standards. Accordingly the great majority of human beings can barely maintain at best the civilization in which they were reared. Even the innovators considered above are unable to escape from the toils in which they were so easily enmeshed and which they regard not as entanglements and restraints but as comforts and assurances. It would be faithless and disloyal to regard them otherwise. Only peculiar temperaments under highly favourable conditions question what they have been taught. They can do this only on a most modest scale as a result of continued curiosity and study. A physicist may reach a new theory of the constitution of atoms and yet cling stolidly to the notions of religion he had acquired at ten years of age; he may even engage in subtle philosophical speculation and remain a hot defender of the mores of the most commonplace persons 50 years ago.

If these points be well taken the whole contrast between society and the individual which has been played up in various rather futile ways takes on a new aspect. From the standpoint of civilization each individual owes his entire equipment as a civilized being to others. Biologically even, he is vastly modified by his domestication, in habits, impulses and moods. The so-called "instinct of the herd," which William Trotter has made famous, tends to become an unnecessary hypothesis. For every child is made by others in their own image. How gregarious mankind was before the onset of civilization it is impossible to say; but the prolonged infantile weakness implied multiform dependence upon others. Of course there is really no such thing as society in the sense of some powerful and precious personality for whose welfare the so-called individual is invited to make appropriate sacrifices of personal preferences. What we have to do is to make terms with the notions of "the good" and "the bad" which those profess with whom we are thrown. These rules of conduct and sentiment constitute society. They have their heavy sanctions if violated or impeached—disgrace, persecution, imprisonment and even death. The methods of eluding society constitute a highly interesting chapter in the history of civilization. It is not difficult for the shrewd, and seems greatly to enrich life for certain temperaments, whether one be a burglar, a storyteller or a philosopher. Wholesale deceit has established the reputation and fame of many a hero from Jacob and Ulysses to those in high places today. Boldness of thought is less likely as yet to arouse primitive enthusiasm.

Words Viewed as Deeds.—One of the most stupendous elements in civilization has hitherto been only casually mentioned—words. Without language civilization could hardly even have begun and certainly could never have attained its higher forms. Speech underlies thinking and conscious planning and research. It does more. It creates a world of ideas which interpenetrates and seems to transcend that of the facts of human experience. What pass for facts are indeed so moulded by our notions of them that recent philosophers are less and less confident in their efforts to separate the functioning of ideas from that of facts. Much has been discovered of late which serves to revolutionize the older theories of language and thinking, and to eliminate some of the agelong quandaries in which philosophers have found themselves involved. These new views can be only briefly suggested here.

The Fourth Gospel opens, "In the beginning was the Word; . . . All things were made by it; . . . In it was life; and the life was the light of men." Goethe declared that in the beginning was the deed. The most recent writers who deal with speech would seek to shed new light on civilization by recognizing that words have always been deeds. They have always been regarded as wonder-working acts; they create things which without them could never exist; they are the chief light of man—and his darkness as well.

Making noises is a conspicuous animal trait. Katydids, frogs, whippoorwills, dogs, and many other creatures exhibit a tireless patience in this matter. Man, too, is a great chatterer. His fellow men may be bored by his talk, but they are likely to be scared by his silence. It is portentous and bodes no good. To keep still is an unfriendly act. So, as Bronislaw Malinowski pointed out, one of the many functions of utterances has been reassurance and the expression of companionability. The cries of animals as related to their needs and behaviour are only just beginning to be carefully studied. Whitman and Craig discovered a marvellous correlation between the ejaculations of pigeons and their ways of life. Others studied our nearer relatives. But all that needs be noted here is that human language must have emerged from the spontaneous sounds made by preman.

Only when men began to make pictures of events and gestures, and painfully developed writing from the pictures, have we the least actual evidence of language. The Egyptian inscriptions illustrate picture writing and its later and most ingenious metamorphosis into sound symbols—an alphabet. This happened 5,000 or 6,000 years ago. But it is clear from the Egyptian language that its surprising complexity and sophistication imply an antecedent development of incalculable length, to judge from the slowness of man's material inventions.

While the beginnings of language are hidden from us by the lapse of hundreds of thousands of unrecorded years, there are several new ways of coming to a far better understanding of them than hitherto. There are historical and contemporaneous sources of information which have been exploited of late and serve to revolutionize the older views. For example, the so-called primitive languages (until recently, never reduced to writing) afford a sufficient proof that words are fundamentally acts, closely related to man's other conduct. Then, watching the way that babies—the Latins aptly called them *infantes*, or speechless creatures—learn to talk greatly re-enforces and corroborates the evidence derived from the study of "illiterate" tribes. Lastly, anyone who has learned the trick can substantiate the same thing if he tests the babble always going on around him.

We have already noted one way in which speech is a mode of action, a friendly gesture, not an expression of thought or conveyance of ideas as philosophers have taught us. "How do you do?" is not a question to be answered under usual circumstances. One concurs in the obvious statement, which conveys no fresh information, "Fine day, sir." These are just tail waggings, like taking off one's hat, bowing, smiling and handshaking. We can, however, do far more with language; we at times can strike with a word more safely and more effectively than with our fist; by words we can cower and dodge and elude danger. Those in highest standing in all communities make a living by words, unwritten and written. Whole professions confine their activities to words, —clergymen, teachers (of the older type), lawyers, politicians; brokers deal in alternately saying "buy" or "sell." Doubtless other things lie behind this trafficking, but words are effective acts, or so intimately intertwined with them that it is impossible to say where one sets in and the other ends. Pure talk and written words seem often to do the business without the intervention of so-called things. The magic operations and achievements of words can be observed everywhere and in all ages. Jacob and Esau struggled bitterly to win a blessing from their blind old father. His words were momentous. They might cause unborn generations to bow down before his son's offspring or doom him and his children to perpetual slavery.

As a clergyman of the 18th century remarked, "Words have a certain bewitchery or fascination which makes them operate with a force beyond what we can naturally give account of." Joy and infinite woe follow in their train; from which our wordless ancestors must have been spared. The main emotional structure of civilization—so poignant and so unique an element in human life—is largely reared on words. They serve to establish new orders of sensitiveness and excitability. Words increase the clarity of our memory to a tremendous degree and at the same time they vivify imagination, which could exist on no considerable scale without them. With these word-created adjuncts we can elaborate our hopes, fears, scruples, self-congratulations, jealousies, remorses and aspirations far beyond anything that seems justified to the onlooker; we can project them backward into the past and forward into the future. Words can rear more glorious palaces and dig deeper, darker dungeons than any made with hands.

Talking and Thinking.—What has so far been said of the recent views of language helps to explain the newer interpretation of the old terms mind and reason. These seem to be processes, as we have seen, rather than agents. They are ways of doing things rather than things themselves. John Dewey called his admirable little book on mind, *How We Think*. When older philosophers began to think about thinking, and how by thinking we reached truth, they commonly found themselves writing very long books, very hard to read; and they called their great theme epistemology or the theory of cognition. The effective thinking which has built up civilization has not, however, relied upon their treatises; nor has it been influenced by them. Two or three considerations only can be touched upon here which impress recent students in investigating thinking.

Thinking and words go together. For thinking, to be clear, has to rely upon names and their various associations with one another. For instance, grocer's bill, checkbook, fountain pen, envelope, stamp, letter box are names put together in a particular sequence. Of late there has been a good deal of discussion as to whether thinking was not always talking quite noiselessly to ourselves. A child will first utter sounds at random, then begin to find that the sounds he makes bring things; then he gets to naming with vast enthusiasm; then he prattles too freely and inopportunely to please his elders; then he may merely move his lips—as many childish people continue to do—and finally hold his tongue. It can be shown, however, by appropriate tests that this suppressed talking is accompanied by muscular adjustments of the vocal organs which indicate a silent execution of the words and sentences. We can say openly "That's too bad," or mutter it, or adjust our organs so as to say it if we wished. This suppressed talking seems to be thinking. That all thinking is merely talking to ourselves many will doubt or deny. While some minor reservations are justifiable there is an overwhelming mass of evidence, derived for instance from the study of deaf-mutes, that fortifies the contention stated above—no words, no thinking.

But thinking can easily be seen to be of several varieties. There is the meandering succession of recollections, vague apprehensions, hopes, preferences, disappointments and animosities which has come to be called reverie. It underlies other and more exacting forms of thinking. It is found on inspection to consist of recollections, anticipations, excuses for past or contemplated conduct, reflections on the unfairness of our fellow creatures and of the world in general; or assurances that all is well and must in the nature of things remain so. Ordinary daily planning is an essential form of thought—making homely decisions and adjustments. Underneath, we can perceive the reverie flowing as a sort of undercurrent—for thinking is very complicated.

We occasionally turn our thinking to trying to find out something that we do not yet know. This may be the result of mere personal suspicions and vulgar curiosity, or of an honest desire to improve a defective social situation, or learn more of light waves, Chinese paintings, psychoneuroses or investments. In dealing with the workings of the physical universe a special kind of thinking, the mathematical, has produced results that tend to safeguard the investigator from the usual prejudices which beset us in all thinking. It is a peculiar, highly refined language, or way of talking about things, by employing the vocabulary of sines and cosines, logarithms, constants, variables, roots, powers, etc. It has proved to be a wonderfully fruitful way of talking about light, for instance, and the nature of "matter" and "force" and in dealing with engineering problems. Few are addicted to this type or any other variety of scientific thinking. Most practical inventions seem to proceed from our power to experiment by thinking; to fumble and stumble mentally, and sometimes succeed. This mental trying-out is a kind of trial and error. It cannot proceed long without various external acts to check up the guesses and inferences produced by meditation.

One of the most novel and promising methods of learning more about all kinds of thinking is abnormal psychology. Illusional and obsessive thinking which fill the madhouses appear to be only the exaggerations of the thinking of those at large. The psychiatrists hold out hopes of discovering through their special knowledge, and a study of infants and children, ways of eliminating or reducing some of the vices of civilization as it has hitherto developed. To them civilization is in many of its manifestations a species of mild madness; these can only be eliminated by a great change in the way children are brought up, so as to obviate the maladjustments and distress incident to a rapidly altering cultural environment.

Men and women think not only when they are awake but when they are asleep. Their sleeping thoughts and visions and experiences we have learned to set off sharply—far too sharply as it would appear—from waking thought. Primitive man did not do this. He did not deem his dreams mere illusions, comical or distressing, to be banished when he opened his eyes. They were not negligible to him but quite as real and instructive for conduct as what he saw in the daytime. Indeed they had a weight and authority superior to the pronouncements of daily experience; and they served vastly to widen it. What civilization would have been without the manifold influences of dreams it is quite impossible to guess. Had man been dreamless would he have had his religions, his symbolism and his allegories, his poetry and much of his art? This much at least is assured that the beliefs and practices of primitive peoples are in many cases directly attributable to their dreams. Later beliefs and practices of more elaborately civilized peoples can usually be traced back to primitive ideas, which seem to be the soil from which they sprang. So we have to conclude that dreams are one of the most remarkable factors that have entered into the fabrication of civilization as we know it today.

When asleep we find ourselves visiting distant places; for instance when walking the streets of Paris we suddenly wake in New York. How could early men escape the conviction that they had a second self which could wander forth from the body, leaving it behind in the hut, while the "spirit" led for a time an emancipated and adventurous existence freed from the slow and lumpish flesh? Then in dreams the dead appear to us in full life and activity. They may admonish or fortify us; rebuke our departure from the old ways, or fill us with assurance of success. The North American Indians shared the confidence of the ancient Hebrews and Romans in dreams. In India and China the veneration of ancestors forms a highly practical obstacle to the introduction of western institutions. So have we here, without the possibility of much question as to the main issues, a fair explanation of the original belief in the spirit or soul and its survival of death. We have much more. We have the dawn of the gods and the demigods, and the whole foundation of beliefs about supernatural beings and their converse with men; their anger and the possibility of their propitiation by sacrifice.

Looking Forward.—In the preceding sections of this article certain important considerations are enumerated which escaped until recently the attention of students of mankind. They are clear enough when once pointed out. But it has always been a tragic trait of civilization that the obvious has been difficult to perceive, for it is too familiar to catch our attention. It requires a peculiar penetration to discover what in all discussions we are unconsciously taking for granted. And what we are most prone to take for granted are unrevised childish impressions.

There is much complaint of the childishness of mankind, which has become more conspicuous with the democratic assumption that everyone should have his say. John Langdon-Davies' *New Age of Faith* and E. C. Ayres' *Science the False Messiah*, to cite two examples, dwell with some petulance and bitterness on the easy gullibility and obstinate ignorance of humanity. They assume standards of intelligence which obviously do not prevail, as one reads popular newspapers, sermons and political speeches. They are disappointed, but have no reason to be surprised. Why should a former animal not have made grotesque mistakes as he floundered about with words and besetting mysteries and hardened orthodoxies? Then, as we have seen, civilization is mainly acquired in childhood and perforce ever haunted with infantile longings and misapprehensions. When there is an issue between his dreams and visions and his waking experiences why should man not prefer the former? As a matter of fact those reputed as great and deep thinkers have dealt mainly, until very recently, with imaginary beings, with events that never happened; with empty concepts, allegories and symbols and false analogies. John Dewey in his *Reconstruction in Philosophy* deduced philosophy and ethics from savage antecedents and showed how these have interpenetrated later speculations. The hardly to be overcome prejudice which attributes to mind and body separate existence and regards them of diverse substance is the easily explained and inevitable mistake of a savage. The will, the unconscious, the moral sense, regarded as agents, belong to the category of primitive animistic conceptions. Even causation as it used to be conceived is but an expression of the naïve urge to blame or praise some particular person or thing for this or that event. We are now learning to think in terms of situations. For example when Edward Carpenter wrote many years ago on *Civilization, Its Cause and Cure*, he yielded to a venerable usage. It has become apparent enough that civilization has had no one cause but is the result of a situation of cosmic complexity. There can be no one cure for its recognized defects. An Italian writer, Vilfredo Pareto, filled two large volumes with instances of the misapprehensions upon which current sociological treatises are based.

As humanity, or at least their leaders, become more fully aware of the nature and origin of civilization and the manner in which it has hitherto developed they will discover firmer foundations on which to build, more efficient ways of eradicating the inevitable and congenial errors of the race and of stimulating patient and fruitful reconstruction and reform. So far mankind has stumbled along, enslaved by its past rather than liberated by it for further advances. The reasons for this are beginning to become more apparent than ever before and might as time goes on be made the basis of a type of education, especially in man's early years, which would greatly forward and direct the progress of civilization rather than retard its development. (J. H. Rob.)

CONCEPTS OF CIVILIZATION AND CULTURE

In anthropological usage, the term "culture" covers the subjects discussed in the foregoing article on civilization, while "civilization" refers to a particular kind of culture. A culture is the way of life of a human group; it includes all the learned and standardized forms of behaviour which one uses and which others in one's group expect and recognize. In a more general sense, culture also refers to those ways of life which characterize all humans and no animals. All humans use language and symbols, have a learned social heritage, operate in societies whose forms of organization are peculiarly and particularly human.

With qualifications that will receive attention later in the discussion, it may be said that civilization is that kind of culture which includes the use of writing, the presence of cities and of wide political organization and the development of occupational specialization. A civilization (as Roman civilization or the civilization of India) is a culture, usually maintained by a large population over a considerable period, which has these elements. The main contrast is with primitive cultures and tribal societies which are, generally speaking, without them.

Both terms, culture and civilization, came into European and English usage with something of their current sense about the 18th century. They have been given varying meanings. Frequently they have been (and still are) used as synonyms, as in the phrase "the civilization of a tribe" in the preceding section. Frequently also they have borne the connotation of refinement, elegance or advancement in style of living. Several German and U.S. scholars have sought to endow the pair with contrastive meanings—civilization to denote technology and that objective information which is socially cumulative; culture to indicate subjective religion, philosophy and art which are nonadditive. But other writers, mainly anthropologists, have found that the two terms are best used neither as synonyms nor as antonyms, but as a class of phenomena, culture, and a subclass of it, civilization.

The development of the word and of the concept, civilization, was well presented by W. R. Dennes and others in a collection of essays entitled *Civilization* and by L. Febvre in an article of another collection, *Civilisation: le mot et l'idée*. A comprehensive survey and able analysis of both terms was given in *Culture: a Critical Review of Concepts and Definitions* by A. L. Kroeber and Clyde Kluckhohn. (See *Bibliography* below.)

This concept is given in the article ANTHROPOLOGY and also is discussed briefly in SOCIAL ANTHROPOLOGY. In the latter article, "social structure" denotes the learned, standardized—cultural—aspects of social relations.

All men acquire culture and participate in a culture; not all have been born into civilization or help carry on a civilization. Some of the distinctions which often exist between primitive and civilized societies are given in SOCIAL ANTHROPOLOGY. Primitive societies are generally smaller; in them individuals tend to have fewer and more permanent relations with other individuals. There is less differentiation of roles; established relationships tend to be many stranded; there are few groupings of voluntary membership. Yet these are not absolute criteria; there is such overlapping as is exemplified by the 19th-century Yoruba of west Africa, whose tribe numbered hundreds of thousands, who maintained large cities and specialists, but lacked writing and some other appurtenances, such as large public works, which usually accompany civilization. Then there are peasant and folk communities, as in parts of India, which have been as small, as self-sufficient and as homogeneous as many a tribe, which have had few or no literate members, yet which have come sufficiently under the cultural influence of cities, under the social influence of a state and within the authority of a literate tradition to be counted within the scope of Indic civilization.

The use of writing is a convenient clue for identifying civilization because, in the known cases, the introduction of writing into a culture so improves cultural transmission and so enhances the availability of knowledge as to affect and change all else in the society and culture. Similarly, the maintenance of cities and the specialization of occupation make available to a people more effective energy and wealth than they collectively possessed before.

In cities there are such full-time specialists as blacksmiths, priests, traders and rulers; there must be a technology and economic organization to support them. They cannot well exist without a rural hinterland to feed city dwellers and without transport for food supplies. Once this economic basis is available, the possibility is open, as it is not otherwise, for the development of civilization.

There has been relatively little empirical study of the quality, the consequences and the varieties of civilization. Particular aspects of certain civilizations have been well depicted by historians and others, but few scholars have used objective evidence to analyze the nature of civilization or have compared, one with another, the various civilizations which man has developed.

Civilization as a stage in the cultural development of a people has been discussed by some archaeologists. Thus R. J. Braidwood tells that in the near east, particularly in what is now Iraq (Mesopotamia), the hunting-food gathering way of life was quite quickly transformed, about 6000 B.C., into a food-producing way with settled agricultural villages. The manner of living was in turn changed, about 3000 B.C., into a civilized culture with urban centres and a literate tradition. Braidwood noted that the technological advances which made for greater food-producing efficiency were necessary but not sufficient elements in the rise of that civilization. Also necessary was the additional development of social, political, moral and religious patterns which made possible the integration of the increased population into a functioning society and culture.

In a long series of influential books and articles, V. G. Childe showed the significance of the technological-economic advances—the urban revolution, in his terms—as marking the advent of civilization wherever it has appeared on earth. He considered writing as a part of technology, as an intellectual tool used by the first civilized societies in the old and new worlds, a tool which led to such achievements as calendrical astronomy, predictive arithmetic and geometry. Further, Childe noted that the invention of writing apparently coincides with a critical point in the enlargement of local groups and in the accumulation of a social surplus. Childe's use of the term civilization tends more to emphasize this turning point in universal human history than the quality of the culture which subsequently was established. Another turning point seems to have been reached when science and machines powered by inanimate sources of energy became vital elements of civilizations; the quality of every living civilization has been affected by these developments.

The 19th-century social theorist Lewis Henry Morgan formulated a scheme of cultural evolution in seven stages in which civilization was the culminating stage. Later anthropologists demonstrated the failings of Morgan's notions. Yet his approach has not been totally rejected. Leslie White presented the evolution of civilization in terms of the increase of the use of energy and Julian H. Steward tested some evolutionary concepts by using data from primitive and civilized cultures.

There have been only a few main centres in which the shift to civilization was independently accomplished; archaeologists and ethnologists have considered the possible influences of one such centre on the others. Braidwood and Childe tended to the belief that the Egyptian and the Indus valley civilizations, while clearly distinct from that which arose in Mesopotamia before them, were stimulated in origin by it. The earliest civilization to appear in China may have arisen independently, but there is as yet insufficient evidence about it to make a judgment. The Maya, Aztec and Inca civilizations which arose in the new world seem to have developed independently of old world civilizations for the most part, although some contact between these civilizations and the civilizational centres of Eurasia may well have existed. Although Peruvian Inca culture lacked true writing, it included an elaborate government, complex specialization, great public works and urban settlement, and is generally classed as a civilization.

The whole of European and Asian civilization was viewed by Kroeber as an interconnected whole and as the product of a unitary process. Kroeber saw a single great web of culture growth, reaching from Japan and China to Europe. Within it, such cultural innovations as sculpture, domesticated plants and animals and divine kingship have tended to be transmitted from end to end. Within this range, Kroeber also noted a number of distinctive civilizations and observed that civilizations are delimited from one another by no single criterion, partly by geography, partly by period, by speech, religion and government, less by technology and, most of all probably, by values and style.

A. J. Toynbee's large-scale comparison of civilizations lists more than 20 distinct civilizations. This impressive survey of all civilizations has been vigorously criticized by scholars (especially in the fields of their respective specialties) for mistaken historical reconstruction, for lapses of detail and for untenable theoretical assumptions. Some insisted that no comparison among civilizations is possible, each being a unique ensemble with no relevant similarity to any other. But a good many of the critics agreed that a survey of all civilization and a comparison of particular civilizations should be attempted and that Toynbee's work would stand as an important trial toward that end.

While, as Robert Redfield observed, it is useful to think of civilization as one of a pair of classes, it seemed likely that further analysis would move beyond this dichotomy. As comparative studies of civilization proceed, gradients and continua are seen between primitive and civilized cultures, varieties of civilization are discerned and the concept of civilization is apt to become more useful in terms of a set of processes than as an initial category for sorting out societies and cultures.

The communities of a civilization tend to participate in a dual cultural tradition. One tradition (or in certain cases, several) is embodied in the literature, represents reflection and refinement of thought, relates the community to the wider society and culture and is often exemplified in the behaviour of an elite group. The other is not sanctioned by scripture, focuses on local deities and parochial relations, is carried out by the bulk of the people. Redfield suggested several kinds of interaction between the two traditions. Among the Maya, the literary works of the specialists were devoid of story or ethic and had only slight relation with the oral traditions of the people. Chinese literature had ethical content and its specialists influenced the people by precept and example. In India there was more reciprocal influence between literati and common people, between sacred literature and popular tradition.

Such relations and much else about civilization have yet to be explored. But not every writer has been as diffident as this about what it means to be civilized. Many an author, Clive Bell in his *Civilization* (1928) for one, has known just who and what a civilized person is—the best kind of person, the kind which appeals to the author's sense of propriety and good taste. Thus Bell's dictum that those who use authority, like those who create wealth, can be civilized but not perfectly civilized. Intriguing as such cultural ideals can be, necessary as they may be for a particular society, they do not offer suitable answers to the historian's and anthropologist's questions. To these inquirers, civilization appears as the result of a series of widespread processes in human history and as a quality of life whose characteristics and varieties remain to be thoroughly studied. (D. G. M.)

CULTURE AND HUMANITY

In the tradition of the humanities, the term culture assumed its meaning in application to the variety of things that might be "cultivated." The terms culture and cult have the same derivation and were applied by the Romans to the cultivation of the fields (*agri cultura* or *cultus*), the cultivation of the mind (*animi cultura* or *cultus*) and the cultivation of religion and God (*Dei cultus* or *cultura*). Cicero, thus, defined philosophy as the "culture of the mind," and argued that philosophy first educated men to the cult of the gods.

The development of the idea of culture centred about three related problems: the relation of culture to nature; the relation of the cultivation of man to the cultivation of God; and the use of the arts and literature to achieve "humanity," both in the sense of individual perfection and in that of mutual love. As early as the Greek Sophists the distinction was made between man in the state of nature and in various stages of civilization, and the Cynics used the criterion of natural simplicity in opposing culture as a sign of corruption and decadence.

The Roman censor Cato the Elder wrote a treatise on agriculture as well as a handbook for his son warning him against Greek physicians and Greek literature. According to Cicero, on the other hand, the circle gathered about Scipio used culture as a synonym of literature and of humanity or (in modern languages) of the humanities. In the western empire the humanities came to mean erudition in the arts and the cultivation of letters (Aulus Gellius, 14, 6, 1: *litterarum cultus*), while in the eastern empire Themistius argued against the Christians that the love of mankind (*philanthropia*), essential to the training of a statesman, is achieved by the study of literature.

During the Renaissance the term culture was applied to the arts and letters in *cultura bonarum artium* and *cultura litterarum humaniorum*, and the nature of culture was explored in treatises on pedagogy and the arts. Philosophers of the 17th century, on the other hand, sought to apply the methods of science to the study of man and spoke of the culture of the mind or of man. Francis Bacon, having expounded the reasons for the discredit of learning in book i of the *Advancement of Learning*, uses the figure of agriculture and husbandry in book ii to name one part of human philosophy *De cultura animi*. Thomas Hobbes uses the word cultus to signify the labour which a man bestows on anything, and distinguishes two applications: one to things subject to us, as "the labour bestowed on the earth is called *culture*, and the education of children a *culture* of their minds"; the other to God as in *cultus Dei*. John Locke used the analogy of "breeding" in *Some Thoughts Concerning Education*, and gives a subordinate place to learning or the culture of the mind, *ingenii cultus*.

The reaction to this conception of culture as the cultivation of man based on knowledge of his nature took two characteristic forms during the 19th and 20th centuries. German philosophers, taking their start from the study of the "history of culture," investigated the nature of culture and of the spiritual life, and the relation of the sciences of culture, *Kulturwissenschaften*, to the sciences of nature, *Naturwissenschaften*. According to Johann von Herder, in the 18th century, "The culture of a people is the blood of its being," and after him Hegel and the Romantic philosophers Nietzsche, Wilhelm Dilthey, Wilhelm Windelband, Heinrich Rickert and Georg Simmel laid the lines of philosophic and sociological speculation concerning the values embodied in cultural objects, the structure and nature of cultural values and the interplay of subjective and objective in the transformation of cultures. English essayists and reformers, on the other hand, taking their start from problems of politics and religion, investigated the practical uses of culture. Matthew Arnold responded to John Bright's dismissal of culture as "a smattering of the two dead languages of Greek and Latin" in *Culture and Anarchy* (1869), defining culture as a pursuit of our total perfection by means of knowledge of the best which has been thought and said in the world and the development thereby of all sides of our "humanity." Religion is one of the forces by which men perfect themselves, and Hellenism, which is the effort to see things as they are, and Hebraism, which is conduct and obedience, are interacting ways in which they have pursued this aim.

The meanings of culture in contemporary literature continue to reflect the three problems which influenced the first development of the term. John Dewey conceived culture to be the result of interaction between man and his environment, but philosophers of existence emphasize the creative aspects of culture which exceed naturalistic determinations. A large literature has grown up concerning the relation of culture and religion, and writers like T. S.

Eliot, who question Arnold's usage of "culture" as more comprehensive than "religion," make culture the incarnation of the religion of a people.

Humanists finally continue to ask how culture, in the sense of the cultivation of the arts and literature, may further the self-realization of individual men and the mutual understanding of peoples. (Rd. McK.)

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CIVIL LAW, a phrase applied principally to that group of laws which has grown up on the continent of Europe as a combination of Roman and Germanic traditions together with ecclesiastical, feudal and local influences. In this sense, the civil law constitutes one of the two great families of law of western civilization, the other being the common law (*q.v.*), or Anglo-American law. In ancient Rome, *jus civile* was used to distinguish the proper or ancient law of the city or state of Rome from the *jus gentium*, or the law thought to be common to all the nations comprising the Roman world, as developed and incorporated with the former through the praetors and jurists (*see* Roman Law). The phrase has also been used to distinguish private law, or the law governing the relationship between citizens, from public law and criminal law. Again, the national law of a state is sometimes described as civil law, in contrast to international law.

The Civil-Law and Common-Law Nations.—The common law is constituted by the law of England and the laws of those countries in which the law of England has been received or implanted, and, although often transformed in certain respects or supplemented by local or religious traditions, has been preserved in its principal features. Besides England, common-law countries in the strict sense are thus the United States, Canada, Australia, New Zealand, the Republic of Ireland and the West Indies. Common law prevails in India, Pakistan, Burma, Malaya and Singapore, where it is supplemented in matters of personal status by religious laws, as well as in Liberia and most of those parts of Africa and Oceania which were, or still are, British colonies, protectorates or trust territories, and where the common law is supplemented in many respects by native customs.

The civil law has traditionally been the law of most of continental Europe; from there it spread to Latin America and later to those countries of Asia and Africa which found it necessary to westernize their laws; *i.e.*, Japan (1890–98), China (1929–31), Thailand (1925), Turkey (1926) and Ethiopia (1958–60). It also prevails, supplemented by religious laws or native customs, by and large in those regions which were, or still are, colonies, protectorates or trust territories of France (Morocco, Tunisia, Algeria, Guinea, Mali and other territories in Africa, the West Indies and Oceania), Belgium (Congo, Ruanda-Urundi), the Netherlands (Indonesia, Dutch West Indies), Portugal and Italy (Somalia). Civil law, supplemented by Islamic law, has also come to prevail in the countries of the near east, but not in Libya and Iraq, where common law has been influential.

Another group may be said to be constituted by the laws of the Nordic countries (Sweden, Finland, Denmark, Norway and Iceland), which are closer to the civil law, however, than to the common law. In the Soviet Union it is claimed that the legal system constitutes an entirely new beginning. While the collectivist spirit of Soviet government, economy and society has certainly resulted in many innovations in the law, civil-law traditions have by no means been eradicated from the modes of legal thinking. In the people's republics these traditions have been preserved even more strongly, especially in Poland.

In a few parts of the world, civil law and common law have come to interpenetrate each other, viz., in Scotland, in the Canadian province of Quebec, in the U.S. state of Louisiana, in Puerto Rico, the Philippines, the Republic of South Africa, Southern Rhodesia, Ceylon and on the island of Mauritius. While in most of these regions the common law seemed to be the prevailing influence, an opposite trend set in after the 1920s, so that in most of these areas the private law can be regarded as being of the civil-law variety.

Early Development.—The features characteristic of each of the two systems have been shaped by history. In the 5th and 6th centuries western and central Europe was dominated by Germanic peoples, especially those who had overrun the Roman empire. Among them were the Anglo-Saxons of England, the Franks of western Germany and northern France, the Burgundians, the Visigoths of southern France and Spain and the Lombards (Langobardi) of Italy. Although Roman-law traditions lingered on for some time, the Germanic customs came to prevail in most regions. In the middle ages these customs underwent vigorous growth to satisfy the complex needs of a society of chivalry and feudalism, growing cities, eastern colonization, increasing trade and a constantly refined culture. Among the many strands that went into the weaving of the complex pattern of medieval law, the customs of the merchants and the canon law of the church were of special significance. It was mainly through the canon law that entry was found for concepts and ideas that had been elaborated in the law of ancient Rome. As a whole, Roman law had been forgotten, but in the late 11th century it was rediscovered and made the subject matter of learned study and teaching by scholars of northern Italy, especially at Bologna. With the increasing demand for trained judges and administrators, first by the Italian city republics, then by princes in other localities, students flocked to Bologna from all over Europe, until the learning and teaching was gradually taken over by local universities. As a result of this process, Roman law penetrated into the administration of justice north of the Alps, especially in Germany and the Netherlands, where the Roman-law influence finally became so strong that one came to speak in these countries of a reception of the Roman law.

One of the reasons why Roman law was able to acquire special strength in these Germanic nations of the Holy Roman Empire was because the new emperors cherished the idea of being the direct successors of the Roman Caesars; the Roman law, collected in the *Corpus Juris* by the emperor Justinian I (*q.v.*) between 527 and 565, could be regarded as still being in effect simply because it was the imperial law. Decisive for the reception, however, was the superiority of the specialized training of Roman-law jurists over the empiricist activities of the lay judges and practitioners of the local laws, combined with the superiority of the Roman type of procedure, with its rational rules of evidence, over the forms of local procedure in which proof by wager of law, battle and other irrational methods still prevailed, though they no longer corresponded to the mentality of the Renaissance. Nowhere, however, did the Roman law completely supplant the local laws. So far as the content of the law was concerned, there developed various amalgams. Roman law strongly influenced the law of contracts and torts; canon law achieved supremacy in the field of marriage; and combinations of Germanic, feudal and Roman traditions developed in matters of property and succession. Strongly Roman, in the manner of elaboration of the scholars of the Bologna schools of glossators (12th century) and commentators (13th–15th centuries), were the conceptual formulations in which the norms and principles of the law were expressed, as well as the procedural forms in which justice was administered. The system that thus emerged was called the *jus civile*. In actual practice it varied from place to place, but it was nevertheless a unit that was held together by a common tradition and a common stock of learning. The law of the *Corpus Juris*, especially its main part, the *Pandects*, was as such in effect nowhere, but constituted the basis of study, training and discourse everywhere. In spite of all variety, the civil-law world experienced a sense of unity which corresponded to the strongly felt unity of European civilization.

Codification.—The undermining of this unity was brought about by the religious split of the Reformation and Counter Reformation and by the rise of nationalism, which accompanied the unification and stabilization of the European nations and their struggle for hegemony. In the field of law the split found expression in the national codifications, through each of which the law was unified within a particular nation but simultaneously set apart from that of all others. National codification, although not yet in the full sense, was achieved first in Denmark-Norway in 1683–87, then in Sweden in 1734 and in Prussia in 1791–94. In Austria codification began in the 1750s, but was not fully completed until 1811. Because of the personality of their backer and the novel technique applied, the greatest fame and influence were achieved by the Napoleonic codifications of the private and criminal law of France, especially their central piece, the Code Civil (Code Napoléon) of 1804. Napoleon's codes were introduced by the victorious French armies into Belgium, Luxembourg, the parts of Germany on the left bank of the Rhine, and even a small part on the eastern bank. Once introduced, the codes survived the retreat of the French armies. In the 19th century codes were adopted in other parts of Europe. These were either somewhat modified translations of the Code Napoléon, as in the Netherlands (1838) and Italy (1865, replaced by a new code in 1942), or new codes fairly closely following the model of the French, as in Spain (1888), Portugal (1867) and Rumania (1865). Partly direct and partly by way of Spain, the French model of codification found its way into the countries of Latin America. While some of their 19th-century codes branched out in directions of their own, especially the Chilean code of 1855 and the Argentinian code of 1869, Latin-American legal studies have remained firmly linked with France and Spain. (*See* also CODE NAPOLÉON; ITALIAN LAW.)

In Germany codification could not be undertaken until political unification had been achieved in 1871. Unification of the law, *i.e.*, codification of the criminal law and the law of procedure, was achieved shortly thereafter, but the national civil code was not completed until 1896 and did not take effect until Jan. 1, 1900. The German civil code thus came almost 100 years later than the codes of France and Austria, and its draftsmen profited from the intensive efforts at systematization, clarification and modernization of the law that had been carried on by German scholars during that century. As a result, the German code is markedly different from its predecessors. Its arrangement is more orderly, its language more precise and its use more exacting. The Code Napoléon is written in a style that easily induces the reader to believe that he can understand it; the German code is technical. A slightly modified version of the German code was adopted in 1898 in Japan, and from there it was introduced into Korea.

Codification in Germany was followed in 1907–12 by that of Switzerland and, because of the masterly technique of the principal draftsman, Eugen Huber, the code of that country has been copied or has exercised a far-reaching influence in countries as diverse and as distant from each other as Brazil (1916), Turkey (1926) and China (1929–31). The new Greek code of 1940–46, however, was closer to the German than to the Swiss model. (*See* also GERMAN LAW.)

Comparison of Civil Law and Common Law.—Between the 11th and the 15th centuries the law of England was also strongly influenced by Roman-law learning and, in the 16th century, experts trained in Roman law were welcomed as administrators as much by the kings of England as by continental rulers. However, in contrast to the countries of the continent, where justice was administered locally, it had, as a result of the Norman conquest, been centralized in England. There had grown up at the courts of Westminster a profession of practitioners expert in the law and procedure of the centralized court system, strongly organized and unwilling to yield its position, power and income to a new group of specialists of Romanist learning. In its resistance to royal innovation, the organized bar came to ally itself with the Parliamentary party in the great constitutional struggle of the 17th century. There was thus prevented in England a reception of Roman law of continental style, and there was also established that connection between the principles of constitutionalism and individual freedom on the one side, and the common law on the other, which has created the image of the common law as the legal system of freedom, in contrast to the civil law as the system in which the state is exalted over the individual. This view seems to obtain support from the fact that free political institutions were developed earlier, and have been maintained more firmly, in countries of the common law than in countries of the civil law.

However, political institutions are one thing, and techniques of dealing with civil litigation and criminal prosecution are another. Intimate connections exist, of course, between the two; a society is not free if civil cases are not handled impartially and if persons accused of crime are not safeguarded against injustice. In both these respects, however, neither of the two great legal systems lags behind the other. The ways of argumentation and procedure differ, but in its own way each of the two systems has developed its own guarantees and safeguards and neither can be shown to be superior to the other. The view frequently found in England and the United States, that in civil-law criminal procedure the accused is presumed guilty until he has proved his innocence, is as unfounded as the view widely held on the continent that trial by jury is tantamount to lawless appeal to passion and emotion.

If one compares countries having firmly established institutions of constitutional government, such as, on the one hand, the United Kingdom and the United States and, on the other, Belgium, the Netherlands, Switzerland, the Federal Republic of Germany or France, it appears that in the civil-law countries the protection of the individual against illegal actions by executive agencies is generally about the same, and in some respects such protection is even more elaborate in France than in the United Kingdom. Again, the United States has not yet fully caught up with Germany as regards compensating an individual out of public funds for harm caused to him by wrongful acts of public servants. In general, it may also be said that it is less expensive on the continent for the citizen to seek legal protection of his private rights than it is in the common-law countries.

It is difficult to define what constitutes the real difference between common law and civil law. It would be erroneous simply to identify civil law with codified or even statutory law, and common law with judge-made or case law. For one thing, the contrasts between the two systems existed long before the civil-law countries began to enact their codes. In addition, large parts of Anglo-American law are also contained in statutes or even codes, while in France, Germany and other civil-law countries large parts of the law have never been reduced to statute at all but have been developed by the courts; and many of the statutes and code provisions have come to be overlaid by judicial glosses to such an extent that, in effect, they are dominated by judge-made law.

No essential difference can be found either in the role of judicial precedent. In theory, it is true, common-law courts are bound by precedent in the sense that once a legal question has been decided a certain way by a court, it must always be decided in the same way by all other courts of inferior or equal rank until the legislature sees fit to change the rule. In civil-law countries, on the other hand, courts are, in official theory, free to consider anew any legal question irrespective of how often it may have been determined before by other courts or even by the one before which it is pending. In practice, however, common-law courts, especially those in the United States, have developed techniques of distinguishing new cases from older ones which have reduced the role of *stare decisis* to a minimum indispensable for maintaining the stability of social life; and civil-law courts, on their part, have been inclined to follow precedent, not only for the sake of continuity and social stability but also in accord with the inclination of courts everywhere to save time and effort by following precedent rather than rethinking every problem each time it arises for judicial determination.

The main difference between the systems consists of the ways in which the norms of the law are articulated and in which new rules are derived from older ones in novel cases. Though law cannot remain static, the change must be orderly and gradual so as not to interrupt the continuity and stability of life. In the common law, this role of adapting the law to changing conditions has traditionally been the task of the judges. In civil-law countries, the task had widely come to be performed by university professors. There, the multiplicity of courts stood in the way of the leading role being assumed by the judges, who could well assume it in England, where the administration of justice was centralized. Judges must proceed from case to case, and cases present themselves in isolation and without prearrangement. Professors deal with hypothetical cases rather than actual ones. They can develop comprehensive ideas and principles, and they are impelled toward systematization and conceptualization by the didactic necessities of instruction. The civil law, as a professorial law, has thus tended to be more systematic and more comprehensive and consistent in its proportions and terminology than the judge-made common law, which may have tended, on its part, to be closer to life and perhaps more detailed.

These traditional differences may diminish, however, for in the civil-law countries judicial power has increased with the national centralization of the administration of justice, while in the common-law part of the world the courts of Westminster have lost their supremacy to the multiplicity of supreme courts in the United States and in the commonwealth. The role of maintaining the unity of the law is thus passing to that group of professionals—the professors—by which it was once exercised in the civil-law world. Gradual assimilation of the techniques of the two great systems of law may thus well be expected.

See also references under "Civil Law" in the Index volume.

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(M. RN.)

CIVIL LIBERTIES. Next to the struggle for national independence, the struggle for civil liberties or for the fundamental human freedoms has been one of the major aspects of modern history, and one of the most persistent and pervasive themes in literature, philosophy and religious thought at all times in the history of man. Pres. Franklin D. Roosevelt expressed mankind's intense concern with civil liberties when, in his "Four Freedoms" address (1941), he said that humanity looked forward to a world founded upon four essential freedoms: freedom of speech, freedom of religious worship, freedom from want and freedom from fear. The first two of these four freedoms have been generally thought of as basic civil liberties. Indeed, in modern history, the nationalist's cry of "Give me liberty, or give me death!" (Patrick Henry of Virginia in 1775) has often been linked with the simultaneous demand for civil liberties. Thus, in justifying the American Revolution for national independence, the Declaration of Independence (1776) proclaimed the right of a people to abolish a government that failed to secure the people's "unalienable rights," among which were "Life, Liberty and the pursuit of Happiness." The Declaration in effect stated that the American colonists were seeking not only to throw off a foreign yoke but also to become a free people; *i.e.*, a nation that would enjoy self-rule and the rights or freedoms with which they were endowed by their Creator and that, as such, were inalienable. They made it clear that a denial of these freedoms marked a government (foreign or domestic) as "an absolute Tyranny."

Natural Law Theory.—This assertion of limits on government followed from the belief that every man has rights or freedoms that are so intimately connected with his nature as a human being that to take them away would be to deprive him of part of his humanity. They enter into the very nature of man as God or Nature made him. The enumeration of specific civil liberties or basic human freedoms would depend upon the character of the culture, on time and place; *e.g.*, freedom of speech could not seem very significant among ignorant, illiterate peoples, and freedom of the press took on a dimension of importance only after the printing press replaced the scribe. But the root idea of rights or freedoms inherent in a person, and not subject to destruction by the prince or ruler, was found in many and diverse cultures and civilizations. Sometimes this assertion of basic freedoms was expressed briefly as a belief in the dignity of man, or in the biblical idea that every man was made in the image of God, or in the existence of natural law and natural rights. All these beliefs flowed into the position that there were limits on government, or that government is the result of a contract (*see* SOCIAL CONTRACT) in which only certain powers were delegated to the ruler, or that rulership was vested in a government of laws, and not of men, or that the laws of a ruler were subject to judgment under a higher law. (*See* CONSTITUTION AND CONSTITUTIONAL LAW.)

These conceptions were implicit in the incident of Naboth's vineyard related in the Old Testament. Naboth owned a vineyard that adjoined the property of Ahab, king of Israel in the 9th century B.C. Ahab wanted the vineyard but Naboth refused to sell it, for it was the inheritance of his fathers. Jezebel, the queen, contrived through perjured testimony to have Naboth executed for treason. As Ahab took possession of the vineyard, he was met by Elijah the prophet, who pronounced doom on him and Jezebel and his house. (I Kings xxi.) God, through the prophet, condemned a ruler who presumed to take property or life under an unjust law or judgment without due process.

When Creon, regent of Thebes, forbade the burial of Polynices, the son of Oedipus, Antigone, the sister of the deceased, attempted to bury the body despite the prohibition. She dared to defy the law, Antigone told Creon, because the king's law contradicted God's law, and the laws of men must give way before the immortal unrecorded laws of God, which exist not only now, but always existed and always shall be effective, for these laws are beyond man utterly. Her story is told by Sophocles in his *Antigone*.

In time it came to be widely accepted that human authority could not have the last word, and that human beings could, at least morally, appeal to a higher law that comprised the law of nature or the law of God. This right of appeal was recognized by Aristotle and the Greek and Roman Stoics. "The highest law," wrote Cicero in the first century B.C., "was born in all the ages before any law was written or any state was formed." This tradition was transmitted to modern times through St. Thomas Aquinas, the common law of England, Magna Carta, Hugo Grotius and other thinkers and institutions. The struggle between pope and emperor, between church and state (*q.v.*)—a struggle that goes back to the Maccabaean revolt against Syria in the 2nd century B.C. and the Roman persecution of Christians in the first three centuries A.D.—helped keep the tradition alive and significant.

Modern Application of Natural Law Doctrine.—In the 17th and 18th centuries the theory of natural law flowed into the theory of natural rights. The social contract among the members of society and between society and government provided that government had, as one of its chief ends, the protection, as John Locke put it, of the lives, liberties and estates of members of society. Locke added that by property he meant "that property which men have in their persons as well as goods." (*Second Treatise of Government*, 1689.) For the vindication of their "inherent and inalienable" rights—Jefferson's phrasing of Locke's doctrine, in the original draft of the Declaration of Independence—the people should look to parliament; if this failed, they had the right to resort to revolution.

The English nation kept these alternatives. In the English view, at least from the time of Sir Edward Coke (1552–1634), parliament represents not merely the coercive aspects of the state but also, and more significantly, the free political will of the people, and it is the protector of their liberties no less than of their security. In championing parliament against king, and attacking royal prerogative and law by royal proclamation as contrary to common law and constitution, Coke enunciated principles of liberty; but while parliament could check the king in the interests of individual liberty, there was no projection of an institutional check on parliament. The common law has its rules and "fundamental points"—what would be called in modern times the basic constitutional principles—and these principles, especially the ones that may be thought of as pertaining to the law of nature, should be respected by parliament; but if it failed to respect them, there was no institutional appeal from the decision of parliament—except, of course, to the electorate. The ultimacy of parliament, however, is not to be denominated as being exclusively, or even distinctively, an expression of legislative sovereignty. There was attached to parliament the character, in some sense, of a court of last resort, as that of the highest court in the land. There was no appeal from its acts because there was no appeal from a court that is supreme. But such a court was bound in conscience to stay within constitutional limits and to observe fundamental or natural law.

This approach was aided by the common view—as it was expressed by Sir William Blackstone in his *Commentaries on the Laws of England* (1765–69)—that English law was based upon and embodied biblical and natural law, in which were rooted the imprescriptible rights and liberties of Englishmen. In other words, no special bill of rights and liberties was needed, for they were already enshrined in the common law, from which no "high court of parliament" would, in fact, remove them.

Implicit in this view is a philosophy of human nature and politics that reflects biblical and classical influences and that attempts to avoid extreme positions. This view assumes that man is not radically depraved, although he is prone to sin. Society must be protected against man's prideful thrusts and overreaching will. The state, as an instrument of coercion, must contain man within the limits that God and nature and social needs impose upon him. At the same time, since man is not altogether lost, he must be permitted to enjoy his rightful liberties, given to him by the same God and nature that hem him in; and the state is instituted in part to afford protection for these rightful liberties. The power of government is a consequence of human perverseness and also of human dignity and independence. It is instituted to assure both justice and liberty.

Fortunately for the development of civil liberties, these beliefs had a chance to take root and grow in the minds of men in ancient and medieval civilizations before the modern notions of state sovereignty emerged. While Englishmen no longer think of parliament as a high court and are reconciled to the conception of parliamentary sovereignty, they do not fear that parliament will assail the civil liberties of English citizens.

While the English have looked to parliament for vindication of their fundamental liberties, some other nations, notably the United States, have looked chiefly to the courts, to judicial review (*q.v.*), for the protection of their fundamental liberties. The latter alternative became more of a possibility with the development of written constitutions and bills of rights. Into these documents flowed the religious, philosophical and juridical conceptions that had been developed over many centuries, among diverse civilizations, peoples and religions.

Partial precedents for written bills of rights were Magna Carta, the English Bill of Rights (1689) and the Declaration of Independence (*qq.v.*). The Virginia Declaration of Rights (adopted June 12, 1776, and drafted largely by George Mason) was especially notable, since Virginia was the leading colony, and the language of that document was particularly felicitous. It declared that all men are by nature equally free and independent, and that they have certain inherent rights of which they cannot deprive themselves or their posterity; "namely, the enjoyment of life and liberty, with the means of acquiring and possessing property, and pursuing and obtaining happiness and safety." Specific civil liberties enumerated included freedom of the press, the free exercise of religion and the fact that no man was to be deprived of his liberty except by the law of the land, or the judgment of his peers.

The constitution of the United States, ratified in 1789, contained some safeguards of personal liberty—a guarantee of the privilege of the writ of habeas corpus, a prohibition on bills of attainder, ex post facto laws and test oaths; but it did not include a bill of rights. The authors of *The Federalist Papers*, while approving these guarantees, justified the omission of a bill of rights by the argument that since the federal government was to enjoy only delegated powers, there was no need to reserve to the people powers not surrendered by them: "For why declare that things shall not be done which there is no power to do?" (*Federalist* No. 84.) But the ratifying states demanded a bill of rights, and in 1791 the constitution was duly amended to include the Bill of Rights. (For the text of the Bill of Rights, *see* UNITED STATES [OF AMERICA]: *Administration and Social Conditions.*)

Here it should be noted that in the meantime, in 1789, at the beginning of the French Revolution, the National Assembly of France issued the Declaration of the Rights of Man and of the Citizen, which stated that there were certain sacred rights of men and of citizens, among them the following: that men are born, and always continue, free and equal in respect to their rights; that the end of all political associations is the preservation of the natural and imprescriptible rights of man; and these are liberty, property, security and resistance of oppression; that political or civil liberty consists in the power of doing whatever does not injure another; that the law ought to prohibit only actions hurtful to society, and no man should be accused, arrested or held in confinement, except in cases determined by law, and according to the forms which it has prescribed; that no one ought to be punished except under a law promulgated before the offense; that a man is presumed innocent until he has been convicted; that no man ought to be molested because of his opinions, including his religious opinions, as long as their expression does not disturb the public order established by the law; and that every citizen may speak, write and publish freely his thoughts and opinions, provided he is responsible for the abuse of this liberty, in cases determined by the law.

The post-World War II constitutions of the French republic (1946 and 1958) reaffirmed attachment to the rights of man as defined by the declaration of 1789. The 1958 constitution (title vii) provided for a constitutional council of nine members, plus former presidents of the republic, which had authority to decide whether laws were in conformity to the constitution. At the same time the constitution reiterated (title i) the provision of the declaration of 1789 that sovereignty belongs to the people, which exercises it by its representatives, and no section of the people, nor any individual, may attribute to themselves or himself the exercise thereof. This seemed to mean that the whole of sovereignty was vested, by delegation, in the representatives and that no power was retained by individuals. It remained to be seen how this concept of total sovereignty would be squared with the idea that there are natural and imprescriptible rights of man, and that there is in some sense a right to resist oppression.

This idea that sovereignty is in the nation and that no part of sovereignty can be claimed by individuals goes back to Rousseau's general will and even further back to Spinoza's *Tractatus theologico-politicus* (1670). The impulse of Rousseau's and Spinoza's political theories was democratic and libertarian; they spoke for the liberties of men against the tyrannies of governments, but they found no way of resolving the conflict between majority rule and individual rights. They spoke for the need of strong government; and the constitutions of France also reflect a need of strong government—a government that in fact will govern; but the ambivalence with regard to civil liberties remains unresolved for governments and nations that have been obsessed with the notion of state sovereignty.

In U.S. constitutional development there was no preoccupation with state sovereignty. On the contrary, limit on government was a leading concern. The inalienable liberties of men must be preserved; and since the "natural progress of things is for liberty to yield and government to gain ground" (Jefferson, 1788), everything possible must be done that will protect liberty and restrict government. One significant limit on government may be a bill of rights.

United States Bill of Rights.—The Bill of Rights of the United States constitution (*see* BILL OF RIGHTS, UNITED STATES) was demanded not only by the states, but also by Thomas Jefferson, who perhaps was influenced by the revolutionary atmosphere of France, where he lived from 1784 to 1789. Jefferson was the author of the Virginia bill for the establishment of religious freedom in which was expressed the conviction that the opinions of man cannot be coerced; that measure, with the support of James Madison, was adopted in 1786. Writing to James Madison from Paris in 1787, Jefferson stated, concerning the constitution of 1787, that "a bill of rights is what the people are entitled to against every government on earth."

Both Jefferson and Madison, however, maintained that a bill of rights alone would be insufficient to assure enjoyment of fundamental freedoms; proper social, economic and political conditions were essential to give reality to the liberties constitutionally recognized or provided. Thus, Jefferson insisted on the practical necessity for the widest possible distribution of farm ownership, an agricultural and rural economy and society and a work force made up of farmers and craftsmen; for cities, he believed, breed mobs, and mobs add as little to democratic government as sores do to the strength of a man's body. Madison emphasized the conviction that religious freedom was dependent more on the existence of a multiplicity of sects than on a constitutional guarantee. Both were convinced, however, that social, constitutional and governmental institutions must be developed so that every person would be free to use and develop his faculties; that governments were instituted primarily to protect opportunities for the development of a man's faculties or abilities; that the use of opportunities may lead to the acquisition of property; that government is instituted to protect property; that a man has property in his personal safety and personal liberty no less than in his physical possessions; that, as Madison put it, government may not violate, directly or indirectly, "the property which individuals have in their opinions, their religion, their persons and their faculties," so that a wise and just government "will equally respect the rights of property, and the property in rights."

As adopted, the first ten amendments to the United States constitution, generally spoken of as the Bill of Rights, provide that "Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech or of the press; or the right of the people peaceably to assemble, and to petition the Government for a redress of grievances" (1st amendment); and that no person shall be "deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use without just compensation" (5th amendment). These are the most far-reaching guarantees. Other guarantees are the following: security against unreasonable searches and seizures affecting persons, houses, papers and effects; that no warrants shall issue except upon probable cause, supported by oath or affirmation, and particularly describing the place to be searched, and the person or things to be seized; that no person shall be held to answer for a capital or infamous crime except on presentment or indictment by a grand jury; that no person shall be twice put in jeopardy of life or limb for the same offense, or be compelled to be a witness against himself in any criminal case. In criminal cases, the defendant is guaranteed the right to a speedy and public trial by an impartial jury, to be informed of the nature of the accusation against him, to be confronted with witnesses against him, to have compulsory process for obtaining witnesses in his favour, and to have assistance of defense counsel. Excessive bail, excessive fines and cruel and unusual punishments are prohibited.

Since the United States is a federal republic, the courts were faced with the question of whether the Bill of Rights was a limit on only the federal government, or on both the federal government and the government of any state. In 1833, in *Barron* v. *Baltimore*, the supreme court limited the effectiveness of the Bill of Rights to the federal government. Following the Civil War, however, three important amendments were added: The 13th amendment prohibited slavery and involuntary servitude. The 14th amendment provided that all persons born or naturalized in the United States are citizens of the United States and of the states wherein they reside (this meant that Negroes were thereafter to be citizens without regard to their previous condition of servitude). This amendment also provided that "No State shall make or enforce any law which shall abridge the privileges or immunities of citizens of the United States; nor shall any State deprive any person of life, liberty, or property without due process of law, nor deny to any person within its jurisdiction the equal protection of the laws." The 15th amendment provided that the right of citizens to vote shall not be denied or abridged by the United States or any state on account of race, colour or previous condition of servitude.

While these Civil War amendments do not expressly make applicable to the states the guarantees of the first ten amendments, the supreme court established that the terms "liberty" and "due process of law," as used in the 14th amendment, make available against state action certain fundamental rights guaranteed to accused persons in the original Bill of Rights—those basic rights that are "implicit in the concept of ordered liberty"—for if they were sacrificed, "neither liberty nor justice would exist." (Justice Cardozo, *Palko* v. *Conn.*, 1937.) The freedoms of the 1st amendment, for example, have been held protected by the 14th amendment against encroachment by the states (*Gitlow* v. *N.Y.*, 1925). Some members of the supreme court, it may be noted, maintained after World War II that the 14th amendment incorporates all of the freedoms guaranteed by the Bill of Rights, but this was a minority view.

Rights of Women and Aliens.—The United States constitution was amended in 1920 to add an additional civil liberty: "The right of citizens of the United States to vote shall not be denied or abridged by the United States or by any State on account of sex." Agitation for equal women's suffrage started in the United States in the middle of the 19th century, and was successful in ten states, but this progress was slow, and a movement to amend the constitution in the second decade of the 20th century led to the adoption of the 19th or equal suffrage amendment.

Except for the right of suffrage, civil liberties are not limited to citizens. They are enjoyed by all persons. The civil liberties of aliens are, however, not as secure as are those of citizens, since aliens are subject to deportation under legislative terms. Thus, while a citizen may not be subject to punishment on merely a showing of membership in an organization ostensibly subversive, an alien may be deported for such membership (*Harisiades* v. *Shaughnessy*, [1952]; cf. *Rowoldt* v. *Perfetto*, [1957]). However, as long as he is permitted to remain within the host country, the alien must be permitted to enjoy fundamental substantive freedoms and procedural rights (*Yick Wo* v. *Hopkins*, [1886]; *U.S.* ex rel. *Bilokumsky*, [1923]).

Civil Liberties Distinguished From Civil Rights.—Generally, civil liberties are freedoms to do certain things without restraint from the government; but they ordinarily imply no absence of restraint from private individuals or agencies. For example, a person may publish his opinions freely insofar as governmental action is concerned; but this liberty does not imply a duty imposed on a newspaper to publish those opinions. In this regard civil liberties may be distinguished from civil rights. States, in the exercise of their police power, may enact laws to prohibit public officials and private individuals from discriminating against persons because of their race, colour, creed, religion or national origin, in employment opportunities, in offering of accommodations in hotels, restaurants, common carriers and other places of public resort, in educational institutions and in housing (at least when supported by public funds). These, known as civil rights acts and fair employment practices acts, have been enacted in many U.S. states and municipalities.

The United States constitution has been interpreted as prohibiting state action (but not individuals acting as private citizens, not under authority of any law) that discriminates against persons by reason of their race or colour. Racial discrimination by states; *e.g.*, segregation in public education, has been held a violation of the equal protection clause of the 14th amendment (*Brown* v. *Bd. of Education of Topeka*, [1954]). Similarly, discrimination by the federal government was held to violate the due process clause of the 5th amendment (*Bolling* v. *Sharpe*, [1954]). These decisions, though they flow from constitutional guarantees and not from legislative enactments, are generally conceived of as involving civil rights rather than civil liberties.

Civil rights, generally speaking, may be viewed as attempts to give meaning to the ideal of equality, while civil liberties flow from the ideal of freedom. But civil rights and civil liberties are, however, intimately related and are perhaps interdependent, for a person who is denied equality is not likely to find that he enjoys much freedom, and a person who is denied freedom is likely to find that he has lost also his equality.

Other Countries.—Following the example of the French Declaration of the Rights of Man and of the Citizen and of the U.S. Declaration of Independence and Bill of Rights, many nations in the 19th and 20th centuries adopted written constitutions with bills of rights. Other countries, influenced in various degrees by the example of Great Britain, adopted no written constitutions (*e.g.*, Israel), or written constitutions containing no bills of rights (*e.g.*, Australia, Canada, New Zealand). In these countries fundamental rights are nonetheless recognized and guaranteed by common law, court decisions and legislation that reflect deep traditions. Some countries also adopted written constitutions including bills of rights, where civil liberties are barely acknowledged. Such was the case in totalitarian states and in countries where a feudal order still prevailed despite some modern trappings. It is not possible to summarize here the great diversity of laws and usages relating to human rights in the various member states of the United Nations organization; the interested reader is referred to the *Yearbook on Human Rights for 1946* (UN. [1947]) for a summary of these laws and usages for some 70 countries, and the subsequent issues of this *Yearbook* for supplementary and later data.

UN Universal Declaration of Human Rights.—The interest of the United Nations in civil liberties and civil rights—human rights—reflected a world-wide concern with these subjects. The "Four Freedoms" address of President Roosevelt has a special relevance at this point; for Fascism and Nazism had as their objective the destruction of civil rights, the substitution of police tyranny for due process of law, and the rooting out of the ideals of freedom and equality. In meeting the military challenge of totalitarianism, the leaders of the free nations of the world at the same time promised to meet the ideological challenge of their enemies. The Atlantic Charter (*q.v.*) of 1941 affirmed the objectives of the "Four Freedoms" address.

When the representatives of 50 governments at the San Francisco conference in 1945 signed the United Nations charter, they put their signatures to a document that referred to human rights in no less than seven provisions. The charter provides that the peoples of the United Nations established the international organization in order to prevent future wars and in order "to reaffirm faith in fundamental human rights, in the dignity and worth of the human person, in the equal rights of men and women and of nations large and small." The charter states that one of the purposes of the UN is to promote and encourage respect for "human rights and for fundamental freedoms for all without distinction as to race, sex, language or religion." Article 13 of the charter provides that the general assembly shall initiate studies and make recommendations for the purpose of "assisting in the realization of human rights and fundamental freedoms for all without distinction as to race, sex, language or religion." Article 62 imposes upon the Economic and Social council the function and power to make recommendations "for the purpose of promoting respect for, and observance of, human rights and fundamental freedoms." Thus civil liberties and civil rights became an international responsibility.

In furtherance of these purposes, the UN Commission on Human Rights was established in 1946 by the Economic and Social council. The first efforts of the commission were directed toward preparing an international bill of rights. On Dec. 10, 1948, the general assembly of the UN adopted a Universal Declaration of Human Rights, which embodies the 18th-century ideals of fraternity, equality and liberty. The preamble expresses recognition of "the inherent dignity and of the equal and inalienable rights of all members of the human family" and the conviction that these values are "the foundation of freedom, justice and peace in the world." It expressly reaffirms the "Four Freedoms" as "the highest aspiration of the common people." The declaration was proclaimed by the general assembly as "a common standard of achievement for all peoples and all nations." Article 3 states that "everyone has the right to life, liberty and the security of person," and other articles affirm specific civil liberties: slavery should be prohibited; no one shall be subjected to cruel or inhuman punishment; everyone shall be recognized as a person before the law; all are equal before the law and are entitled to equal protection against discrimination; no one shall be subject to arbitrary arrest or detention or exile; everyone is entitled to a fair and public trial, shall be presumed innocent until proved guilty, and shall not be punished under a retroactive penal law. The right of privacy is recognized; also affirmed are freedom of residence and movement within a country, and freedom of exit and asylum; freedom to marry without restriction on account of race, nationality or religion; and the freedom to own property. A number of articles provide for freedom of thought, conscience and religion; freedom of opinion, speech and press and other mediums of communication; freedom of assembly and association; and the right to participate in the government of one's country, directly or through freely chosen representatives. There are also provisions that assert social and economic rights.

Following adoption of the Universal Declaration, the Commission on Human Rights turned to consider measures of implementation and to the drafting of a covenant which, when adopted, signed and ratified, would take the form of an international treaty imposing specific legal obligations to observe and protect the freedoms and rights therein provided. In the development of these documents, involving sanctions, progress was slow. Notwithstanding this fact, adoption of the Universal Declaration of Human Rights by the world community was an outstanding achievement as recognition of the central importance of civil liberties and rights for the welfare of peoples and the peace of nations and the world.

Special recognition of the importance of freedom of the press was made manifest by the UN and some of its agencies—notably the Commission on Human Rights and United Nations Educational, Scientific and Cultural organization (UNESCO)—by the work done in drafting international covenants on this subject, by calling international conferences, and by their publication of studies and surveys.

Governmental Practices.—Important as are constitutions, laws and declarations, equally important, if not more so, are the actual practices of governments. Here we find extremes and many shadings between extremes. While the U.S.S.R. constitution guarantees freedom of religious worship, it is only antireligious propaganda that is permitted, and collective religious instruction to children under 18 is prohibited. Freedom of the press is guaranteed, but the government decides who will have a printing press and stocks of paper. Citizens are ensured the right to unite in public organizations, but only the Communist party of the Soviet Union is permitted to exist. In Saudi Arabia Islamic religion is the foundation of all rights; the practice of other religions is subject to restrictions. Spain prohibits foreign sects to carry on proselytizing activities. Totalitarian, dictatorial or feudal governments severely restrict religious, political and personal freedoms, so that civil liberties under such rule barely exist. In countries with well-established democratic governments and deeply rooted traditions of freedom, *e.g.*, the United States, Great Britain, France, the Netherlands, Sweden, civil liberties are recognized, respected and protected. Wars or other crises tend to strain fundamental liberties, but they tend to reassert themselves—the restrictions will be limited to what are considered grave emergencies, as; *e.g.*, in the treatment of the Japanese in the United States shortly after Pearl Harbor, or of the Communist party of the U.S. during the cold war.

Because of the great diversity in governmental practices, despite the adoption of the 1948 Universal Declaration of Human Rights, and because only a small fraction of the member states of the UN can be considered democratic, it was impossible in the second half of the 20th century to foresee rapid progress in the spread, implementation or strengthening of civil liberties. There was no universal agreement on what the civil liberties are or ought to be, on their definitions, or on how they should be achieved or promoted.

European Convention for the Protection of Human Rights.—Where, however, peoples share common traditions and institutions of freedom, they may agree on a program of protection of fundamental liberties. This agreement was achieved through the Council of Europe, set up in 1949 with the participation of Great Britain, France, Italy, the Netherlands, Sweden, Denmark, Norway, Belgium and seven other nations. On Nov. 3 and 4, 1950, the Committee of Ministers of the Council signed the European Convention for the Protection of Human Rights and Fundamental Freedoms, a document intended to guarantee citizens of council members their basic civil liberties and established a European Commission on Human Rights. In 1952 three additional rights were added to the convention. By the convention, member states agreed to submit to international control their actions affecting basic freedoms.

The European convention, unlike the UN Universal Declaration of Human Rights, provided legal protection for fundamental human rights. Private individuals and associations might file complaints after exhausting domestic or local remedies. The convention substantially duplicated the freedoms enumerated and defined in the UN Universal Declaration of Human Rights, but by providing for their implementation and by recognizing private individuals' complaints, it marked a notable step forward in the struggle for civil liberties in Europe.

Mass Communications and Freedom of Expression.—Formidable obstacles in the way of civil liberties in the second half of the century were held to be certain objective developments that were to be found even in democratic, free societies.

To Thomas Jefferson, if it were a question of having a government without newspapers or newspapers without a government, he would have chosen the latter; for newspapers, he thought, were guardians of all other liberties—without free reporting of events and free discussion of policies democracy could not endure. But in modern society, the mediums of mass communications have been used by totalitarian governments as instruments of control of thought, culture and political institutions.

Concentration of ownership in mass communications industries had in the second half of the 20th century become a prominent fact of modern industrial society. A few chains possessing multiple newspapers dominated in the newspaper field. In the motion-picture industry, competitive restraints in exhibition and distribution of films persisted as challenges to governmental and social policies. Radio networks tended to impose restraints on their member stations, and the common ownership of newspapers and radio or television stations restricted competition in the market place of ideas. Despite increases in population, the number of daily newspapers decreased, so that one-newspaper cities or towns had become an accepted pattern of urban life, and even these newspapers were often not independent but under single control. Thus, with respect to the most important mediums of mass communications, there existed the challenge and problem of monopoly.

These developments imposed strains on democratic theories and practices. Democratic nations are uneasy when they see these mediums become controlled by a few chains or monopolies. This problem was one of the most complex and delicate that free societies faced—societies that still believed, with Jefferson, that "error of opinion may be tolerated where reason is left free to combat it."

These developments affected the formation and direction of public opinion in such ways that the strength and extent of conformity offered threats to civil liberties. Concentration of control in the fields of communication was not the only cause of conformity; industrial, technical civilization, the existence of pressure groups and interests, and the desire for personal and economic security were additional causes in the formation of mass cultures that were inimical to dissent, deviation and nonconformity. Yet open societies, traditionally and historically pluralistic in ideals and institutions, were committed to finding ways to keep themselves open and free, tolerant of diversities and differences, so that majority rule was limited by minority rights, and the imprescriptible freedoms of persons were protected and sustained.

Pragmatic *v.* Natural Rights Considerations.—Quite apart from religious convictions and natural law beliefs, which often do not play a controlling role in modern secular societies, the pragmatic basis of civil liberties had by the second half of the 20th century won widespread support. As citizen replaces subject, it is held, self-government and free society can be maintained only if two practical conditions are met; namely, that the enjoyment of human freedoms imposes limits on government, and that there is a free and universal suffrage. The justification and basis for the latter is found in the former condition; for self-government can be reasonable only where the citizens are free to develop their intellectual and spiritual powers. For this development they need civil liberties—freedom of speech, press, assembly and association, freedom of religion, freedom to teach and to study, freedom of the person from arbitrary acts of government, the right of privacy and other liberties. Without the enjoyment of these liberties, men cannot qualify for self-government, and without self-government men are subjects and not citizens.

But it is precisely at the point where men chose to be citizens and not subjects that the modern world presented in the second half of the 20th century the greatest threat to civil liberties: men will fight their external enemies in order to preserve themselves from subjection to a foreign power; in this fight they will vigorously seek to uncover agents of the foreign power and will try to control thoughts that may seem suspiciously subversive. They are willing to fight and die for their freedom, yet freedom will be curbed in order to vindicate and win the war. Civil liberties may thus give way to security interests. It, therefore, also becomes apparent that a free society is dependent on peace; and so it becomes a practical issue for free peoples to seek peace among the family of nations. Thus it happens that the organs of international relations, such as the United Nations, are concerned with both freedom and peace—with fundamental human rights and with freedom from fear.

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CIVIL LIST, the English term for the account in which are contained all the expenses immediately applicable to the support of the British sovereign's household and the honour and dignity of the crown. An annual sum is settled by the British parliament at the beginning of each reign and is charged on the consolidated fund. It is thus not open to parliamentary criticism, but the account is audited by treasury officials, one of the permanent secretaries of the treasury being appointed auditor of the Civil List.

William and Mary.—The history of the Civil List dates from the reign of William and Mary. Before the revolution no distinction had been made between the expenses of government in time of peace and the expenses relating to the support of the sovereign; the ordinary revenues, derived from the hereditary revenues of the crown and from certain taxes voted for life to the king at the beginning of each reign, were supposed to provide for both. Any saving made by the king in the expenditure on the government of the country or its defense would go to swell his privy purse. But with the revolution a step was taken toward the establishment of the principle that the personal expenses of the sovereign should be separated from the ordinary expenses of the state.

The parliament of William and Mary voted in 1689 an annual sum of £600,000 for the charge of the civil government. This was a mere resolution without statutory effect. In 1697 the first Civil List act was passed. Certain revenues (the hereditary revenues of the crown and a part of the excise duties), estimated to yield £700,000, were assigned to the king to defray the expenses of the civil services and the payment of pensions, as well as the cost of the royal household and the king's own personal expenses or privy purse. The Civil List meant practically all the expenses of government except the debt charge and defense. If the yield of the assigned revenues exceeded £700,000 the surplus was to be disposed of by parliament. This restriction was removed by an act of 1700. In the reign of Anne the Civil List consisted of the same assigned revenues (subject to certain deductions). The yield fell short of £700,000, and during the reign debts were incurred amounting to £1,200,000 which were paid off by parliament.

The Hanoverians.—For George I additional revenues were assigned, and it was enacted in effect that the Civil List should become independent of the yield of the assigned revenues and should be a fixed sum of £700,000 a year. Any surplus was to be surrendered and any deficiency would be made good. But this was found insufficient, and parliament from time to time made additional grants from the exchequer to pay off debts totaling £1,300,000. In the reign of George II there was again a change of system. The Civil List was composed of the assigned revenues, together with certain fixed grants, and a minimum yield of £800,000 was guaranteed by parliament. Any surplus yield over £800,000 was retained by the king. On the accession of George III the system of a fixed Civil List was resumed. The assigned revenues were no longer paid to the crown but to an aggregate fund as part of the revenues of the exchequer, and the fixed allowance of £800,000 was paid out of the aggregate fund to the king (subject to certain annuities payable to members of the royal family).

During the reign of George III the Civil List played an important part in the king's effort to establish the royal ascendancy. The "king's friends," his supporters in parliament, were lavishly rewarded with places, pensions and even bribes. There was no independent check upon the expenditure of the Civil List. As long as the total was not exceeded, the king, with the co-operation of complacent ministers, was free to spend as he pleased. As it turned out, despite stringent economies in the cost of the household, excesses were incurred. But parliament, already corrupted, was persuaded to provide extra funds to pay off the debts (£513,511 in 1769 and another £618,340 in 1777). In the latter year the Civil List was raised to £900,000.

Edmund Burke had already attacked the extravagance and corruption of the Civil List and in 1780 introduced bills embodying his scheme of economic reform. The scheme could not be passed against Lord North's government, but in 1782 the Rockingham ministry passed a Civil List act which abolished many useless offices, imposed restraints on the issue of secret service money, stopped secret pensions payable during the king's pleasure and provided for a more effectual supervision of the royal expenditure.

The Civil List was divided into classes, but estimates for the several classes were not binding and were in fact soon exceeded. Indebtedness accumulated and had from time to time to be paid off (£3,398,000 in all between 1782 and 1820). The amount of the Civil List itself was augmented and in 1816 it was fixed at £1,083,727. Meanwhile the principal provision for the civil government had come to be made outside the Civil List. Annual votes of parliament for what were called miscellaneous services had been between £200,000 and £300,000 in the earlier years of George III's reign. By 1820 they amounted regularly to about £2,000,000 a year. George IV on his accession in 1820 received a Civil List of £845,727.

During the reign of William IV, the Civil List was finally freed from all charges for the government service as distinguished from the court and royal family. The expenses left were covered by a Civil List of £510,000, including £75,000 for pensions.

Civil List Pensions.—The pensions were excluded from Queen Victoria's Civil List and a new system was set up. The queen might, on the advice of her ministers, grant pensions up to a limit of £1,200 in any one year, in accordance with a resolution of the house of commons of Feb. 18, 1834, "to such persons as have just claims on the royal beneficence, or who, by their personal services to the crown, by the performance of duties to the public, or by their useful discoveries in science, and attainments in literature or the arts, have merited the gracious consideration of the sovereign and the gratitude of their country." In 1937 the limit of £1,200 was raised to £2,500, and in 1952 it was raised to £5,000.

Queen Victoria to Elizabeth II.—Queen Victoria's Civil List amounted to £385,000, separate provision of £100,000 being made for Queen Adelaide, who had had a privy purse of £50,000 during her husband's reign. The sums granted after 1901 were as follows:

	Edward VII	George V	Edward VIII	George VI	Elizabeth II
	1901	1910	1936	1937	1952
Privy purse . . .	£110,000	£110,000	£110,000	£110,000	£ 60,000
Salaries and retired allowances of household	125,800	125,800	134,000	134,000	185,000
Expenses of household	193,000	193,000	152,800	152,800	121,800
Works . . .	20,000	20,000	. .	. .	. .
Royal bounty, alms and special service . .	13,200	13,200	13,200	13,200	13,200
Unappropriated . .	8,000	8,000	. .	. .	. .
Supplementary provision	. .	. .	. .	. .	95,000
	£470,000	£470,000	£410,000*	£410,000	£475,000

*Of this amount £40,000 in respect of the king's possible marriage, and £79,000 representing the revenues of the duchy of Cornwall, were undrawn.

In the reigns of Edward VII, George V and George VI £40,000 was earmarked for the queen. In the reign of Elizabeth II £40,000 was paid to her consort, Prince Philip, from the consolidated fund.

The Civil List acts, 1901–37, made provision for an annuity of £70,000 to the widow of a sovereign. Queen Alexandra and Queen Mary drew this allowance and Queen Elizabeth, the Queen Mother, continued to draw it. On the accession of George V in 1910 a slight change of practice was introduced. In 1842 Victoria, though under no legal or constitutional obligation to pay taxes of any kind, undertook voluntarily to pay income tax. Edward VII continued the voluntary payment. George V agreed with the government of the day that it should be discontinued, but in exchange placed on the Civil List the cost of state visits of foreign royalties previously defrayed from public funds. In 1916 the king made a voluntary gift of £100,000 toward the cost of World War I. In the financial crisis of 1931 George V voluntarily offered to make a reduction in the Civil List. It was not until July 1, 1935, that this economy cut was fully restored. In 1948 George VI transferred to the consolidated fund a sum of £100,000 which represented the savings on the Civil List during World War II. The transfer was made so that no additional charge should be imposed for a period of four years for the payments of Princess Elizabeth and the duke of Edinburgh.

In addition to the Civil List the sovereign receives the revenues of the duchy of Lancaster. It has also been the practice for provision to be made for the sons and daughters of the sovereign. The heir apparent, if the only or eldest son of the king, is duke of Cornwall and as such possesses the revenues of the duchy. Edward, prince of Wales (later Edward VII), received the revenues of the duchy, then £60,000 a year, with the addition of £40,000 on marriage; the duke of York (later George V) £80,000, with the addition of £20,000; Edward, prince of Wales (later Edward VIII) £80,000. Prince Charles, duke of Cornwall, receives one-ninth of the revenues until he is 18 and then £30,000 a year until he is 21. He would then receive the entire revenue of the duchy.

Annual provision to other members of the royal family was made (in 1958) to: the duke of Gloucester, £35,000; the princess royal £6,000; and Princess Margaret, £6,000. These payments, like those to the queen mother and to the duke of Edinburgh, were paid out of the consolidated fund. The Civil List act 1952 had increased the allowance to Princess Margaret to £15,000 in the event of her marriage (which occurred in 1960). From the supplementary provision of £95,000 in Queen Elizabeth's Civil List, £25,000 was available for other members of the royal family (*e.g.*, the duchess of Kent and the countess of Athlone) who undertook official duties.

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(R. G. H.; Jk. W. G.)

CIVIL-MILITARY RELATIONSHIPS. In all societies that have a professional soldiery there is a constant two-way flow of influence between the civilian and military components. This is true both in civilian governments and in military dictatorships. The relationship between the civilian and military groups has commanded the attention of students of military affairs to an increasing degree in the 20th century. The nature of military organizations and their employment and control have become matters of serious concern to civilian and military leaders.

The military organization is always a potential threat, in one way or another, to civilian authority, for the military class holds the double-edged sword of tyranny and national security. Military force has been used throughout history to both limit and advance ideologies, to expand and defend borders and to occupy and administer foreign states. It has at times been an indispensable factor in instituting and protecting civilian authority within the state; at other times it has been instrumental in bringing about the demise of civilian government. In some states the armed services have played a part in the overthrow of monarchies, republics and dictatorships; in others they have helped bring such regimes into existence. On some occasions the military force has been a factor making for change; on others it has created stability.

Tensions between civil and military authorities often arise because of a difference in the emphasis each places on the importance of the military security of the state. The military leaders tend to demand heavy public sacrifice for defense; civilian authority must promote other values as well. As a distinguished civilian statesman, Robert, marquis of Salisbury, once cynically observed, "If you believe the doctors, nothing is wholesome; if you believe the theologians, nothing is innocent; if you believe the soldiers, nothing is safe."

Civilian authority also demands that the armed forces conform to its political policy and social ethic. Sometimes explicitly, sometimes implicitly, the civilian leadership lays down a set of policy limits within which the military organization must plan and operate. In societies that place a high value on a nonmilitary way of life, the civilian authority determines both the goals and the means by which they are to be attained. Rarely have those in the armed services of such states been free to use their best military judgment as to over-all strategy, tactics or even training. Under certain conditions, for example, civilian leadership will not subscribe to the starting of war in the interest of the security of the state no matter how strong the case for it in military logic. On the other hand, the vitality of an ideology may be such that civilian leadership will force the military organization into war long before the military leaders believe war to be feasible. In some circumstances civilian leadership determines the composition and level of military armaments; in others it prevents the use of certain tactics as too costly in human life.

It is precisely this civilian role to which the military authorities object. Certain aspects of civilian control inevitably appear irresponsible and may appear positively dangerous to the military mind. There is a tendency among military men to react as political idealists who project their own conception of Spartan self-sacrifice into the political affairs of the state.

Civil-military relationships within the great powers of modern times have passed through three general phases as the fundamental concept of war itself has changed. In the first, during the period of royal absolutisms, the nation-state subdued its feudal barons and gained control of the military forces within its borders. In the second, with the rise of popular democracies, the military arm gained control of all the resources of the state for the prosecution of war. In the third phase, with the advent of 20th-century totalitarianism, the historic difference between war and peace, between things civilian and things military, faded. In this last stage virtually every activity of the state came to bave some bearing on its military strength.

Roughly speaking, the first phase began in Europe at the end of the middle ages and carried through until the last years of the 18th century. The second began in the late 18th century with the revolutions in the North American colonies and in France and was complete by the end of World War I. The final phase began with the Russian Revolution in 1917 and came to ideological fruition in Nazi Germany in the 1930s and during the Chinese revolution of the second quarter of the 20th century. Each change in civil-military relationships was complemented by new political ideologies —royal absolutism, popular democracy and Fascist and Communist dictatorship. Each shift was buttressed by new economic thinking—mercantilism, laissez-faire capitalism and the garrison economy. The flow of influence between the civilian and military components of the state was affected by new developments in transportation, weapons, communications, mass psychology and the patterns of economic development. In a sense, the main military achievement of the 20th-century dictatorships was their recognition that war is broadly political and that, therefore, old distinctions between war and peace may be made meaningless.

In its simplest form the problem of civil-military relationships is as easy to state as it is difficult to solve: how to provide a strong military organization to protect the state and yet prevent the military class from seizing the reigns of government. For many nations this problem has continued to pose difficult questions throughout the period of modern history. The problem in its modern form was first faced by the European states in the 16th and 17th centuries.

Military Absolutism in the 17th Century.—For both the intellectual and the common man, war in the 17th century was a sordid and continuous affair. It was also something that they took for granted. As commercial competition was directed toward destroying one's competitor, world trade and world peace were considered opposites. War was thought to be an inevitable part of economic competition. Under such circumstances it is understandable that much thought was given to war as a state institution.

The military problem of the 17th-century state was twofold. The first aspect was the supply of war material. Because armies were larger than before, and weapons more expensive, the logistics of war had entered a new phase that demanded new solutions. The second aspect, not so universally troublesome, was that of gaining control of mercenary armies and turning the free-lance soldier into the military bureaucrat. New tactics on the battlefield required greater uniformity of training on the part of both officers and men. War in the 17th century had become a science as well as an art. Officers had to be taught engineering and the common soldier had to learn a new discipline. The solutions to these problems were in a sense complementary, for the organizations created to feed, clothe and arm the soldier were also useful to control his actions. By fulfilling a military need the new bureaucrats were able to achieve political control. By offering schools to the officer group and putting uniforms on them all, the state was able to enforce a degree of homogeneity on armies that they had never before possessed. The changes took place gradually, and there was no single pattern of development that applied to all states. But finally, with their account books and regulations, the bureaucrats of the 17th century made the state the owner of the tools of war and thus were able to create a dependent military hierarchy.

While the government took away the independence of the officer, it also gave him certain security, awards and privileges which he had not previously enjoyed. In Sweden and Russia, for example, officers were given titles of nobility for their achievements. In France they were made members of the Order of St. Lazare and received financial emoluments accruing therefrom. For the common soldier, whose status was much lowered by these developments, old soldiers' homes were founded or provisions were made whereby the old soldier was not turned out of the barracks. Patient indifference was consciously inculcated into the minds of the soldiery as the height of virtue.

These developments, taken together, meant that at the end of the 17th century the national government was firmly in control of the army. The military developments of the 18th century gradually made it possible to isolate war from society, at least until new revolutions in North America and France inaugurated new ways of war at the very end of the century.

Civilian-Military Separation, 18th Century.—Frederick the Great of Prussia remarked in his *Political Testament* that the civilian population of a state should not be aware when a state of war existed. And, for all intents and purposes, the civilian population in 18th-century Europe was unaware of military activities in the sense that war seldom touched their homes and persons. As the 17th century had clearly shown, a military force was necessary but nothing was so harmful to the economic well-being of the state as war. Therefore, the scum of society was swept into the army by such recruiters as tbose described in Voltaire's *Candide* or into the navy to live the vile life described in Tobias Smollett's *Roderick Random*. The solid strata of the working classes were only slightly touched. Furthermore, the officer class was no greater drain on the more productive elements in society than were the common soldiers. The lower officer ranks seem for the most part to have come from the landed gentry, and the upper ranks were reserved as sinecures for the great families. The usual ravages of war were not apparent in the 18th century, and battles, though bloody wben fought, were seldom fought.

Moreover, the absolute monarchy was never able to tap all the resources of the state. The monarch was limited by the interests of his officer nobility, by custom, by the restraints of tradition and precedence, and above all by current economic beliefs. The French monarchy went bankrupt at the end of the 18th century in large part because of military expenditures in connection with financing the revolution in America. But revolutionary France was able to fight all Europe for a quarter of a century immediately thereafter. The difference was that patriotism brought mass participation along with it. Yet, despite or because of isolation from civilians, the aristocratic military class was frequently bitterly criticized by the intellectuals. This was not only true of the philosophers but was part of popular thought as well.

Creation of the Citizen Soldier.—The intellectual background of the two great revolutions that brought the 18th century to an end was antimilitarist. The difference in the attitudes of revolutionaries in France and America lay in the fact that the American colonists tended to be against standing armies per se, as the Declaration of Independence made abundantly clear, whereas the French, as the famous art. i of the decree of tbe Convention of Aug. 23, 1793, affirmed, simply wanted their army to be a civilian army responsive to the state. The revolutionary saw himself as an antimilitarist, but in the eyes of the rest of 18th-century Europe he had brought a new barbarism to war. The 18th-century absolutist state had tried to separate the civilian from the soldier, whereas the democratic revolutions made a soldier of the citizen.

By the beginning of the 19th century the nature of war had changed; wars had become national. Although the extent of change can be overstated—the revolutionaries both in France and the United States made use of aristocratic officers and old methods of drill—the revolutions did create a new set of civilian values, and these in turn allowed greater scope to military tactics. The virtue of stoicism was replaced by the spirit of patriotism. The soldier as a citizen became a hero. Society put the warrior back on the pedestal of honour.

These changes in civilian values gave the army a sense of dedication and purpose; political revolution had made the army the bearer of political ideology and war itself a crusade. The armies of Napoleon carried the revolutionary ideal across the Alps and over the Rhine. Thereafter, conquering armies throughout the 19th and 20th centuries imposed their ideologies where they planted their flags.

A concomitant of this change was the active intervention of the civilian politician in military affairs. Members of the continental congress gave Gen. George Washington, as well as their naval captains, specific and detailed advice on all manner of military matters, and in France the political representatives on mission to the armies likewise enforced politico-military policy. The activities of both were roughly paralleled by the activities of the political commissar during the Russian Revolution over a century later. Civilian control became more directly political, less wholly bureaucratic. To a greater or lesser extent both military tactics and strategy were made responsive to the popular will.

Civilianization of War, 19th and 20th Centuries.—The revolutions of the late 18th century, together with the impact of the Napoleonic wars, wiped away the 18th-century distinction between soldier and citizen. Mercenaries continued to be used extensively by Europeans in colonial warfare but the use of mercenaries in Europe became the exception rather than the rule. Yet the 18th-century concept that war and peace were separable conditions, and that civilian affairs and military affairs were likewise largely so, continued as an integral part of the democratic credo.

Nineteenth-century thinking on military forces followed two distinct lines: as a symbol of patriotism the army was a source of national pride; as a symbol of tyranny within the state it was a source of political suspicion. This dual concept continued in the democratic states until World War II and left its imprint on civil-military relationships thereafter. The strength of these conflicting convictions varied in men's minds according to their concept of the extent and source of military danger. From Napoleon's departure for St. Helena to the Franco-Prussian War of 1870–71, the possibility of war between the nations appeared remote and armies were not looked upon with great national pride. Where the army was used for political repression of democracy, as it was in Turkey and Germany, it was looked upon by the democratic citizenry as a tool of tyranny. But when, in the years following the Franco-Prussian War, the possibility of war between the nations became an accepted part of public opinion, then armies became objects of pride and symbols of national security.

Between 1815 and 1870 military thought and economic thought were mutually exclusive. So little did they have in common that it was even considered quite acceptable to deal in the bonds of the enemy state on one's own stock exchange. It was only after 1870, with the advent of national tariff barriers and the complementary new thrust and direction of imperialism, that national economics were once more considered a co-ordinate part of war potential. Between 1815 and 1870 civilian thought on military matters and professional military thinking on these same matters had very little in common. The professional military man tended to think of the good soldier as the old hand to whom the barracks was home and to whom the highest virtue was a sense of duty and a remembrance of discipline. But that professional sense of duty, immortalized in Alfred de Vigny's *Servitude et grandeurs militaires*, was emphatically not that of the liberal. For the 19th-century liberal, the military ideal was the Minute Man, the embattled farmer of the American Revolution, the citizen soldier of the levee en masse. When, after 1870, it became generally recognized that infinitely larger masses of men could be successfully employed in war, this separation of thought was modified and the argument between the civilian and the military man became one as to the length of time it took to train a soldier. The farther to the political left, or the farther from the area of possible conflict the civilian happened to be, the greater was his belief in the military virtues of the relatively untrained soldier.

Finally, civilian appreciation of military virtues changed as the concept of war, its likelihood and its desirability, changed. Only after 1870 was conflict itself considered a virtue. The political philosophers earlier in the century scarcely mentioned war, yet those who wrote in the shadow of World War I, or under the rays of the never-setting sun of imperialism (Rupert Brooke, Nietzsche and others), saw a virtue in struggle. For Mr. Pickwick, Charles Dickens' military enthusiast of the mid-19th century, the soldier was an inspirational ornament. By 1900 the soldier had become a rough, rugged, unappreciated hero, the frontiersman of the thrust of civilization—the hero of Rudyard Kipling's *Soldiers Three*.

The economic developments of the 19th and 20th centuries served to complicate and expand civil-military relations. Civilian transportation facilities such as the railroad and the steamship increased the size of the military mass that could be thrown into battle. The new technology made the inventor and the scientist the indispensable intellectual partners of the military. Civilian technical contributions became greater with time. By the middle of the 20th century, it is no exaggeration to say, the civilian had become a military specialist and the military man a generalist on the military aspects of war. And when during time of peace civilians and military men part company the military tend to become moribund.

The Industrial Revolution made a big business of war. Hence there developed new political interests on the part of civilians in the financial aspects of military contracts. Always a potential source of graft, the military establishment now became a source of legitimate business concern. The converse was also true. As war expanded, governments came to take an increasing interest in industrial and technical progress. By the middle of the 20th century the demands of war were such that in the capitalist countries governments had to go into business themselves to create the weapons of war. Whole sections of the U.S. economy depended during the 1950s on military contracts.

Throughout the 19th and early 20th centuries the distinction between war and peace remained clear in men's minds. Both civilians and military men found it easy, therefore, to admit that there could be an exchange of leadership as peace changed into war. In the years immediately preceding the outbreak of World War I this concept was particularly easy to entertain because of a general belief that in the future, as in the immediate past, wars would be of short duration. Only with the failure of military leadership did civilian decision become dominant once again. As a result, in World War II political leaders such as Winston Churchill and Franklin D. Roosevelt, with the experience of Lloyd George and Woodrow Wilson in World War I in mind, took a direct interest in military affairs, frequently at the expense of what might be more properly considered political affairs.

Civilian authority must be in a position to change the military leadership if necessary. This enormous problem for democratic states could have been more satisfactorily solved had the democracies been willing to make preparations for war in time of peace. The British government, just after the start of the 20th century, did make an attempt to co-ordinate civilian and military organizations for efficiency in time of war when it formed the Committee of Imperial Defence. But in most cases war was fought with organizations formed at the time for the current emergency. French organization for this sort of emergency remained rudimentary until after World War II, despite much discussion of the problem over a great many years. In the United States an organization for total war did not exist until the creation of the National Security council in 1947. In Germany the general staff prepared no economic plan at all for World War I; Hitler's economic planning for World War II was inadequate, largely because, like Napoleon's, his economic concepts were badly outdated.

In addition to the difficulties that arose between civilian and military leadership because of the distinctions each accepted between the state of war and the condition of peace, the civilian and the military groups in the free societies found themselves in periodic disagreement because of the peculiar position of the army in a free society. In a free society the military establishment is always a state within a state. Freedom to move, to speak, to write, to argue—the basic freedoms in a free society—are subordinated in a military community, which has its own courts, laws, customs and dress. Insulated from civilian society, it naturally is looked upon with suspicion by civilians. This suspicion has taken a number of different forms, one of which is the belief that the army is a direct threat to the stability of civilian authority. During the first half of the 19th century, for example, there were repeated attempts to destroy the U.S. Military academy at West Point on the grounds that it bred an aristocratic outlook. Or, again, civilian suspicion that military justice is not consonant with the ideals of the state has frequently been a source of conflict between civilian and military interests in the United States. In France the miscarriage of military judgment in the case of Alfred Dreyfus, captain on the general staff, tore the republic into two political factions at the turn of the 20th century.

By far the most serious source of suspicion has been the possibility that the military leaders were playing too large and independent a role in the formulation of national policy in economic and diplomatic terms. This in turn explains the continuous interest by the great democracies in the administrative organization of the armed forces and in the perfection of the mechanisms of civilian control. "Civilian control," however, was never precisely defined. It was simply an expression of democratic faith that armies (always differentiated from navies) are a necessary evil. It follows that at times when armies are considered least necessary they are considered most evil. And when the evil has been thought to outweigh the necessity, there has been greater effort to ensure civilian control.

In great part the interpretation of the meaning of "civilian control" has been the result of historical accident. Those who drew up the U.S. constitution believed, as did their 17th-century English forebears, in strong legislative controls at the same time that they made the president commander in chief. Yet the handling of military budgets is today altogether different in the two countries, and the face-to-face contact with military officers on which the U.S. congress insists is altogether missing in Great Britain where formal parliamentary contact is exclusively with civilian ministers. Both countries, and particularly the United States, have considered civilian ministers or secretaries of military affairs absolutely essential for civilian control. France, on the other hand, has not considered military men in cabinet positions as threats to the state. In Israel, a state that owed its birth to a secret army, there is virtually no concept of control at all. In the Federal Republic of Germany, on the other hand, wherein memory of the destruction of the Weimar republic in the mid-1930s is still bright, control of the military is considered a vital political matter.

Generally speaking, civilian control is exercised through the budget, through legislation affecting military organization and through political control over appointments and dismissals. Civilians have also attempted to set up a force outside the regular army to counterbalance it. The sovereign, for example, has his bodyguard; the dictator has his paramilitary secret police; the democracies have their militias, national guards or organized part-time reserve units, one of whose functions was originally thought to be the protection of the state from the regular army.

Civilian control is limited in free democratic societies because of the many avenues open to protest by the military class. Like other elements in society the military may appeal its case. In the United States the military leaders may protest against executive department action to congressional committees or to the press. In Great Britain army officers have on occasions persuaded sympathetic ex-officers in parliament to argue their case publicly and have threatened mass resignation at least twice. Indeed, only when these channels of communication are closed to the military, as in the case of Nazi Germany, has the civilian been able to make his control complete and almost unquestioned.

Although civilian and military affairs tended to fuse in the 19th-century, the image of their separateness lived on in men's minds. Because war and peace were considered separable, war was considered abnormal, a policy mishap rather than a result of policy. And because it was considered an abnormality, and was studied as such in the universities as well as in the foreign offices, military planning and foreign policy planning had remarkably little to do with one another. In the United States there was virtually no contact between the department of state and the military departments until the eve of World War II. In Britain before World Wars I and II the British military establishment and the foreign office had little cross-fertilization of ideas. In France military planning between the two world wars actually ran counter to foreign policy planning. Hence, because war was not seen in political terms, it was fought as a moral issue, the end result of which was that world wars ended in absolutes—complete victory or complete defeat. And the terms of surrender were considered punishments for crimes committed.

Eclipse of the Distinction Between War and Peace.—The basic difference between totalitarian military thought and democratic military thought is that the former makes no distinction in theory between a state of war and a state of peace. The old distinction of nationality disappeared in totalitarian thinking, and with it gradually went the concept of borders, uniforms, the possibility of acceptable codes of war and all the paraphernalia of 19th-century state warfare. Neither Fascism nor Communism has recognized these inherent limitations to war, because both see war as social rather than political. Hence, both believe that war must be fought within the enemy state as well as against it. Thus, the political organizer has become the skirmisher of modern warfare.

Lenin wrote as early as 1906 that Marxism "recognizes the possibility that struggle may assume the most variegated forms." If war and peace are inseparable, and the army only one of the instruments of war policy, of which every activity of the state is a part, then it follows that state and army are one. Mao Tse-Tung, the most prolific and the most sophisticated of the Communist military theorists, once put the idea in this form: ". . . without armed struggle there would be no place for the proletariat, there will be no place for the people, there will be no Communist Party, and there will be no victory in revolution."

Engels, Lenin, Stalin and Mao Tse-Tung were all conscientious students of military affairs. Each considered military affairs as but one aspect of political struggle. As a result each felt that the political leadership should lay down the explicit principles of war for the military organization to follow. Just as other military heads of states—Napoleon, Ludendorff in the last months of World War I, and the Japanese military chiefs during World War II—felt no hesitation in directing political affairs as an adjunct to the prosecution of war, so totalitarian leadership did not hesitate to direct the military force as an adjunct to the prosecution of their revolution. Furthermore, the Communist military men understood their relatively subordinate role—better, in fact, than did the German generals. As one of their number, Marshal Shaposhnikov, once remarked, "If war is a continuation of politics only by other means, so also peace is a continuation of conflict only by other means." Thus there has been, on the part of the Communist, conscious realization of the fact that the manipulation of foreign trade, subversion and propaganda are part of an over-all war policy.

This does not mean, of course, that in Communist and Fascist countries there have been no difficulties between the civilian and the military authorities. The purges of military leaders in the 1930s in the U.S.S.R. and the periodic exile of military leaders to distant posts after World War II make the dimensions of the problem quite clear. This struggle has been political. It has had to do with the determination of leadership, as well as basic differences as to what should be spent and how. Military leaders in dictatorships have not always avoided doctrinal conflict with civilian politicians. The military group has argued foreign policy ends with the civilian leadership. The famous July 20th plot of the German army officers to kill Hitler during World War II makes obvious the point that even in a dictatorship there are limits to the military tolerance of civilian dictation.

As war came to permeate every social and economic institution within the state, it was quite natural that the military and the civilian should influence one another to a greater extent than ever before. The "cold war" of the mid-20th century forced the democracies to change their concepts of war and to organize their governments, their minds and their economies for a different kind of struggle, one which was alien to their established system of values. Their understanding of the new dimensions of struggle evolved slowly. For the Communist the concept of struggle as a complete subordination of means to ends was part of a long tradition, an integral part of a theory of social behaviour and a concept of historical evolution dating from the inception of Marxism.

Technology shrank the world not only in terms of geographical relationships but also in terms of the numbers of powers able to afford the most modern weapons. It also made the great powers less able to use the weapons in their own arsenals, so great had their destructive power become. Technology served to make war a most imprecise and unpredictable servant of policy. And this in turn lessened the relative importance of the military class in the making of war. If war is defined as the manipulation of violence in all of its many forms, then by the mid-20th century the role of the military and the civilian had changed. In a politically bipolar world, in which economic, political and psychological warfare had become the weapons of day-to-day usage, it was the civilian who inevitably played a more vital role in warfare than ever before. Yet this too was a paradox, for in the mid-20th century the military controlled weapons that threatened the destruction of all traditional political institutions. *See* also ARMY; LOGISTICS; STRATEGY; TACTICS.

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CIVIL SERVICE is the term used to describe servants of the local, state or central government employed as civilians. In the United States the term is often used to describe that part of the government service entered by examination and offering permanent tenure. It does not cover cabinet members or ministers or the judiciary. In other countries it usually does not cover local government employees (*see* LOCAL GOVERNMENT), nor the staffs of public corporations such as, in the United Kingdom, the National Coal board; but in some countries, where provincial administration forms part of the central government, some provincial staffs are civil servants.

Organized governments have always had civil servants, if not civil services. The civil service in China is undoubtedly the oldest. The able and powerful Roman civil service disappeared in the west when the empire broke up in the 4th and 5th centuries. In the modern world civil services became important with the emergence of national states, notably France and Prussia.

The wide functions carried out by most governments in providing social services (*e.g.*, insurance against unemployment or sickness) or regulating economic life have brought into being large permanent civil services. Many civilians are also employed in support of the fighting services. The growth of these staffs is often described as "bureaucracy," a term connoting regret for the tendency for the state to dominate the life of the individual. As against this, the personnel systems of the big industrial organizations have taken on many of the characteristics of the civil service, while industrial enterprises undertaken by states have increasingly been modeled on the experience of big business. (E. E. Bs.)

THE UNITED STATES

History.—The high standards of integrity, nonpartisanship and permanence of tenure established by George Washington on the whole prevailed in the U.S. national government until 1829, although the states were less fortunate. The Tenure of Office act of 1820 put terms to some positions and under Andrew Jackson (1829–37) rotation in office, partisanship and personal favouritism introduced the spoils system on a national scale. The second period of party patronage and spoils endured, under mounting criticism from such men as Thomas A. Jenckes, George William Curtis, Dorman B. Eaton and Carl Schurz until 1883, the date of enactment of the present national Civil Service (Pendleton) act. After 1883 there was a steady extension and refinement of the merit system, but patronage continued to play an important role in many states, counties and cities.

The character of the U.S. civil service system has been deeply affected by the democratic manners and aspirations of the people. The patronage system was defended because it was believed democratic; on the other hand, a permanent public service smacked of bureaucracy. Jackson spoke against the idea of property in office and of the advantages of wide participation in officeholding, the duties of which, he said, were relatively "plain and simple." Everyone, it is still held, should have an opportunity to compete in examinations, hence age limits were high or nonexistent (and in 1953 were abolished for many classes of federal positions); hence objections to educational prerequisites except for scientific and professional posts. The U.S. has no historic tradition such as that which underlies the civil service institutions of Great Britain and the European continent.

In the national government the principal advances after 1883 were the increasing coverage of the merit system both by legislation and executive order, culminating in the Ramspeck act of 1940; the classification of positions by duties and a systematic pay plan in 1923; a pension act, 1920; the development of progressive personnel practices in the Tennessee Valley authority after 1933; the extension of the merit system by act of congress in 1939 to state services receiving federal grants; further protection against political interference, by the Hatch acts of 1939 and 1940; statutory provision for veterans' preference in 1919 and 1944; and in 1947 an executive order concerning employee loyalty. The centre of interest had shifted from protection against patronage to improved management methods, although the former still remained a principal duty of civil service commissions.

In the early 1960s the merit system included (1) more than 95% of all permanent federal employees, excluding emergency and temporary workers; (2) all state and county personnel receiving federal funds; (3) the state services generally in about 22 states, (4) county services generally in New York and Massachusetts, frequently in New Jersey and occasionally elsewhere, notably in Los Angeles (Calif.) county and Milwaukee (Wis.) county; (5) city services in more than 800 municipalities and the employees of more than 1,000 council-manager cities, most of which had no civil service commissions; (6) police and fire departments generally.

The county services were still predominantly partisan. In some states and some large cities operating standards were low, the merit system being a form rather than a reality. But such cities as Los Angeles, Cincinnati, O., Milwaukee, Wis., and St. Paul, Minn., had admirable records. The U.S. party system was not fully adjusted to a nonpartisan public service and the process offered difficult problems.

The merit system also had to be adjusted to preference for veterans, which antedates civil service legislation. From 1920 to 1940 veterans of World War I received from 20% to 25% of federal positions filled by examination. The Veterans' act of 1944 gave disabled veterans ten points in addition to their earned ratings and a place at the head of each register, five points to all other veterans and various further privileges. With about 15,000,000 veterans of World War II, the proportion of veterans in the federal service by the early 1960s amounted to about 60%. In some states and cities even more impressive benefits were granted; each jurisdiction makes its own rules.

The legal foundation for the national civil service is a considerable body of legislation, a mass of executive orders and commission and departmental rules; in a few states there are constitutional requirements for civil service. State-wide laws govern county and municipal civil services in some cases; in others, cities are left a free hand. In many states there is a considerable body of judicial interpretation, a branch of the law of public officers.

Administration of Civil Service Systems.—The typical form of organization for the administration of civil service laws is a commission, usually comprising three persons of whom not more than two may belong to the same political party. There is a trend, however, toward either a single personnel director or a commissioner with two associate commissioners concerned only with rules and hearings. The U.S. civil service commission is composed of three members, not more than two of whom may be adherents of the same political party. They serve for six-year terms, and since 1949 one member is designated to be the chairman. The U.S. civil service commission is by far the largest of its kind, with a peacetime staff of about 3,000. Its principal divisions are concerned with examination, position classification, investigations, retirement records, loyalty determinations, incentive awards, life insurance, and appeals and review. A large field force is organized in 14 regional offices and many subordinate stations. Since 1938 every federal department and establishment has had a personnel office to deal with its own problems and with the civil service commission. The heads of these offices form the Federal Personnel council, a body re-established in 1938 to facilitate exchange of experience and the formulation of policy. Regional personnel councils exist in the principal centres. In the Tennessee Valley authority personnel work is in charge of a director of personnel; in the council-manager cities the same pattern is common. There are no special civil service tribunals in the U.S. apart from the loyalty boards, but in the federal departments, since 1940, there are appeal boards (including a representative of the civil service commission) to hear appeals on efficiency ratings.

The examination system developed markedly after 1920. Traditionally examinations were of the essay or problem type or consisted of a demonstration of skill or strength. From the psychological laboratòries came tests of "general intelligence" and aptitude which were progressively adapted to large-scale use. Most written examinations now given by the U.S. civil service commission are of the short-answer type. They are scored by an electric scoring machine which has greatly expedited operations and reduced costs. The short-answer form permits the progressive improvement of the reliability and validity of tests, and much experimental work has been done inside and outside of government.

Tests for higher positions usually comprise a rating of education and experience and an oral interview, rather than a written paper. Tests for positions requiring skill or strength are usually demonstrations by actual performance. Grades are recorded numerically and, although they are not infallible, they represent the most scientific standard yet achieved. Certification is normally made by sending the appointing officer three names from which he must select one; the others are returned to the register for future use. Federal examinations are announced in post offices, newspapers and, in case of shortage, by radio and other means. State and municipal examinations are widely publicized.

The classification of positions by duties was initiated in Chicago, Ill., 1910–12, to facilitate equal pay for equal work. The procedure is to develop an accurate, detailed specification of the duties of each class of position, to determine a scale of pay for such positions and then to allocate each job to its proper class. There are hundreds of classes of positions in a given jurisdiction. This systematic description and arrangement of positions by duties has been found fundamental to many personnel operations, especially preparing examinations, certification, efficiency ratings, promotions, transfers and layoffs. The responsibility for classification is usually vested in the civil service commission. Classification plans are frequently published and are usually open to inspection if not published. A lack of co-ordination of the classification plans of different jurisdictions is one (but only one) of the causes for the inadequate personnel statistics of the U.S.

Promotion is by merit, ascertained by frequent examination in the lower grades, and even among division and bureau chiefs. There is considerable movement from cities and states into the federal system, little in the contrary direction. Important career possibilities exist in all the professional and scientific branches and in many of the administrative, specialized and clerical services. The foreign service, put on a career basis in 1924, is independently administered by the state department. More attention was paid during the period 1930–40 to training young persons for public service and to further training of those already employed. Following a national conference at the University of Minnesota, Minneapolis, in 1930 many universities and colleges developed courses in public administration, public finance, psychology and personnel management. The U.S. civil service and the New York city civil service commissions were especially successful in organizing examinations to take advantage of graduates of these courses. State and municipal governments meanwhile had organized training facilities for employees on a part-time after-hours basis, especially for police, fire, utility and inspectional personnel. In 1935 the graduate school of the U.S. department of agriculture expanded its work from the scientific field into the social sciences, including management. Many programs opened up for municipal employees, especially in Los Angeles where the University of Southern California developed a professional interest within the public service.

Legal Rights of Employees.—Less attention has been given in the U.S. civil service to the formal protection of rights of employees, partly because of a patronage background, partly because of the characteristically frequent change of occupation by Americans and partly because of the influence of the business tradition of freedom to hire and fire, as well as public concern over the growth of bureaucracy. Federal law prescribes a written notice and opportunity for reply in case of discharge, but no hearing. In many federal establishments there are administrative provisions for a hearing within the agency; and if an employee can produce proof of discharge for political or religious reasons, he can appeal to the civil service commission. A veteran can appeal to it on wider grounds. In some jurisdictions, such as Chicago, the civil service commission acts as a hearing board. In a few, such as Massachusetts, a discharged employee may secure a full judicial review of the law and the facts.

An executive order of 1947 required a check of the loyalty of all federal employees and future applicants for employment. Agency and regional loyalty boards were established to make initial determinations on all the evidence as to whether there was reasonable ground to doubt the loyalty of employees or applicants, and a Loyalty Review board was set up to entertain appeals. In a service of more than 2,000,000 about 3,000 employees resigned under charges or investigation. About 350 employees and applicants were found upon hearing to be of doubtful loyalty and were refused employment. The 1947 order was supplemented by subsequent legislation and directives. A few analogous loyalty laws in some states and cities discovered few offenders.

The state department, the department of defense, the Atomic Energy commission and other "sensitive" agencies possess by law special authority for summary suspension and removal after hearing of employees deemed to be security risks. Both loyalty and security requirements were induced by fear of sabotage and espionage in the interest of foreign governments.

In 1953 an executive order imposed security requirements over the whole of the federal service, in addition to the prevailing loyalty standards. Several thousand employees were subsequently discharged but there was no disclosure of the particular reasons other than that their continued employment was not clearly consistent with the national interest. During 1953 and 1954 there was bitter conflict between the legislative and executive branches over the handling of loyalty and security cases.

Unionization.—Unions of public employees were first organized in the post office in the 1890s and were recognized by congress in 1912. Clerical employees formed the National Federation of Federal Employees in 1917 and other groups subsequently. Municipal organizations appeared in the larger cities about 1900; some state employees organized before World War I, but they and county employees remained relatively unorganized. Fire fighters are nationally organized; police are often forbidden to form unions but may organize local social and benevolent associations. Teachers have a national federation.

Such organizations try to secure legislation extending the merit system, better scales of pay and working conditions, protection against arbitrary action and such benefits as group insurance, credit facilities and the like. They are free, as a rule, to affiliate with outside labour organizations but are restrained from taking an active part in politics. They seek recognition of a right to collective bargaining, written agreements and the majority union as the sole bargaining agent. Except in the Tennessee Valley authority these claims have not been widely granted. Strikes of public employees are rare, one dramatic exception being the Boston police strike of 1919. Police are usually forbidden outside affiliation and the right to strike, a right which is rejected by the overwhelming majority of public employee unions. The Taft-Hartley act (1947) prohibited strikes of federal employees and a number of states subsequently enacted comparable laws.

State and Local Civil Service Systems.—The public services of the states vary extremely in their legal organization and standards of competence. About half have formal merit systems, and some of these are indifferently administered. The number of states with merit systems steadily increases, nevertheless, and standards are steadily improving. The older type of bipartisan civil service commission predominates but Minnesota and other states have abandoned the commission in favour of a director of personnel. Functions are chiefly examination, classification and record keeping. Most states have pension plans for teachers, and an increasing number have state-wide pension plans for all employees, on a contributory basis. In New Jersey and Massachusetts the state commissions carry on work for counties. In California there has been notable co-operation between state, county and municipal civil service commissions. There is no co-ordination between state and local agencies and the U.S. civil service commission. State civil service agencies have been handicapped in some instances by political opposition, by lack of funds and by inadequate leadership. During the 1930s substantial progress was made, however, both in extending the merit system and in introducing better methods.

Primary and secondary schoolteachers are subject to minimum standards of training fixed by law. They are required to hold a certificate, usually issued by a state examining agency. Appointments are made by local school boards without competitive or other formal examinations. After a probationary period, teachers acquire a protected tenure. They are a part of the merit system but not under the jurisdiction of civil service commissions.

In a country which has 130 cities with a population of 100,000 or more (1960 U.S. census), the municipal civil services are of great importance. Until 1900 municipal employees were usually political appointees with low standards of competence and, at times, of integrity. The muckraking era (1900–05) and the ensuing period of municipal reform wrought a great transformation, supported by the increasingly technical nature of municipal functions. Municipal civil service commissions were widely established before 1910; by 1960 there were more than 800 cities under the merit system. The introduction of the council-manager plan after 1908 gave a great impetus to the further improvement of municipal standards, although city managers have not favoured the independent, bipartisan civil service commission. Political influence in appointments and promotions has not been eliminated in many of the larger cities, but in the middle-sized and small cities it has lost any major significance. One handicap to the professionalization of the municipal services lies in the preference for local residents for appointment—an almost universal requirement for police, fire, inspectional and clerical services and a usual requirement even in technical and professional posts. The practice of outside appointments has, however, become well established among city managers, school superintendents, health officers and city engineers.

For the purpose of exchanging experience, improving procedures and publishing reports, civil service commissions and agencies in 1906 formed the Civil Service Assembly of the United States and Canada, with headquarters in Chicago. This body holds an annual convention, furnishes technical advice, carries on research and publishes professional bulletins and the quarterly journal, *Public Personnel Review*. (L. D. W.)

UNITED KINGDOM

History.—The British civil service in its present form dates from reforms between 1855 and 1870 associated with the names of Stafford Northcote and Charles Trevelyan. The civil service commission, an impartial body free from all political influence, was set up in 1855 to examine candidates nominated by departments to ensure that they reached an adequate standard. By 1870 the principle was established that, in place of the system of departmental patronage, posts should be filled by open competitive examination carried out by the commission to ensure the high standard of the British civil service and to bring about a sense of unity, hitherto lacking, between the staffs of different departments.

The British civil service is unlike others in that there is no statute regulating its constitution or organization. Pensions, indeed, are governed by statute, and some conditions of service laid down by orders in council, but the management of the civil service has been accepted as an executive function.

Every department of state has its own establishment and organization officer responsible for dealing with its personnel problems. But the central responsibility for civil service questions, which developed gradually out of the power of the purse, rests with the treasury. The treasury has direct responsibility for settling salary questions and for the grading and organization of the main classes of civil servants which are common to the service, and for controlling departmental arrangements for the departmental classes.

Until 1943 the United Kingdom had separate diplomatic and consular services which staffed the embassies, legations and consulates, while the staff of the foreign office itself formed part of the home civil service. In that year the staffs of the foreign office and its posts abroad were amalgamated into what became known as the foreign service, which is a separate entity from the home civil service, although its staff is recruited by the civil service commission.

The main functions of the United Kingdom civil service are dealt with in the articles Admiralty; Foreign Service; Government Departments; War Office, British.

Classification.—The home civil service is organized into a number of classes, themselves divided into grades. On the nonspecialist side there are three main classes. The administrative class (about 2,500 in the early 1960s) is concerned with advice on broad questions of policy and with direction at the highest and most general levels. The executive class (about 70,000) is responsible for the conduct of business within the framework of established policy and for extensive auditing, accounting and fiscal operations. The clerical class (about 190,000) performs the simpler clerical functions.

Entry to established posts is mainly by open competitive examinations (the minimum ages being closely linked with the educational system), although many have entered since World War II by way of tests for which only temporary civil servants serving in other classes were eligible. The age limits in the case of open competition are: administrative class, 20½–27 years; executive class, 17½–23 years; and clerical officers, 16–59 years. Clerical assistants are recruited either by open competition (age limits 15–19) or by examination after a qualifying period of satisfactory temporary service. There is also a considerable flow of promotion into and between these classes. About one-third of those in the administrative class reach it by promotion.

The civil service also contains more than 75,000 professional, scientific and technical specialists organized in classes appropriate to the type of work to be performed, many of them common to the service. There are, for example, scientists engaged in research and development; lawyers or doctors acting as legal or medical advisers; architects and surveyors engaged in the design and construction of buildings; accountants and actuaries. There is also a large group of more than 105,000 ancillary staff, including typists, machine operators, messengers and cleaners. Also there are more than 215,000 manipulative staff in the post office: postmen, telephone operators, sorters, etc.

Finally there is the industrial civil service, numbering about 360,000. This comprises skilled and nonskilled manual workers, below the level of foremen or supervisors, employed in government industrial establishments; *e.g.*, royal dockyards, royal ordnance factories, workshops, depots and stores. Conditions in the industrial civil service are determined largely by reference to the principles of the Fair Wages resolutions of the house of commons. The government accepted an obligation to observe conditions and hours not less favourable than those established for the trade or industry concerned through the recognized negotiating machinery or, where conditions are not so established, by other employers engaged in similar trades and industries. So in several important respects, industrial conditions are different from those in the nonindustrial civil service.

Suitability Requirements.—No person can be appointed to a permanent post in the civil service until he has satisfied the civil service commission of his suitability. Until World War I it was the practice to rely almost wholly on written examinations of a literary and academic nature. Later, more reliance was placed on interviews at which the interview board had before them full particulars of the candidates' records.

While recruitment is carried out centrally, promotion is for the most part departmental. There are, however, arrangements for the central pooling of a number of vacancies in certain grades so as to reduce disparities in promotion, and interdepartmental transfers are commonly made when new departments are set up or existing departments rapidly expanded. Further, for the top posts in all departments (permanent secretaries and deputy secretaries) the field of selection is the whole civil service. While appointments to these posts are made by the minister in charge of the department, the prime minister's assent is required for all promotions to these grades, and to posts of establishment officer and finance officer.

The British civil service prides itself on its impartiality and its capacity to give loyal and devoted service to ministers of whichever party is in power. For many years no civil servant (other than industrial staff) has been allowed to become a candidate for parliament until he has resigned his civil service post. Further, no civil servant, save in the subordinate grades, is allowed to take any overt part in party politics. Originally this applied to all civil servants, with the exception of certain industrials, but in 1948 an independent committee set up to examine the limitations on the political activities of civil servants recommended that all minor, manipulative and industrial grades should be free to engage in political activities. This recommendation was accepted.

In 1953 it was decided that while the ban on political activities must remain for the middle and higher ranks of the civil service, some measure of freedom (but not including parliamentary candidature) should be allowed to civil servants in the subclerical and clerical classes and in the lower reaches of the scientific and technical classes.

Unions and Grievances.—Civil service unions have been recognized by government from 1906 in the post office and from about 1912 in the rest of the civil service. In 1919 Whitley councils were set up to provide machinery for dealing with grievances and to give the staff a greater share in and responsibility for working conditions. There is a National Whitley council for the whole nonindustrial civil service and separate departmental councils for each department. Each council has an official side appointed by the minister and a staff side, representatives of which are appointed by the civil service unions and associations which are recognized as representative of the staff interest concerned. These joint councils are negotiating bodies and can proceed only by agreement.

After World War I a system was set up for compulsory arbitration at the request of the staff or official side about conditions of service. Disputes were to be referred by the ministry of labour to a tribunal consisting of an independent chairman appointed by the minister, one member drawn from the panel of persons appointed by the minister as representing the chancellor of the exchequer and one member drawn from the panel of persons appointed by the minister of labour as representing the staff side of the National Whitley council. This system only applied to the conditions of service of civil servants below managerial level.

A Standing Advisory committee on the pay of the higher civil service was set up in 1957 which, at the request of the government or on its own initiative, can carry out reviews of the pay of civil servants above the scope of compulsory arbitration and make recommendations to the prime minister.

The Civil Service Pay Research unit, also set up in 1957, collects information about the pay and other conditions of service of employees outside the civil service whom it regards as comparable with the civil servants in particular grades. This information is made available to the unions and to the official side for use in negotiations.

For the industrial civil service the machinery for negotiation and joint consultation consists of joint councils, representing the departments and trade unions concerned in each of the industrial groups; *e.g.*, engineering, shipbuilding or miscellaneous trades. The government, although a major industrial employer, is not represented on any of the negotiating bodies for outside industry. These councils are represented on a central body, known as the Joint Co-ordinating Committee for Government Industrial Establishments, which can deal with matters brought before it by either side or with matters referred to it by the other councils. It does not deal with pay claims. Disputes affecting the industrial civil service that cannot be settled through this machinery are referred for arbitration to the industrial court, set up in 1919, which also deals with disputes in outside industry. (E. B. Bs.; N. Bk.)

COLONIES AND COMMONWEALTH

Colonial Service.—Each British colonial territory has its own civil service, paid from local funds voted by the local legislature. To an increasing extent, colonial civil servants are locally recruited, but many of the administrative and technical posts are filled from her majesty's overseas civil service. Its members are recruited by the secretary of state for the colonies, though they are employed by the government of the colony in which they serve. They are servants of the crown and the secretary of state accepts general responsibility for seeing that their conditions of service are satisfactory. As self-government advances, the secretary of state relinquishes his detailed responsibilities laid down in the Colonial regulations, but in Colonial Office Paper 306, published in 1954, the secretary of state indicated that the U.K. government would ensure, in any transfer of full responsibility to overseas legislatures and governments, that members of her majesty's overseas service who lost their employment would receive adequate compensation and that endeavours would be made to find them alternative employment in another colony.

Commonwealth Countries.—Each commonwealth country has a civil service which has developed on the same general lines as that in the U.K. Those with federal governments have state or provincial civil services in addition to the federal civil service. The public service commissions, however, which correspond to the U.K. civil service commission in conducting centralized recruitment on the principle of open competition, are also concerned by statute with promotions and discipline, which in the U.K. are mainly left to the employing department; and in the older commonwealth countries the public service commissions also deal with general matters of civil service control such as structure, complements, grading, salaries, conditions of service and central staff negotiations which in the U.K. are mainly the functions of the treasury. (E. E. Bs.)

Australia.—Each Australian state has its own civil service, based on the same general pattern as the central commonwealth civil service, the organization of which was provided for by the Public Service act, 1922–54, in conjunction with the Superannuation act, 1922–55, and the Public Service Arbitration act. Control is in the hands of a board of three members with semijudicial tenure. Appointments are in general competitive, at school-leaving and university standards; preference is given to ex-servicemen; there are no restrictions on interdepartmental or interstate movements.

Canada.—After long experience with patronage, Canada introduced an effective merit system in 1918 when an act strengthened the position of the civil service commission and laid down provisions for recruitment, promotion, dismissal and political rights.

The Canadian system is based on the British pattern in that it is controlled by the treasury and has an administrative class recruited principally from the universities, but it follows the United States in its classification plan. There is a civil service for the federal government as well as one for each province.

Ceylon.—The civil service of Ceylon was founded in 1798 by the first British governor of Ceylon, Sir Frederick North, with the help of 8 officers who went out with him and 24 more who were personally selected by the secretary of state. In 1831 the first step was taken toward native staffing when the Colebrook commission recommended education for the natives in order that they might in time qualify for higher posts in the public service. In 1856 a general competitive examination held in London was substituted for the earlier Haileybury examination, and in 1891 a local division of the public service (known as the lower division) was established. Examination for this was held in Ceylon. After 1924 the competitive examination was held simultaneously in London and Ceylon, and in 1938 it was agreed that no more Europeans should be recruited. In 1931 a public service commission had been set up and in 1947, under the Soulbury constitution, Ceylon was made independent.

India.—The Indian civil service (I.C.S.) owed its early organization to Warren Hastings, dating from 1772. It remained predominately British in composition until 1920. After World War I, recruitment to the I.C.S. was conducted simultaneously in the U.K. by the civil service commissioners and by the public service commission in India which introduced a difficult all-India competitive examination similar to the examination held in London. The Indian element in the service gradually increased in number until about half the officers in the service were Indians at the time of transfer of power in 1947. Thereafter, there was no fresh recruitment to the I.C.S. A new service known as the Indian administrative service was introduced, recruitment to which is through an all-India competitive examination. The new service also provides district officers who may be in charge of all public activities for an area of over 4,000 sq.mi., but unlike the old service it does not provide officers for the judiciary. An Indian foreign service (I.F.S.) was also set up after 1947 and was joined by many officers of the former I.C.S. New entrants to the I.F.S. are also selected by competitive examination. Unlike the I.C.S., the new services are open to women.

New Zealand.—Political control of the public service in New Zealand lasted until 1912, when the Public Service act introduced control by an independent commissioner (replaced in 1946 by a commission not exceeding three) whose functions included recruitment, training, classification and promotion. Recruitment is at two levels, postprimary and university, and promotion is by merit.

Pakistan.—At the time of its establishment in Aug. 1947, Pakistan was faced with the problem of forming and manning its central and provincial governments. It was decided to form a strong, centrally administered service controlled by the government and by a public service commission, with a separate foreign service from which diplomatic and consular posts would be filled. Recruitment was urgent and numbers were made up by transferring officers from the former Indian civil service and from the defense and other services. In 1949, however, the commission started an open central superior service examination for all appointments. The central superior service of Pakistan is a centralized service whose officers have, since 1950, been transferred throughout Pakistan. In addition to the central civil service the provinces have their own civil service under the provincial civil service commission. (X.)

OTHER COUNTRIES

France.—The most prominent characteristics of the French civil service appeared after the Revolution. The revolutionary assemblies destroyed the traditional and complex organization of the old regime and, under the Napoleonic empire, a new framework was set up based upon two main principles: uniform hierarchy and centralization.

Later regimes maintained this new administrative structure but tried to adapt it to democratic evolution. Successive reforms, mainly at the end of the 19th century, developed local government in the communes and the *départements*. Thus the citizens were enabled to take a more active part in the management of public affairs by electing local assemblies. Permanent links were established between central services and local authorities through the mayor, elected by the council of the commune, and the prefect, appointed by the government. The presence of a prefect in every *département* secured a permanent control upon all local decisions.

In the 20th century the civil service was affected by the development of administrative tasks which implied an increase in the number of civil servants. New ministries were created for health, economy, housing, etc. The organization of the French civil service became so intricate that uniform regulation appeared necessary. Some laws and the constructive work of the highest administrative court, the *conseil d'état*, began to establish a general statute which was completed and codified by several acts of 1945 and 1946. The French civil service is divided into classes which correspond, broadly speaking, to the British ones. At the upper level the *administrateurs civils* can be compared to the members of the administrative class. New regulations also established a uniform hierarchy of salaries. Most members of the upper class are selected through the École Nationale d'Administration, the students of which come directly from universities as well as from the lower classes of the civil service. Courses last two years and a half, a first year spent in local services and a year and a half in attending lectures and seminars in Paris. The competitive system is generally used for selection in all classes.

The statute of the French civil servants also determines their rights and duties. In 1946 the right to form *syndicats*, or unions, was recognized by the government and joint committees were created to deal with disciplinary questions and technical improvements. The regulation of the French civil service, despite its uniformity, is not as rigid as it may seem. The main exceptions reside in the way in which certain traditions have survived in some parts of the organization. First, in the upper reaches of the civil service, special and important functions are assumed by the main bodies—*les grands corps*—principally by three bodies of control. The *conseil d'état* is both an administrative organ frequently consulted by the government and a tribunal for administrative cases. The *cour des comptes* is a court of financial control over public expenses. The *inspection des finances* is a service which inspects the financial officers. The prestige and tradition of these three bodies constitute one of the most original features of the French civil service. Their members frequently occupy the highest executive functions in most departments.

Secondly, a particular importance has always been given to the good staffing and working of some technical services. Some of the most important specialized schools were created around the beginning of the 19th century, such as the École Polytechnique (1795) for scientific careers and the École Normale Superieure (founded 1794; took its present name, 1845) where many professors of the universities are trained. (P. Vt.)

Germany.—The German civil service emerged out of feudalism under a succession of outstanding Prussian monarchs culminating with Frederick the Great (1740–86). Legally it was based partly on custom, partly on executive acts and partly on statutes. The foundations of the civil service of the German *Reich* were laid by the Civil Service act of 1873; in addition, the German states had developed civil services of their own.

Up to 1933 the German civil service was characterized by high standards of competence, integrity and impartiality. Its prestige was high and it was closely supported by active citizen advisory groups in municipalities and rural communities. Partisanship was prevented partly by tradition and partly by the fact that conservative groups prevailed under the first *Reich*. After 1920 the Socialists made some partisan inroads, and after 1933 the Nazis required active party membership from all civil servants. Under the Nazi regime the standard of integrity of the civil service suffered heavily, but its competence and efficiency remained high.

The Civil Service act of 1937 was based on the old German law, but a number of enactments were introduced by the Nazis with the purpose of strengthening Nazi rule and of eliminating several categories of "undesirable persons." After Hitler's abolition of the German states the 1937 act was applied to all civil servants.

In 1950 the German Federal Republic eliminated all National Socialist clauses from the law of 1937. Both the federal civil service and those of the *Länder* returned to the principles contained in the Weimar constitution of 1919 by which entry into the civil service is determined by ability, regardless of race, sex or political or religious ideas. Provision was made for legal protection of civil servants: the state accepts liability for their wrongful acts and freedom of association is allowed. Many of the German states which were re-established after World War II issued new laws for their civil servants.

There are in the German civil service four different classes: the administrative class, requiring a university education; the higher executive class, based on secondary education; and the executive and clerical classes, requiring only a primary education and before 1945 largely reserved for soldiers at the end of their military service. The vast majority of those preparing for the highest grade take a law course, including economics, history and political science. Applicants are then admitted for a training period of several years, during which they work at the courts and in civil administration. They finally take an examination called the *Grosse Staatsprüfung* under the direction of one of the boards set up in every *Land*. Applicants for technical, medical and other careers within the administrative class receive specialist training.

Republic of Ireland.—Recruitment to the civil service is governed by the Civil Service Regulation acts of 1924 and 1926 which empowered the government to appoint three commissioners. In general no person may be appointed to a permanent situation in the Irish civil service unless a certificate of his qualification for the situation has been issued by the commissioners. Under the Civil Service Regulation act, 1924, and the Ministers and Secretaries act, 1924, the control of remuneration and conditions of service generally is vested in the minister for finance.

The local appointments commission, a body parallel to the civil service commission, selects the senior staffs of local authorities. Other staffs are recruited by the county and city managers who discharge the executive functions of the local authorities. In staff matters a manager is not controlled in detail by the elected council. The central government supervises the numbers, pay and qualifications of these staffs. (X.)

AN INTERNATIONAL CIVIL SERVICE

The elements of an international civil service were first found in the Universal Postal union (1874–75). The League of Nations and the International Labour office (ILO) required a staff of about 600 experts and subordinate personnel which took the form of a true international civil service. It drew mainly on British, French and Swiss sources, but more than 40 states contributed members in response to the requirement that the staff should be recruited "on as wide a geographical basis as possible." There were no formal methods of selection for the higher personnel; the director-general depended on personal acquaintances and trustworthy recommendations. The staff fell into three divisions: administrative, supervisory and clerical, and custodial and manipulative. The main point of interest in an international civil service lies perhaps in the steps it takes to free itself from national loyalties. The League existed during a period of rampant nationalism and irreconcilable conflict, but its experience showed that a broad measure of international loyalty can be achieved, even under difficult conditions. The staff of the League was dispersed after 1939 but that of the ILO was maintained, principally in Canada.

A much larger international civil service was required for the United Nations and the specialized agencies. In the United Nations charter, each member state undertook to respect the international character of the duties of the staff and to refrain from influencing them in their work. International secretariats are also provided for other organizations; *e.g.*, the Organization for Economic Cooperation and Development. Officials and employees of such organizations are paid from the funds of each of these organizations, and are assigned duties by its head. They are subject to its discipline and owe it full responsibility. Valuable experience in international co-operation was obtained during World War II through the various combined boards and through the lend-lease organization. *See* also references under "Civil Service" in the Index volume. (E. E. Bs.)

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CIVIL WAR, AMERICAN: *see* AMERICAN CIVIL WAR.

CIVIL WAR, ENGLISH, the fighting which took place in England during the years 1642–51 between supporters of the king and parliamentarians, generally called the Civil War or, sometimes, the Great Rebellion. There were three main phases in the conflict: the first civil war, which began in 1642 and ended with Charles I a prisoner of the parliamentarians in Jan. 1647; the second civil war, which began with the Scottish "Engagement" at the very end of 1647 and ended with the king's execution in Jan. 1649; and the third civil war, initiated by the Scottish rising in favour of Charles II in 1650 and ended by the royalist defeat at Worcester in Sept. 1651.

Background to the War.—By 1642 there had been for many years a struggle for power between the English monarchy and parliament. In the middle ages the principal critics of the king had been the nobility who were directly summoned to the house of lords, but from the 16th century their influence declined, partly because so many of them had been killed in the wars of the 15th century, partly because of the repressive policy of the early Tudor rulers and partly because the ecclesiastical baronage had been reduced in size after the Reformation. In the reign of Elizabeth I it was the house of commons which increasingly asserted the right to criticize the policies of the crown. Elizabeth warded off attacks on her personal authority or her "prerogative rights" as best she could, and she was adamant that matters of religion and foreign policy were the sole concern of the monarchy. Nevertheless she was obliged to yield now and again. During her reign much of the procedure and some of the privileges of the commons were firmly established. When she was succeeded by James I, the claims of the lower house to an authoritative voice in public affairs were emphasized with even more vigour. Members who to some extent had held their fire out of deference to Elizabeth would not be browbeaten by Stuart claims to high prerogatives which they regarded as contrary to both the laws of nature and the privileges of parliament.

The Stuarts answered the restive attitude of the commons by defending their prerogative powers with every resource at their disposal. Charles I (*q.v.*), "in common with most European sovereigns of the time, wished to strengthen the central government and was impatient of the hindrances put in his way by parliament and by the gentry who exercised local power. The gentry, in and out of parliament, resented interference with what they believed to be their liberties and privileges" (C. V. Wedgwood, *Truth and Opinion*, Macmillan & Co., New York, 1960). When Charles I discovered that he was unable to repulse the attacks on his favourite, the duke of Buckingham (*see* BUCKINGHAM, GEORGE VILLIERS, 1st Duke of), and, after Buckingham had been assassinated, was unable to secure the money to sustain his policies abroad, he decided in 1629 to try to govern the country without a parliament at all and to raise money without the consent of the house of commons.

To the political conflict between Charles I and many of his leading subjects were added serious religious differences. The king, a keen supporter of a unified Church of England with a unified ritual, had to contend with the Puritan movement, dating back to the reign of Elizabeth, well represented in the house of commons and strong in many parts of the country, notably in London and the smaller towns. In general, the Puritans wanted to abolish all vestiges of the old Roman Catholic ceremonies and to increase and spread extempore preaching in the churches. Charles's two archbishops devoted themselves to repressing these tendencies with the full backing of the crown. During the 11 years after parliament ceased to sit in 1629, it was mainly by the Puritan preachers that the flame of discontent with the king's government was kept alive.

The influence of social and economic factors on the course of events leading to the Civil War remains a matter of opinion. It seems likely that the landed gentry, normally represented in the house of commons, had for the most part recently increased their material wealth at the expense not only of the crown and the church but even at that of the nobility. If this were so, it would help to explain the growing political assertiveness of the house of commons in relation to the crown and also in comparison with the house of lords. The gentry and merchants were vexed by various forms of financial exaction imposed by the king. When Charles I came to the throne the commons was reluctant to grant him an indefinite right to impose customs duties (already increased by his father) or to vote him all the subsidies he sought in order to wage foreign wars. Charles's attempts to overcome the effects of this reluctance by the exercise of his prerogative power resulted in economic pinpricks—forced loans, knighthood fines and so on—which angered the well-to-do. Their grievances were further accentuated when in 1635 the king began imposing ship money (*q.v.*) not only upon ports but also upon inland towns.

Finally Charles I's foreign policy was unpopular. The proposal made during his father's reign that Charles should marry a Spanish princess had been much disliked and his actual marriage to a French princess was not much more popular. For two generations Spain had been the traditional foe of England. Yet Charles I, in return for financial aid, assisted the Spaniards in a number of different ways. Consequently there grew up a genuine fear that England was being sold to its ancient enemy.

Immediate Causes.—The two events which most directly led to the Civil War were the king's war with the Scots, known as the Bishops' Wars, and a Roman Catholic rebellion in Ireland (*see* ENGLISH HISTORY). Charles I, following up his attempt to impose religious uniformity upon England, decided in 1637 to insist, solely on his own authority, that the Scottish church should accept a version of the English Book of Common Prayer. For more than two generations the bulk of the Scottish people had been Presbyterians, and this attempt by the king to force English religious practices upon them met with immediate and widespread resistance. In 1638 the Scottish leaders began collecting signatures for a national covenant—a manifesto promising to defend Presbyterianism to the utmost. In November the general assembly of the Scottish church abolished the episcopacy. Charles refused any compromise and, deciding to enforce his ecclesiastical policy with the sword, not only called out the militia but, following ancient precedents, required the English peers to lead their own troops into the field or compound for money. These demands were resented in England; many felt that the Scots were entitled to practise their own religion. When, in June 1639, after his army had been completely outmaneuvered by the Scots, the king was obliged to agree to a truce at Berwick-upon-Tweed, the royal levies melted away. Charles, whose government was already committed to other heavy expenditure abroad, had no money to continue the war and was obliged to summon a parliament, which met in April 1640. The house of commons, which had not met for 11 years and whose leaders wished to concentrate on their accumulated grievances against the king's government, refused all aid and even inclined to favour the Scottish rebels. Thereupon the king dissolved the so-called Short parliament. However, when Charles attempted to resume the war against the Scots, he was even more decisively defeated and had to agree to a humiliating treaty which in effect forced him to call a new parliament.

The so-called Long parliament met on Nov. 3, 1640. Under revolutionary pressure the king agreed to make important concessions but on three points he resisted: the right of parliament to interfere with the organization of the church and, in particular, to abolish the bishops; the right of parliament to nominate ministers and officials; and the right of parliament to control the armed forces. The last question came to a head when a rebellion broke out in Ireland in the autumn of 1641. There then occurred a complete breakdown in trust between parliament and the monarchy. The king naturally wanted to raise troops to repress the rising. The commons feared such troops might also be used against Englishmen.

The house of commons now put forward (Nov. 1641), in a Grand Remonstrance to the king, claims which were far more extensive than those advanced the year before. The narrowness of the majority (159 votes to 148) by which the Grand Remonstrance was passed, however, indicated the growth of a strong royalist party in the commons and encouraged Charles to proceed (Jan. 4, 1642) to his unsuccessful attempt to arrest five members of the commons (*see* ENGLISH HISTORY). A week after the failure of this *coup d'état* the king left London, and though prolonged negotiations took place between parliament and the king for a constitutional settlement (as late as June 1642 parliament offered the Nineteen Propositions to the king), both sides now began to prepare for a civil war.

FIRST CIVIL WAR

Resources of the Two Sides.—The first civil war began on Aug. 22, 1642, when Charles I set up his royal standard at Nottingham. Previously the king's headquarters had been in York and his original intention had been to raise the royal standard in Lancashire, for it was hoped to make use of the historic antagonisms between northern and southern England. Not only was much of the north of England, except the towns of the West Riding of Yorkshire, royalist in sympathy, but so too on the whole were the west midlands, virtually all of Wales and a great deal of southwest England. The main strength of the parliamentarian party was concentrated in the City of London and other ports and in the Yorkshire textile towns. Most of East Anglia was parliamentarian, as were the counties around London. A revolution took place in London on the eve of the Civil War, when a royalist city council was overthrown and the financial and commercial resources of the capital were put at the disposal of parliament. Apart from Newcastle upon Tyne and Chester, Portsmouth was the only port of any size that at first declared for the king, but Portsmouth surrendered to the parliamentarians early in Sept. 1642. On the other hand, the royalists captured Bristol in July 1643. A line running southwest from Scarborough to Exeter roughly divided the country between the royalists in the north and west and the parliamentarians in the south and east. Many counties, however—notably Cornwall and Yorkshire—were deeply divided in their loyalties and some even tried to declare themselves neutral when the war began. No precise class division within the country can be laid down. Many families were divided among themselves, and in the house of commons those who declared themselves parliamentarians and those who fought for the king had no distinctive social or economic characteristics. The parliamentarians were nicknamed Roundheads, after the short-haired, bullet-headed London apprentices, and the royalists were dubbed Cavaliers by their enemies, after the brutal Spanish *cavaliero* or trooper.

The Royal Navy, which inherited traditions dating back to Elizabeth I and her father and had recently been strengthened by the king's expenditure of ship money on it, at once declared itself to be on parliament's side and until 1648 parliament commanded the sea. As to the army, there really was none. Each county was supposed to have available militia or trained bands for local defense, but the only trained bands of any real military value were those of the City of London. Armaments had also become antiquated, though both sides at once tried to seize what weapons there were in the county arsenals. The arms factories—for example, the iron foundries of Sussex—were mostly at the disposal of parliament and the king had to try to import arms from abroad. Before the war began he sent the queen to the Netherlands to buy munitions.

For cavalry the king was able to call upon the outdoor staffs of the nobility and many of the better-off gentry who rallied to his cause. The parliamentarian cavalry was much more of a scratch force, although the yeomen farmers of east England had experience in riding and shooting. Both sides were able to employ officers who had acquired some knowledge of war in Europe. The king had his two German nephews, Prince Rupert (*q.v.*) and Prince Maurice of the Palatinate, and the parliamentarians had Sir Thomas Fairfax (*see* FAIRFAX OF CAMERON, THOMAS FAIRFAX, 3rd Baron) from the West Riding and Philip Skippon, who commanded the London militia. The cavalry was the cream of the army on both sides and a cavalry charge usually had a decisive effect on the course of a battle. The infantry, armed either with clumsy matchlock muskets or equally clumsy 18-ft. pikes, was most valuable in closed country where the cavalry could not operate. Artillery was somewhat primitive. The big guns were only able to fire a ball every five minutes or so, but they were essential in siege warfare. After the first campaign the parliamentarians were better equipped with guns. For a war chest the king was largely dependent on gifts or loans from his friends and on what he could borrow from abroad. Parliament was soon able to raise new taxes including assessments, a property tax divided between the counties and also an excise levied both on imports and on some home-produced goods.

Campaign of 1642.—At the beginning of the war the armies of both sides, each numbering about 13,000 men, marched westward. The king's army moved from Nottingham to Shrewsbury and thence on to Worcester with the intention of recruiting its strength in Wales. Robert Devereux, 3rd earl of Essex (*q.v.*), commander of the parliamentarian army, left London on Sept. 9 with the object of confronting the king in the midlands. After a preliminary skirmish at Powick Bridge near Worcester (of which Prince Rupert got the better, though he allowed Worcester to be occupied by the earl of Essex) the armies lost each other until, in the second week of October, Essex learned in Worcester that the king was marching through the midlands upon London. The parliamentarian army then marched eastward so as to cut off the king, and the two armies met at Edgehill, near Warwick, where drawn battle was fought on Oct. 23. The royalist cavalry on the wings at first routed its enemy, but the king's soldiers in the centre were beaten. Both sides encamped that night on the battlefield, but the king was able to occupy Banbury and then, on Oct. 29, Oxford. Essex withdrew on London where his army was reinforced by the City's trained bands, while, after setting up his headquarters at Oxford, the king prepared to conquer the capital. Prince Rupert surprised and defeated two parliamentary regiments at Brentford in Middlesex on Nov. 12, but was unable to force the river Thames. After the two armies had confronted each other at Turnham Green the royal force withdrew on Oxford which remained the king's military headquarters for the rest of the war. Meanwhile fighting had also developed in Yorkshire, where the parliamentarians were based on Hull under the command of Lord Fairfax (*see* FAIRFAX OF CAMERON, FERDINANDO FAIRFAX, 2nd Baron) and his son Sir Thomas, while the royalists holding York were under William Cavendish, earl (later marquess, then duke) of Newcastle (*see* NEWCASTLE, DUKES OF), and in the southwest where a royalist army was raised in Cornwall by Sir Ralph Hopton (*see* HOPTON, RALPH HOPTON, Baron) while Sir William Waller (*q.v.*) recruited a parliamentarian force in Gloucestershire.

Campaign of 1643.—The Fairfaxes in Yorkshire repelled a royalist attempt to expel them from the West Riding early in 1643 and on May 21 captured Wakefield, but Newcastle defeated them at the battle of Adwalton Moor (June 30) and practically the whole of Yorkshire except Hull came under royalist control. Newcastle then entered Lincolnshire. There in east England Oliver Cromwell (*q.v.*), M.P. for Cambridge, had raised a cavalry regiment and was urging an aggressive policy. In May he had won a cavalry skirmish at Grantham in Lincolnshire and in July he repelled an enemy attack on Peterborough, but lack of trained troops prevented him from following up these successes. In the west of England Waller was beaten at Lansdown, near Bath, on July 5 and again at the battle of Roundway Down in Wiltshire on July 13. Hopton had already overrun most of Cornwall, Devon and Somerset. These royalist victories enabled Prince Rupert to march out of Oxford and to obtain the surrender of Bristol on July 26. The royalists then decided to besiege Gloucester so as to clear their lines of communication between Bristol and northwest England and gain full control of the river Severn, but Essex led his army out of London and was able to raise the siege of Gloucester early in September. On his way back to London Essex fought an inconclusive drawn battle with the king's army, which tried to intercept him, at Newbury on Sept. 20. The second year of the Civil War ended without notable results but, on the whole, the royalists had much the better of the fighting. Only in East Anglia, where the parliamentarian counties were bound together in the Eastern association, were the royalists effectively repulsed. On Oct. 11, 1643, Sir Thomas Fairfax and Oliver Cromwell defeated a royalist force at the battle of Winceby. This led to the surrender of Lincoln (Oct. 20). Apart from the London area, eastern England was the only part of the kingdom that was in firm parliamentarian control. The royalists had most of Wales and western England as well as Yorkshire.

The Search for Allies.—Both sides began to look for allies. The English parliament began negotiations for a treaty with the Scottish leaders, which was to be known as the Solemn League and Covenant. The English sought a military alliance; the Scots a religious guarantee. After long discussions the Scots promised to send an army into England on payment of £30,000 a month, while the English undertook to bring the churches of England, Scotland and Ireland "to the nearest conjunction and uniformity in religion," though not specifically committing themselves to a rigid Scottish Presbyterianism. The Solemn League and Covenant was accepted on Sept. 25, 1643, and a Scottish army of about 20,000 men entered England in Jan. 1644. Thenceforward the conduct of the war was placed in the hands of a Committee of Both Kingdoms. Meanwhile Charles I had been negotiating with the Irish. By concluding a truce or "cessation" with the rebels (Sept. 1643) he was able to withdraw royalist soldiers from Ireland to fight for him in England.

Campaign of 1644.—The arrival of the Scots in England at once transformed the course of the war. Newcastle marched north from Yorkshire to try to stop the Scots and, in his absence, the Fairfaxes defeated his second-in-command, Sir John (afterward Lord) Bellasis, at the battle of Selby on April 11. This compelled Newcastle to withdraw and shut himself up in York, where he was besieged by the Fairfaxes and the Scottish army. The parliamentarians now had five armies at their disposal. Besides the Scots and the army of the Fairfaxes, an army had been formed in the eastern counties under the command of Edward Montagu, earl of Manchester (*see* MANCHESTER, EARLS AND DUKES OF), with Oliver Cromwell as his lieutenant general; the main army under Essex was harrassing the king at Oxford; finally, there was Waller's army from the south which on March 29 inflicted a defeat on Hopton's army at Cheriton in Hampshire.

Under pressure from his Anglo-Scottish foes the king's strategy had become eclectic. It seems that in 1643 he had envisaged some sort of scheme for a triple attack on London, but now he was content to stay on the defensive, using Prince Rupert to engage in sorties and to relieve threatened positions. On March 21, 1644, Rupert successfully relieved Newark, a key point between the midlands and Yorkshire, which had been besieged by the parliamentarians. Next he was sent to Lancashire to assert royalist control there and clear the way for the expected reinforcements from Ireland. He took Stockport and Bolton and cleared the port of Liverpool, although he avoided Manchester, which was parliamentarian. Then he received orders from the king (in a letter dated June 14) to march to the relief of York.

Battle of Marston Moor.—Early in June the earl of Manchester's army from the Eastern association joined the Scots and the army of the Fairfaxes in the siege of York, where the marquess of Newcastle was confronted by a combined force three times the size of his own. He held out for a month. At the end of June, however, Prince Rupert with an army of about 10,000 men crossed into Yorkshire, outmaneuvered his opponents and relieved York. Fearful that Rupert might now try to break through into East Anglia, the three parliamentarian armies decided to bar his advance at Marston moor, 8 mi. W. of York. There, on July 2, 1644, Rupert, outnumbered 27,000 to 17,000 (including Newcastle's men), was defeated because of the bravery and skill of Sir Thomas Fairfax, who commanded the parliamentary right, and of Oliver Cromwell, who commanded the left (*see* MARSTON MOOR, BATTLE OF). The king's army lost 4,000 men killed and many were taken prisoner. However, the parliamentarians failed to follow up this great victory. The Scots went north to besiege Newcastle upon Tyne; the Fairfaxes turned to clear up royalist pockets of resistance at Pontefract and Scarborough; and Manchester's army from the Eastern association returned to Lincolnshire.

Meanwhile Waller, after his victory at Cheriton, had joined Essex near Oxford, but he and Essex did not get along well together and the king was able to defeat them separately. Waller was checked at Copredy Bridge, near Banbury in Oxfordshire, on June 29 and Essex, who had marched into southern Cornwall and thereby dangerously extended his communications, was cut off and surrounded by a superior army under Charles I at the end of Aug. 1644. At Lostwithiel the whole of the parliamentarian infantry under Colonel Skippon surrendered on Sept. 2, but the cavalry managed to cut its way out and Essex himself fled by sea. The king did not, therefore, achieve as complete a success as he might have done, but the surrender at Lostwithiel offset the parliamentarian victory on Marston moor.

The Committee of Both Kingdoms met this disaster by ordering Manchester's army to join the remnants of those of Waller and Essex and try to defeat the king on his return from the southwest to his base at Oxford. Manchester, who was a lethargic general, had already refused to confront Prince Rupert in the northwest, but by Oct. 20 he joined the armies of Waller and Essex and reluctantly agreed to attack the king at Newbury. However, the king's army was excellently posted and on Oct. 27 he beat off a two-pronged assault by his enemies at the second battle of Newbury. This virtually ended the campaign of 1644. The parliamentarian leaders were left to contemplate the fact that though they everywhere outnumbered their enemy and had superior resources and allies, two long campaigning seasons had passed without their being any nearer to compelling the king to capitulate to their political demands.

The New Model Army.—The comparative failure of the parliamentarian armies in 1644, except at Marston moor, induced parliament to agree to the formation of a "New Model army" (Feb. 1645) and to pass a Self-Denying ordinance (April 1645) whereby members of both houses were discharged from civil and military offices so as to prevent jealousies and accusations of corruption and to promote professionalism. The nucleus of the New Model army was the Eastern association's cavalry, which had been trained largely by Oliver Cromwell. Much of the infantry, however, consisted of new recruits. Sir Thomas Fairfax was created commander in chief, and it was he, not Cromwell, who was mainly responsible for the organization and discipline of this new army of 22,000 men. But it could not be assumed that the New Model army would at once achieve the much-needed victory, and Essex and Manchester, the former commanders, were disgruntled at their exclusion from office.

The king, on the other hand, was resilient and optimistic. He had found a champion in Scotland in James Graham, marquess of Montrose (*q.v.*), a natural-born soldier who, in Aug. 1644, had joined up with royalist troops landed from Ireland and was inflicting a series of defeats on the covenanters. In September his men sacked Aberdeen, and the Scottish army in England was compelled to send a detachment to help cope with him. The king rejected in Jan. 1645 the extreme terms offered to him by Anglo-Scottish commissioners, who met his representatives at Uxbridge in Middlesex, and in the spring he was considering leading his army from Oxford either to attack the parliamentarian base in East Anglia or going north to link up with Montrose.

Campaign of 1645–46.—Early in 1645 Cromwell, having had his period of command extended despite the Self-Denying ordinance, was sent with a group of cavalry to give encouragement to parliamentarian resistance in the southwest where Col. Robert Blake was desperately holding out in Taunton. Later, with his command again extended, he successfully disrupted royalist movements around Oxford. Fairfax was ordered westward at the beginning of May to blood his New Model army by relieving Taunton, but Cromwell's force was not large enough to contain the king and after three weeks Fairfax was recalled from Taunton and Cromwell retired toward Ely. The royalists decided to relieve the increasing pressure upon Oxford by assaulting Leicester, which they sacked on May 31.

Battle of Naseby.—When he learned this news, Fairfax abandoned his preparations for the siege of Oxford and determined to bring the king's army to battle. Cromwell was recalled to take command of the cavalry of the New Model army and a battle took place at Naseby in Northamptonshire on June 14, 1645. Better discipline, a more effective high command and the larger numbers on the parliamentarian side all contributed to its gaining a notable victory. Five thousand prisoners were taken and the royal infantry was almost wiped out (*see* NASEBY).

Charles I, who had left the battlefield with reluctance, retreated into Wales hoping to raise fresh forces there, while Fairfax, after retaking Leicester, moved into the southwest and defeated the one remaining royalist army at Langport in Somerset on July 10. Taunton had at last been relieved and Bridgwater in Somerset was taken. Meanwhile the Scots had cleared the north of England and moved south to Hereford, though they failed to capture it. On Sept. 11, 1645, Prince Rupert surrendered Bristol to Fairfax, for which "mean action" King Charles I dismissed his best general from all his commands. But Rupert had indeed realized that the end of the war was only a question of time. On Sept. 13, 1645, Montrose's long run of successes in Scotland was brought to an end by defeat at the battle of Philiphaugh. In March 1646 Sir Ralph Hopton disbanded the remnants of his Cornish army. Oxford finally surrendered on June 24, 1646. By that time the king himself had fled in disguise from his headquarters and had thrown himself on the mercy of the Scots who were encamped at Newark. Ultimately, having come to terms with the parliamentary leaders in Jan. 1647, the Scottish army left England and handed over the king, a prisoner, to the parliamentarians. Charles was placed in honourable captivity at Holmby house in Northamptonshire, and the victors considered how to reach a constitutional settlement.

NEGOTIATIONS IN 1647

Attitude of the King.—Though his armies had surrendered and he himself was a captive, Charles I still did not entirely despair. He boasted that the kingdom could not continue without him. He still hoped to raise fresh troops from Ireland by coming to an arrangement (which he had no intention of keeping) with the Irish Catholics or to reach an understanding with the Scottish covenanters who favoured their ancient Stuart monarchy provided it was subjected to a Presbyterian church. Above all, he felt sure that his conquerors would quarrel among themselves. Therefore, when stringent terms were offered to him by parliament, he was careful not to give a downright refusal and later he said that he was willing to allow Presbyterianism to be established in England for three years and for parliament to control the militia for ten if only he were granted a treaty.

Quarrels Between Parliament and Army.—Parliament had permitted the New Model army to continue in being for a further six months after the end of the war, but early in 1647 it required the soldiers (apart from some garrison troops) either to disband or accept service against the rebels in Ireland. At a meeting held in March at army headquarters at Saffron Walden in Essex, the army's spokesmen demanded to know who was to take command in Ireland, what payments the soldiers would receive there and what would be done about the arrears of pay and indemnity for services already performed in England. Not receiving satisfactory answers to these questions, officers and men began to agitate. To grievances over pay and conditions were added religious differences. Many of the soldiers in the New Model army were "Independents" or "sectarians" who believed in the right of congregations to organize their own services and resented being asked to serve not under their former generals but under Presbyterian commanders. So dangerous did the situation become that early in May 1647 parliament invited Cromwell and his son-in-law Henry Ireton (*q.v.*), both of whom were members of parliament and were trusted in the army, to try to persuade the soldiers either to volunteer for Ireland or to disband.

By the middle of May it seemed as if Cromwell had managed to induce the leaders of the army to agree to a compromise with parliament provided that their arrears of pay and an indemnity were guaranteed. But deep suspicions had been inflamed. A democratic political movement, directed by men nicknamed Levellers, stirred up further trouble, while the City of London, predominantly Presbyterian, began strengthening its militia as a deliberate counterpoise to the New Model army. The king fished successfully in these muddied waters by choosing this time to announce his willingness to accept Presbyterianism in England for three years. The army took alarm and on May 31 a certain Cornet George Joyce was sent into the midlands to make sure that the arsenal and artillery at Oxford were safe and that there was no danger of the king's being taken into the power of the Presbyterian leaders. When he reached Holmby house on June 2, Joyce, who had collected a force of 500 soldiers, decided to compel the king to come back with him to the army at Newmarket. Cromwell upheld Joyce's action and himself went to Newmarket. Thus parliament and the army were at loggerheads.

At a meeting of the army council in July, Cromwell and Ireton resisted a demand that the army enter London, disarm the City militia and compel the release of political prisoners, who included the Leveller leader, John Lilburne (*q.v.*). They themselves attempted to come to terms with the king and offered him a constitutional scheme known as the Heads of the Proposals. But the day for compromise had passed. The Presbyterians in London, under pressure from a City mob, forced the Independents out of parliament, collected a defense force and defied the army, and General Fairfax was forced to retort by marching into London (Aug. 6, 1647) and restoring order there.

The Scottish Engagement.—Now the situation deteriorated further, for there were disputations within the army between those who favoured the Heads of the Proposals on one side and, on the other, the Levellers and their friends who advocated, in the so-called Agreement of the People, a democratic scheme of government without the monarchy or the house of lords. Sensing his opportunity, the king (although he had given his parole) escaped from the army's custody and fled to the Isle of Wight where, though still a prisoner, he was given sufficient freedom to enable him on Dec. 26, 1647, to enter into a secret agreement, known as the Engagement, with a group of Scottish leaders. In return for Charles's firm promise to introduce Presbyterianism into England, to suppress the Independents and to grant favours to the Scots, he was given an undertaking that a Scottish army would invade England to regain his power as king.

SECOND CIVIL WAR

Defeat of the Royalists.—The Scottish Engagement and the profound dissensions between the army and parliament were the signal for widespread royalist risings. Many Presbyterians who had fought against the king in the first civil war now rose for him, and half the fleet mutinied against parliament. The second civil war began in Wales where in March 1648 the governor of Pembroke declared himself for the king; other big revolts began during May in Kent and in Essex. General Fairfax defeated the Kentish royalists at Maidstone and then besieged those in Essex at Colchester, which held out against him until August. Cromwell had left London for Wales at the beginning of May. He was held up by lack of siege guns, but compelled Pembroke to surrender on July 11. Three days earlier a Scottish army under the duke of Hamilton had crossed the border and found no opposing forces except four regiments and some militia under Maj. Gen. John Lambert (*q.v.*). As Fairfax was still held up in the southeast, Cromwell made a forced march north and joined Lambert in the West Riding in the middle of August. The parliamentarian army was inferior in numbers to the Scottish Engagers, who were reinforced by northern royalists and Scots from Ireland, but it was far better equipped, disciplined and led. Cromwell crossed the Pennines and struck the enemy army at Preston when it was not concentrated. The northern royalists were destroyed and the Scots were then pursued to Warrington near which a second battle was fought. On Aug. 25 Hamilton himself surrendered. Cromwell then turned about and marched to the Scottish frontier, where he came to terms with Archibald Campbell, marquess of Argyll, who was not a party to the Engagement. Argyll promised that the Engagers should be excluded from all power in Scotland and, as a guarantee of his good intentions, surrendered to Cromwell the key towns of Berwick and Carlisle, which had been occupied by royalist supporters. Thus, with Fairfax's victories over the southern royalists and Cromwell's defeat of the Scots in the Preston campaign, the second civil war came to an end.

Execution of Charles I.—The parliamentary leaders had continued to negotiate with the king in the Isle of Wight even after the Engagement. The army, however, was embittered by the second civil war. Both its northern and southern sections petitioned that the authors of the war be punished, and the Levellers asked that the king be brought to a public trial. What incensed the army was that the king and principal royalists had broken their word not to fight again and that they had engineered a fresh invasion of the north of England by a Scottish force. On Dec. 1, 1648, Fairfax sent officers to fetch the king from the Isle of Wight and, after he had been temporarily lodged at Hurst castle in Hampshire, he was taken to Windsor castle and thence to Whitehall. On Dec. 6 Col. Thomas Pride and a body of musketeers entered the house of commons, expelled all the leading Presbyterians and put some of them under arrest, an incident that came to be called Pride's purge. The remaining Rump parliament of about 60 members agreed, under pressure from the army, to an ordinance of Jan. 1, 1649, establishing a high court of justice to try the king. The remnant of the house of lords refused to accept the ordinance, whereupon the commons assumed the full responsibility and appointed 135 commissioners to act as judges and jury. The court met in Westminster hall on Jan. 20. On Jan. 27 it condemned the king to death as a tyrant, traitor and public enemy. Charles himself refused to recognize the legality of the court and claimed that he was a martyr of the people. On Jan. 30, 1649, he was executed on a scaffold erected outside his palace of Whitehall.

THIRD CIVIL WAR

Royalist Policy.—Soon after Charles's execution, kingship and the house of lords were abolished and England became a commonwealth, or republic, with the attenuated house of commons, originally elected in 1640, exercising both executive and legislative powers. The royalists, however, regarded Charles II, the 19-year-old eldest surviving son of Charles I, as king. An exile in the Netherlands, Charles II based his immediate hopes of regaining the throne less on the English royalists, who were now entirely crushed, than on support in Scotland, where he was at once recognized as king, and in Ireland where the royalists were still fighting. Most European states preferred to wait and discover the strength of the English republic before committing themselves to war against it. Charles II's first thoughts therefore turned to Ireland, where sympathy might be translated into active assistance.

Rebellion in Ireland.—Charles I's lord lieutenant of Ireland, the earl of Ormonde, at last succeeded, in Jan. 1649, in concluding a treaty at Kilkenny between the Roman Catholic rebels, known as the confederates, and the royalists. In return for a promise of the abolition of the penal laws against them and of an independent parliament, the Irish Catholics undertook to fight for the king; soon almost the whole of the country was in their hands. The English republican parliament decided to counter the threat of a possible Irish invasion by sending Cromwell to Ireland with a well-equipped expeditionary force of 12,000 men. Even before Cromwell arrived, Ormonde was defeated at Rathmines, near Dublin, by a parliamentary army that was there already. In Aug. 1649 Cromwell's army landed at Dublin, where he was also sustained by English sea power. Prince Rupert, who was now distinguishing himself as an admiral in command of a few ships, was soon compelled to leave Irish waters. In a brief, brilliant and ruthless campaign Cromwell cleared most of southern Ireland of his enemies and after fighting through the winter returned home in May 1650, leaving Ireton to carry out mopping-up operations. King Charles II was sadly disappointed by the failure of his friends in Ireland; it had been his expectation that Ireland would become a firm base, that the marquess of Montrose would rally the Scottish royalists to his cause and that with some foreign help he might reconquer England. But an attempted rising by Montrose had already been crushed by the covenanters in April 1650 (and Montrose executed) and now Charles was reluctantly driven to come to terms with the Scottish covenanters who had humiliated and betrayed his father.

Charles II in Scotland.—Though Charles II had been proclaimed king by the Scottish estates after the death of his father, the covenanters, headed by the marquess of Argyll, demanded harsh terms for their military assistance. Sorrowfully Charles promised to uphold the Covenant and, once he was restored, to impose Presbyterianism both on England and Ireland, in an agreement signed on June 11, 1650, while he was on his way to Scotland. The English parliament, however, was determined that this time it would not suffer another invasion of northern England by a Scottish army. Thomas Fairfax, who had now succeeded to his father's title, was therefore ordered to assemble an army and lead it into Scotland. Fairfax, who had not approved of Charles I's execution and had somewhat unwillingly become a member of the republican council of state, refused on the ground that this would be an act of unprovoked aggression. Cromwell was then appointed to lead the expeditionary force and on July 22, 1650, crossed the border with 16,000 men.

The Scottish covenanter army outnumbered the English, was able to operate on inner lines and had a capable general in David Leslie. But Leslie was hamstrung by interference from the church leaders, who criticized his strategy and insisted on purging his army of doubtful elements. Nevertheless Cromwell experienced great difficulties because the country was denuded of supplies; he also found that the fortified line covering Edinburgh could not easily be outflanked. But on Sept. 3, 1650, he won an astonishing victory at Dunbar, 30 mi. E. of Edinburgh, where Leslie's larger army was outmaneuvered and shattered at small cost to the English. Later Cromwell was taken ill and bad weather held up the progress of his campaign. Meanwhile Charles II had not been unduly depressed by the defeat of the covenanters. On Jan. 1, 1651, he was crowned a covenanted king at Scone and placed in nominal command of the remaining Scottish forces, which were concentrated in a strong defensive position near Stirling, protected by the river Forth.

Charles II's Invasion of England.—Charles II's last hope was to lead the Scots into England and there rally the royalists to his cause. Cromwell, finding it hard to attack the Scots in their strong position, was willing to give the young king his opportunity. He ordered his son-in-law Charles Fleetwood to raise a fresh army in England and then himself forced his way across the Forth, thus giving the king the chance he wanted to move south across the border. Early in Aug. 1651 the king led an army of about 20,000 men through northwest England, hoping to pick up recruits both in Lancashire and in Wales and, having incited a general rising, to advance in triumph on London. But his progress was harrassed by cavalry under Lambert's command and Cromwell, after taking Perth, followed Lambert with the bulk of his army. On Aug. 24 Fleetwood joined Cromwell at Warwick and early in September Charles II and his tired troops were surrounded and cut off at Worcester.

The young king put up a gallant fight at Worcester on Sept. 3, 1651, but the Scots were demoralized and overwhelmed. Few escaped home. For the remainder of the period of republican supremacy Scotland, like Ireland, was subject to the English Commonwealth. Charles II himself escaped from Worcester and after many adventures arrived safely in France. Some royalist strongholds in Scotland hung out until 1652 and abortive royalist rebellions continued to take place until the Restoration, but the battle of Worcester marked the real end of the English Civil War.

EFFECT OF THE CIVIL WAR

The loss of life, suffering and damage caused by the Civil War were relatively small. On the whole, the first civil war was conducted in a humane spirit with courtesies extended across the lines. Bitterness was felt in the second civil war, but episodes such as the sack of Leicester by the royalists in 1645 and the slaughter at Drogheda by the parliamentarians in 1649 were exceptional. Economic losses were heaviest among what may be called the lower middle classes; but considerable unemployment, poverty and hardship were general in the late 1640s and overseas trade was interrupted by an increase in privateering at sea.

On the whole, the war was fought by amateurs and there was no striking evolution in the arts of war. Both Prince Rupert and Oliver Cromwell used the cavalry as a shock weapon, which was sharpened as the war went on. In the infantry, Rupert introduced new formations which he had learned on the continent and which owed their origin to Gustavus II Adolphus of Sweden. Both Fairfax and Cromwell sought to meet their enemies in the field rather than allowing themselves to be bogged down in prolonged sieges, as was customary on the European mainland until the days of Turenne and Marlborough. One consequence of the Civil War was an enduring dislike in England of a standing army.

The Civil War influenced the development of social and economic ideas. The natural leadership of the nobility and established gentry was to some extent temporarily undermined, and on the parliamentarian side men of comparatively humble birth rose to high positions. For a while the whole social and constitutional order was called into question by the democratic Levellers and army "agitators," though the Leveller movement continued for little more than a decade. Above all, the destruction of the church hierarchy and the Puritan victory in the war brought about increasing demands for complete liberty of worship and liberty of conscience among Christians. This independence of outlook, which was particularly marked in the New Model army, survived the Restoration and contributed to the strength of later English Nonconformity. *See* ENGLISH HISTORY; CHARLES I; CROMWELL, OLIVER; *see* also references under "Civil War, English" in the Index volume.

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CIVITA CASTELLANA, a town in the Lazio region of Italy, in the province of Viterbo, is 29 km. (18 mi.) E.S.E. of the town of Viterbo, on the railway from Viterbo to Rome. Pop. (1957 est.) 12,699 (commune). The town is possibly on the site of the 9th-century B.C. Falerii. The cathedral, begun in the 7th century A.D. and destroyed and reconstructed after 1000, is one of the oldest in Italy. The façade and doors are by the Cosmati; the remarkable porch of Jacopo (son of Lorenzo) and his son Cosma inspired Brunelleschi in the design of the front of the Pazzi chapel in the cloister of Sta. Croce at Florence. The apses contain Lombardic elements, also present in the Romanesque church of S. Gregorio. Outside the town is the 12th-century church of Sta. Maria of Falerii. The imposing pentagonal fort was built by command of Pope Alexander VI in 1494 and the octagonal keep by order of Pope Julius II in 1512. The people are mainly occupied in the production of cereals and in viticulture. There is also an important ceramics industry.

Falerii Veteres, the capital of the Falisci, was in existence in the Iron Age. Faliscan vases of local make have been found in its very rich necropolis. It was destroyed in a struggle against Rome in 395 B.C. and again during the Punic Wars (*q.v.*). The inhabitants were moved to the plain where Falerii Novi was built and where ruins of the walls, nearly 2 mi. long, are standing. Falerii became part of the domain of the church and in 998 Pope Gregory V gave it the title of *civitas*. In the 14th century it was given to the princes Savelli. It was raised to an episcopal see in 990 and Orte (1437) and Galese (1805) were later united with it. (M. T. A. N.)

CIVITAVECCHIA, an episcopal town in the Lazio region of Italy, in the province of Roma, 76 km. (45 mi.) W.N.W. of Rome by road, is the principal seaport for Rome and central Italy. It is on the Rome–Pisa railway line. Pop. (1957 est.) 37,545 (commune). Three-fourths of the town was destroyed during World War II, and the subsequent reconstruction was spread over a larger area. The rebuilt civic museum was endowed with the world's largest collection of engravings by Luigi Calamatta, a native of the town. A short distance outside the town, on the road to Tolfa and in the Fioncella area, are imposing ruins of Roman baths. In addition to the maritime traffic, the town's industries include a thermoelectric centre, cement, brick and spirits factories, mechanical laboratories and workshops for the treatment of marble.

The port, on a stretch of coast already known as Centumcellae, was founded by the emperor Trajan to replace the silting-up harbours on the Tiber. The Porta di Traiano is preserved in the central part of the modern port. Flourishing during the late Roman empire, the town was attacked by Vandals and Saracens and the people fled to the Monti di Allumiere. The settlement there, originally called Cencelle, was renamed Leopoli after Pope Leo IV, who constructed, in 854, a walled town protected by towers. Later the inhabitants returned to the old site. Several popes interested themselves in the protection of the port. The keep, commissioned by Paul III from Michelangelo, was finished in 1537 and the naval arsenal was begun in 1663. By 1870 the town was the most strongly fortified in the states of the church.

CLACKMANNAN, an ancient town of Clackmannanshire, Scot., formerly the county town but now a civil parish, about 12 mi. W.N.W. of Dunfermline by road. Pop. (1951) 3,024. Clackmannan tower (in ruins) was at one time the seat of the Bruce family and is now an ancient monument under the care of the ministry of works. The Tollbooth and Mercat cross still exists, and with this group stands the stone that gives the town its name (Gaelic, *clach*, "stone"; *Mannan*, the name of the district). In the area are three collieries, the Forth paper mills at Kilbagie and a woolen factory in Clackmannan. (N. A. S.)

CLACKMANNANSHIRE, the smallest county in Scotland, is bounded on the southwest by the river Forth, west by Stirlingshire, north by Perthshire and east by Kinross-shire and Fife. Area 54.5 sq.mi. Pop. (1961) 41,391.

The northern half of the county is the southwestern part of the Ochil hills, a dissected moorland plateau of 1,900–2,000 ft. (Ben Cleuch, 2,363 ft.) planed across andesitic lavas and tuffs of Old Red Sandstone age, with intrusive hypersthene-diorite in Kirk Crags, northeast of Tillicoultry. The Ochils have a spectacular fault-line scarp facing south across the woods, the farm land, the pit heads and small towns of lowland Clackmannanshire. First are the alluvial fans laid down by the Ochils streams; then across a plain the river Devon winds to a low (about 250-ft.) plateau, narrow in the west but broadening toward the east of the county; and then the carse-land fringes the Forth in the south, with a belt of 100-ft. raised beach on the inland side. The lowlands are planed across the outcrops of a south-north trending syncline in Carboniferous rocks: Barren Red Measures in the centre, the Coal Measures around these and then the sandstones of Millstone Grit age in belts on either side of the Coal Measures; the synclinal structures are abruptly terminated in the north by the Ochils fault. The rivers of importance are the Devon, noted in its upper reaches for its scenery and trout fishing, and the south or Black Devon. The only loch is Gartmorn dam, which provides the main water supply to Alloa. (A. T. A. L.)

The early inhabitants belonged to the great Celtic tribe known to the Romans as Damnonii. Later the county was part of the district of Mannan, disputed land in central Scotland. About the close of the 7th century St. Serf, who had come to the Fife peninsula to convert the Picts, visited Tullibody, Tillicoultry and Alva; a well at Alva and a bridge over the Devon commemorate his name. The victory of Kenneth MacAlpin, king of the Scots, over the Picts in 844 is said to have taken place near Tullibody, a stone near Baingle brae marking the battlefield. It is said that in 1559 the bridge over the Devon at Tullibody was broken down to impede the passage of French troops in the service of Mary of Lorraine (or Guise), but the French unroofed the church and repaired the bridge. In 1645 the royalist force of the marquis of Montrose burned Dollar and also Castle Campbell, one of the seats of Montrose's bitter enemy, the marquis of Argyll. By way of reprisal Argyll burned Menstrie house, the seat of the earl of Stirling.

Clackmannan (*q.v.*) was formerly the county town, but the administrative centre is now the small burgh Alloa (*q.v.*). The other small burghs are Alva, Tillicoultry and Dollar (*q.v.*). The county, with part of Stirlingshire, returns one member to parliament. It forms a sheriffdom with Stirlingshire and Dunbartonshire.

The county has a diversity of agricultural holdings, from the sheep farms of the Ochils through the arable and dairy farms in the centre to the carse farms in the south, these last being on land reclaimed from the Forth by the erection of flood banks. Agriculture suffers from land subsidence caused by the extraction of coal which is one of the county's main sources of wealth. In the early

1960s it was estimated that there were unworked reserves in the productive Coal Measures alone to ensure work for 100 years. With the closure of Devon and Meta pits, the surface mines at Forthbank, Zetland and Brucefield and the new mine at Glenochil, northeast of Tullibody, no mine sinkings will be operative; although increasingly coal is being taken from under the county from works near Dollar and at Manor Powis. After World War II miners were transferred from Lanarkshire, and the population of Tullibody has grown. The county's chief manufacturing industries are general engineering, textiles, distilling, brewing, papermaking, printing, woodworking and glass manufacture. (Al. St.)

CLACTON-ON-SEA, a seaside town and urban district of Essex, Eng., 15 mi. S.E. of Colchester and 66 mi. E.N.E. of London by road. Pop. (1961) 27,543. Electrification of the London–Clacton railway line was completed in 1962. The urban district comprises Clacton, Great Clacton, Holland-on-Sea and Jaywick and has over 3½ mi. of sandy beaches backed by low cliffs laid out with sea defenses, promenades, chalets, greenswards and gardens. On the pier are a ballroom, theatres, amusement pavilion, open-air swimming pool and lifeboat house. There are four theatres in the town, a pavilion and winter garden and many other amusement and sports centres. In the summer season steamers cruise down the coast and across the English channel to Calais. Great Clacton church is of Norman and later date and St. Osyth priory (4 mi.) is of considerable beauty and historic interest with buildings dating from the 13th century. The chief industries are tourism, printing, light engineering, manufacture of plastic articles and horticulture. (C. B. He.)

CLAIRAUT (Clairault), **ALEXIS CLAUDE** (1713–1765), French mathematician, was born on May 7 or 13, 1713, at Paris. Under the tuition of his father, a teacher of mathematics, he made such progress that at 12 years of age he read before the French Academy an account of the properties of four curves that he had discovered. His *Recherches sur les courbes à double courbure* (1731), procured his admission into the Academy of Sciences, although he was still below the legal age. In 1736, with P. L. Maupertuis, he went on an expedition to Lapland, for the purpose of estimating a degree of the meridian; and in 1743 he published his treatise *Théorie de la figure de la terre,* in which he promulgated the theorem known as Clairaut's theorem, which connects the gravity at points on the surface of a rotating ellipsoid with the compression and the centrifugal force at the equator. In 1750 he gained the prize of the St. Petersburg academy for his essay *Théorie de la lune;* and in 1759 he calculated the perihelion of Halley's comet. He also detected singular solutions in differential equations of the first order, and of the second and higher degrees. Clairaut died at Paris on May 17, 1765.

CLAIRON, LA (Claire Josèphe Hippolyte Léris) (1723–1803), French actress, was born at Condé-sur-Escaut on Jan. 25, 1723. She began her career as a provincial soubrette, making her début at the Comédie Française on Sept. 19, 1743, in the role of Phèdre. La Clairon's style was that of the declamatory school, and she was best suited for parts that called for nobility of soul and pride coupled with intelligence (Corneille's heroines); in rendering moments of tender sentiment she could not surpass her rival, Marie Françoise Dumesnil. The playwright J. F. Marmontel prevailed upon her to change her acting style and to trim the declamatory display in favour of greater simplicity, the "conversion" taking place in 1753. Soon after, prompted by Diderot, the actress also changed her traditional style of costuming by introducing touches of character and ethnography. In 1766 she retired, though she continued to appear at court and in private theatricals. Her *Mémoires,* which she had written for posthumous release, were published in 1798. She died in Lille, Jan. 29, 1803. (A. M. N.)

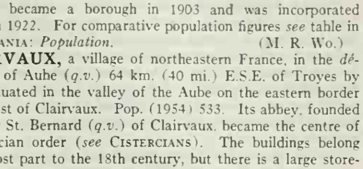
CLAIRTON, a city of Allegheny county, Pa., U.S., lies on the Monongahela river, 12 mi. S.E. of Pittsburgh, and is part of the Pittsburgh metropolitan area. Its major industries are steel, coke and benzol plants. The rolling mills at Clairton produce about 130 varieties of construction steel, while the coking plant produces large quantities of smokeless fuel, coke and raw materials used in the chemical industry in manufacturing medicines, plastics, paints and highway-surfacing materials. By-products of the coke plant are further processed by a large industrial chemical plant.

Clairton became a borough in 1903 and was incorporated as a city in 1922. For comparative population figures *see* table in Pennsylvania: *Population.* (M. R. Wo.)

CLAIRVAUX, a village of northeastern France, in the *département* of Aube (*q.v.*) 64 km. (40 mi.) E.S.E. of Troyes by road, is situated in the valley of the Aube on the eastern border of the forest of Clairvaux. Pop. (1954) 533. Its abbey, founded in 1115 by St. Bernard (*q.v.*) of Clairvaux, became the centre of the Cistercian order (*see* Cistercians). The buildings belong for the most part to the 18th century, but there is a large storehouse that dates from the 12th century. In World War II Clairvaux was in German occupation from June 1940 to Aug. 1944. For a description of the abbey, *see* Monastery.

CLAIRVOYANCE, a form of extrasensory perception, the ability to discern objects not present to the senses (as distinguished from telepathy, the cognition of the mental activities of another person). *See* Parapsychology.

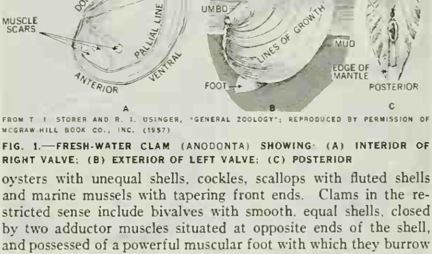
CLAM, in its widest usage, is a name applied to about 15,000 species of bivalve or two-shelled mollusks; the term refers to the tightness with which the shell closes. Four-fifths of these species inhabit the sea or brackish waters, the remainder dwelling in fresh water. Within this large group of aquatic animals are found the fresh-water mussels (Unionidae); also readily recognized are oysters with unequal shells, cockles, scallops with fluted shells and marine mussels with tapering front ends. Clams in the restricted sense include bivalves with smooth, equal shells, closed by two adductor muscles situated at opposite ends of the shell, and possessed of a powerful muscular foot with which they burrow into the bottom. There they lie, from just under the surface to up to two feet for the delicate angel wing, *Barnea costata.* Rarely do they travel over the bottom as is typical of fresh-water mussels.



FROM T. I. STORER AND R. I. USINGER, "GENERAL ZOOLOGY"; REPRODUCED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC. (1957)

FIG. 1.—FRESH-WATER CLAM (ANODONTA) SHOWING (A) INTERIOR OF RIGHT VALVE; (B) EXTERIOR OF LEFT VALVE; (C) POSTERIOR

Most clams inhabit shallow water, where they are protected from wave action by the surrounding bottom. During severe storms, however, tons of surf clams, *Spisula solidissima,* may be deposited on the beach. A species of Abra clam, *Abra profundorum,*



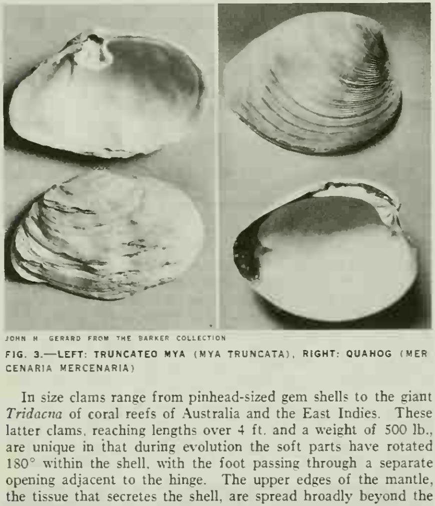
JOHN H. GERARD FROM THE BARKER COLLECTION

FIG. 2.—LEFT: GIANT CLAM (TRIDACNA ELONGATA), RIGHT: ANGEL WING CLAM (BARNEA COSTATA)

has been taken in the mid-North Pacific at a depth of over three miles.

Water is drawn in and expelled through two tubes, the siphons, impelled by the beating of millions of microscopic whips, called cilia, of the gills. Other cilia strain food from the incurrent water and transport it entangled in mucus to the mouth. Reproduction is usually through a free swimming larva developed after eggs and sperm are shed into the water. In a few species, such as the gem clam, *Gemma*, eggs fertilized by sperm drawn in with incurrent water develop within the mother into young adults that are born alive.

The best known life history of a clam is that of the hard-shell clam or quahog, *Mercenaria (Venus) mercenaria*, of the east coast of North America. Ripe male and female clams, in water approximating 77° F., are stimulated to spawn by addition of fresh clam sperm. Eggs and sperm are extruded from the excurrent siphon. The fertilized egg, developing into a microscopic larva with a bivalve shell, is known as a veliger from its ciliated swimming organ, the velum. The velum also aids in gathering minute plants and bacteria from the water. After approximately one week of this free-living existence the larva drops to the bottom and crawls actively about on its ciliated foot. It then secretes a very thin horny thread, the byssus, attaching itself to one or more sand grains or to a shell. After several weeks it releases the byssus thread and burrows into the bottom.

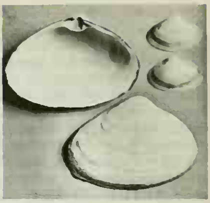


JOHN H. GERARD FROM THE BARKER COLLECTION

FIG. 3.—LEFT: TRUNCATED MYA (MYA TRUNCATA), RIGHT: QUAHOG (MERCENARIA MERCENARIA)

In size clams range from pinhead-sized gem shells to the giant *Tridacna* of coral reefs of Australia and the East Indies. These latter clams, reaching lengths over 4 ft. and a weight of 500 lb., are unique in that during evolution the soft parts have rotated 180° within the shell, with the foot passing through a separate opening adjacent to the hinge. The upper edges of the mantle, the tissue that secretes the shell, are spread broadly beyond the shell margins in *Tridacna* and are brilliantly coloured, orange to purple, by a host of microscopic algae growing in symbiosis or partnership with the clam. These zooxanthellae as they are called are thought to absorb wastes from the clam and in turn furnish much food to their host.

Among the most widely used clams for human food are the quahog (*Mercenaria mercenaria*), ocean quahog (*Arctica islandica*), soft-shell or long-necked (*Mya arenaria*) and surf (*Spisula solidissima*) clams of eastern North America. On the Pacific coast are found the pismo (*Tivela stultorum*), butter (*Saxidomus nuttalli*), giant razor (*Siliqua patula*), gaper (*Schizotherus nuttalli*) and jackknife or broad razor (*Tagelus californianus*) clams. The largest of the Pacific clams is the geoduck (pronounced gooee-duck) (*Panope generosa*) weighing up to 6½ lb. It is delicious eating and is much sought after; in most localities catches are limited to one clam per day.



JOHN H. GERARD FROM THE BARKER COLLECTION

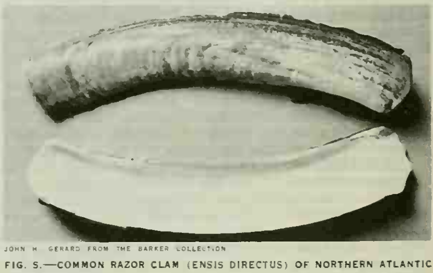
FIG. 4.—ATLANTIC SURF CLAM (SPISULA SOLIDISSIMA) SHELLS OF A YOUNG SPECIMEN AT UPPER RIGHT.

Clams are less abundant in European waters, but the common razor clam (*Ensis directus*) and a large razor clam (*E. siliqua*), the latter reaching a length of seven inches with breadth of over an inch, are sought for eating. The powerful foot of *E. siliqua*, extended by blood pressure, can pull the clam rapidly down into the sand, aided by water jets from the gill chamber. When expanded against the walls of the burrow, the foot holds so firmly that efforts to dislodge the bivalve will frequently break the clam in two. American jackknife clams, about three inches long, have been observed swimming in rapid spurts by water jets expelled about the foot. *Mya* species have been introduced to the Pacific coast and to British waters, but thus far they have found little favour with the English people, who prefer the cockle.

Following serious depletion of *Mya* on the New England coast, where it is strongly preferred to the hard clam, large beds were discovered in Chesapeake bay. In New England harvesting is done at low tide on exposed flats, using a clam rake by hand, whereas in Maryland hydraulic dredges are employed in areas never uncovered by the tide.

Mya is much prized in America as steamed clams eaten with melted butter, and for chowder in which the ground clams are combined with salt pork, onion and potato in a rich cream sauce with milk. Manhattan clam chowder consists of the quahog clam, with carrots but without cream sauce and milk. Small quahogs are eaten raw as the so-called cherry stones. These and oysters on the half shell are perhaps the only animals eaten alive by North Americans. A small clam (*Paphia*) of Japan is canned and exported. The large surf clam of the eastern U.S. is canned in large quantities, but substantial numbers are also used for bait. The surf clam and *Mya* have poor keeping qualities, hence they must be promptly consumed or canned. In sharp contrast, the quahog, under refrigeration, will keep for weeks since it can close its shell tightly, thus excluding air. Thus sealed the hard clam lives under oxygen-free, or anaerobic, respiration, breaking down its stored glycogen to produce energy. The resulting end product, lactic acid, is neutralized by solution of lime from the inner surface of the shell. *Mya*, with its long siphons, and the surf clam, with heavy mantle borders, are unable to close tightly and are thus exposed to the air.

Numerous animals other than man also enjoy eating clams. Chief among the predators of hard-shell, soft-shell and surf clams are blue crabs (*Callinectes*), green crabs (*Carcinides*), horseshoe "crabs" (*Limulus*), clam borers (*Polynices*), several species of small mud crabs and rays. The crabs either crack the clam shells with their claws or chip away bits from their edges to gain



JOHN H. GERARD FROM THE BARKER COLLECTION

FIG. 5.—COMMON RAZOR CLAM (ENSIS DIRECTUS) OF NORTHERN ATLANTIC SHORES

entrance to the meats. *Limulus* grinds young bivalves between spines, the "chewing" gnathobases, borne on bases of their legs. Clam borers drill a neat hole through the clam shell with their rasping tongue, the radula.

The value of annual harvest of hard-shell, soft-shell, surf and razor clams and ocean quahogs in the United States approximates $10,000,000. Several species too small to market are consumed as a broth. Vast numbers of small species and young of larger ones are eaten by bottom-feeding fishes, chief among them the common plaice of Europe. Other small clams include various duck clams such as the dwarf surf clam (*Mulinia lateralis*). Heavy clam shells have been used as shell money by Indians (*see* WAMPUM). Perhaps the greatest value of all bivalve mollusks is in straining microscopic life, plankton, from the water and transforming it into human food either directly, or indirectly through fish.

See also BIVALVE; COCKLE; MOLLUSK; MUSSEL; QUAHOG; also references under "Clam" in the Index. (T. C. N.)

CLAN, a group of fundamental importance in the social structure of many societies in which membership is socially defined in terms of unilineal descent, either matrilineal or patrilineal. Normally clans are exogamous, *i.e.*, marriage within the clan is forbidden and regarded as incest (*see* EXOGAMY), but the occurrence of unilineal groupings without exogamy, as among the Arab tribes or some of the Polynesians, has led to a broader conception of the clan in recent years.

The terminology employed for the clan has gone through a number of permutations during the past century. During the latter half of the 19th century the term "clan" was employed for a wide variety of groups, some based on unilineal descent but others characterized by totemic beliefs or occupation of a common territory. The early cultural evolutionists used the term for both patrilineal and matrilineal groupings and assumed that matrilineal descent was prior to patrilineal. Growing evidence against this evolutionary sequence and the ethnographic differences between the two types of descent groups led American ethnologists in the early 20th century to designate the patrilineal clan as a "gens" (pl. gentes). W. H. R. Rivers, in England, proposed the term "sept" in place of clan, since the Scottish clan from which the term derived was neither unilineal nor exogamous. Later, Robert H. Lowie suggested the substitution of "sib" for clan and referred to "father-sibs" and "mother-sibs" in an effort to clarify the situation.

Soon afterward the conception of a "lineage" as a unilineal group which could trace actual genealogical relationships was developed by E. W. Gifford, A. A. Goldenweiser, Rivers and others, under such terms as the "maternal family," the "joint family," etc. Empirically, subdivisions of clans had been long recognized, but this new distinction was to have considerable theoretical importance, particularly in England, where the term lineage came to be used for unilineal descent groups with genealogical control and corporate functions, in contrast to wider and often dispersed divisions of society in which there is a belief in, but no proof of, common descent and which are commonly called clans. In some African societies such as the Tallensi there are lineages of different genealogical depths, for which M. Fortes has proposed the terms maximal, major, minor and minimal lineages.

G. P. Murdock, in a recent attempt to standardize the terminology for social groupings, has proposed the use of lineage and sib for consanguineal kin groups and has utilized the term clan for residential groupings based on unilineal descent and unilocal residence—often called "localized clans" in the literature. This latter usage has not as yet received widespread support, however.

P. Kirchhoff has attempted to make a distinction of a different character: between a unilineal, exogamous clan in which every member is of equal standing and what he calls a "conical" clan, in which nearness of relationship to the founding ancestor is of greatest significance and where no two individuals have the same status. Such "clans" depend on genealogical control but are not necessarily unilateral or exogamous. As such they may lead over to bilateral descent groups which may have some aspects of clan structure and function and which have been recently called "nonunilinear descent groups" by W. H. Goodenough and others.

Despite the variations in terminology, considerable progress has been made in understanding the role of clans in human society. The clan is first of all to be clearly distinguished from the family. Where the clan is exogamous—and this is the case in the great majority of instances—the husband and wife have to come from different clans. The clan or lineage can therefore not stand alone normally, and marriage is one of the major means by which clans are organized into a social structure. Within such families the children belong with the mother and her relatives in matrilineal descent, and with the father and his relatives in patrilineal descent. In a few societies both matrilineal and patrilineal clans coexist, and children belong to their father's patrilineage or clan and their mother's matrilineage or clan (*see* KINSHIP; MATRILINY).

Through various rules of residence it is possible to keep certain clan members together in the same household or locality. Thus the Hopi Indians, who are organized into matrilineages and clans, have a general rule that the husband goes to reside in the wife's natal household. The household thus comes to have a lineage segment of women as its core, plus husbands who marry in and minus brothers who marry out. In many African societies, such as the Zulu, the household is patrilineal and patrilocal, the wife or wives coming to live in the kraal of the husband and his sons. Not all societies with patrilineal descent are patrilocal, however. Thus the Omaha Indians of Nebraska, who were organized into patrilineal clans, lived in earth-lodges during the fall and spring in matrilocal fashion but hunted as a group during the summer in tepees with patrilocal residence. And some matrilineal groups such as the Tlingit and Haida Indians of the northwest coast of North America, and certain tribes of central Africa, practised avunculocal residence in which the males go to live with their mother's brothers, either as children or for marriage (*see* AVUNCULATE).

In a few extreme but theoretically interesting cases the clan or lineage is also a residential group. Among the Nayar caste of southern India the matrilineage occupied a household and estate in common and resided together. After ritual marriage and divorce a Nayar woman took lovers from neighbouring Brahman castes or other Nayar lineages, but the father had no rights over his children who belonged to the matrilineage. The Menangkabau of Sumatra had a similar system in which marriages took place but the husband remained in his own household and visited his wife at night; otherwise he had little place in his wife's group. In strong patrilineal societies similar results may be accomplished by incorporating the wife into the husband's clan or lineage, often through the exchange of bride wealth. Thus in China a wife became practically a member of her husband's lineage and lost most of her rights in her own clan. Among some of the neighbouring Mongol tribes, such as the Monguor of Kansu province, a wife who was mistreated had only one recourse—suicide. This brought her entire body of clansmen to the husband's camp, where they remained until a large indemnity was paid. But in the majority of cases marriage represents an alliance between clans or lineages, and both maintain an interest in the marriage and the children.

Within the clan the members consider themselves as consanguineal relatives, whether or not they can trace relationship genealogically. This is generally expressed by the use of kinship terms between clansmen, as well as by hospitality and support. In many societies the kinship system is organized in part according to the clan or lineage structure. Thus a Hopi Indian has his closest relations in his own matrilineage and clan but is also considered a "child" of his father's matrilineage and clan. All of his father's clanspeople are "father" and "father's sister," regardless of age or generation; likewise, his mother's father's clanspeople are all "grandfathers" and "grandmothers." Within his own clan a Hopi distinguishes "mother" and "mother's brother," "brother" and "sister," and "son" and "daughter," or "nephew" and "niece," but all who marry into the lineage are generally classed together regardless of generation as "male relative-in-law" or "female relative-in-law." While distinctions are clearly made between close relatives, similar attitudes and behaviour are expected.

Looking at clan societies from without, the clans may be seen as equivalent divisions of society which often have parallel functions as well as special duties. Individual clans may have charge of particular ceremonies or may furnish certain officials, political or religious. The unity of the clan is often expressed in terms of the possession of a common emblem or totem (*see* Totemism). When totemism occurs, and it is not universal in clan-organized societies, each clan may have a special association with a plant or animal species, or some aspect of nature, and may perform rituals to maintain the species or express respect by not eating it. In some cases there is a belief in descent from the totem animal or in a joint ancestry in some primeval period.

Recent research has also emphasized the significance of the clan or lineage as a corporate group. Sir Henry Maine long ago called attention to the primary attribute of the corporation in terms of perpetuity or self-continuation, and Max Weber expanded this conception to include a locus of authority and rules of membership. Maine's conception was first applied to the analysis of lineage structures by A. R. Radcliffe-Brown, in terms of the concept of perpetual corporate succession and the necessity of defining rights over persons and property in unequivocal terms. This analysis has had fruitful results in recent social anthropological research on African societies, particularly those with segmentary lineage structures. In such societies an individual has status only as a member of a lineage, and the lineage frequently operates as if it were a single personality. The lineage perpetuates itself from generation to generation, controlling rights over new members and maintaining ties with past generations through ancestor worship and other rituals. The lineage is often the political unit as well. One aspect of the lineage as a corporate group is seen in blood vengeance: in many cases all members have collective responsibility for revenge or compensation and each is equivalent as an object of revenge.

The problem of maintaining the lineage structure involves the processes of fission and fusion, as well as continuity. The lineage is dependent on the accidents of birth and death for its perpetuation, and there are fictive devices, such as adoption or replacement by a related lineage, to maintain structures in danger of loss. Where lineages grow too large for their resources they frequently split and form sublineages or separate lineages. Or if too small they may merge with another lineage. In such cases the genealogies or traditions are frequently altered to mirror the new situation.

In many African societies the lineages segment at intervals and operate in complementary relationship or in opposition to one another, as described by E. E. Evans-Pritchard for the Nuer. Among some groups the process of segmentation follows relatively regular intervals, and the resulting segments may be organized in hierarchical fashion, as among the Tallensi.

The early evolutionists considered clan organization to be characteristic of primitive society, though they set up various hypothetical periods of promiscuity and group marriage for earlier stages. Clan organization, however, is not found among the technologically simplest peoples now existing, such as the Pygmies and Negritos, the Great Basin Shoshone, the Bushmen and some of the Siberian peoples. Nor is it characteristic of modern western nations with their highly advanced technologies. Between these is a wide range of societies—from Australian aborigines and many American Indian and African groups to certain peoples of India and China—where unilineal institutions are present or flourish.

Within this wide range of societies a number of explanations have been offered for the development of clan organization. Since similar forms occur in widely separated regions, Lowie early rejected diffusion as an adequate explanation and proposed that the transmission of property rights and the mode of residence after marriage were the most important factors for establishing unilateral descent. Murdock has recently further documented their importance. The significance of rights over property and persons has been noted in connection with the discussion of corporate groups and may well be the most important aspect of clan formation. In technologically poor groups, small-scale settlements are the rule and bands are often fluid and unstable. Here the tribe as a whole may act as a type of corporate group to maintain what continuity and stability there is. Where such groups become attached to particular localities, as in Australia, clan organizations may develop on a considerable scale.

In regions such as central Asia, L. Krader has shown a correlation between the ecology of pastoral life and the type of genealogically controlled lineage structure characteristic of Turkic and Mongol peoples; and E. Bacon has suggested that this type of organization may have been widespread in Eurasia. Practices of preferential marriage between clan groups give rise to special forms of social structure, but the causal significance of preferential marriage for the development of clans is still a moot question.

Clans are often grouped into larger aggregations, usually called phratries, which may also be exogamous. In other instances the clans may be grouped into two major divisions, called moieties; or the whole tribe may be divided into two exogamous halves, with or without further subdivisions. Such moieties frequently have a number of reciprocal functions, in addition to exogamy, and often are associated with a dual organization of the cosmos. Other forms of dual organization exist with some aspects of exogamous moieties, but they have a different structure and presumably a different origin. *See* Dual Organization.

See also references under "Clan" in the Index volume.

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CLANRICARDE, EARLS OF. The Irish title of earl of Clanricarde was created in 1543 for Ulick de Burgh (d. 1544), the head of the MacWilliam Uachtar branch of the Burke or De Burgh family (*q.v.*). As head of his clan, he exercised a quasi-royal authority, holding vast estates in County Galway. In 1541 he wrote to Henry VIII, placing himself and his estates in the king's hands. He visited the king at Greenwich in 1543, made full submission, undertook to introduce English manners to Ireland and was made a regrant of most of his old estates with some new ones. On July 1, 1543, he was made earl of Clanricarde and Baron Dunkellin but he did not live to enjoy his new rank long, dying in Ireland on Oct. 19, 1544.

Ulick's son and grandson, succeeding in turn, continued to be loyal to the English, supporting them against the Irish rebels. Richard (1572–1635), 4th earl, who succeeded in 1601, fought on the English side in Hugh O'Neill's rebellion and was granted the English earldom of St. Albans in 1628. His son Ulick became marquess of Clanricarde in 1646 (*see* Clanricarde, Ulick de Burgh, Marquess of), but on his death the marquessate and English titles became extinct. His cousin Richard (d. 1666), 6th earl, succeeded to the Irish earldom in 1657. John (1642–1722), 9th earl, fought for James II in Ireland. He was imprisoned in 1691 and attainted, but he conformed to the established church in 1699 and was restored to his titles and estates in 1702. His descendant Henry (1743–97), 12th earl, was created marquess of Clanricarde in 1789, but died without male issue. The marquessate was revived in 1825 for Ulick John (1802–74), 14th earl, who was ambassador to St. Petersburg (1838–41), postmaster general (1846–52) and, for three weeks in Feb. 1858, lord privy seal. He was also given an English title as Baron Somerhill in 1826. On the death of his son Hubert George (1832–1916), 2nd marquess, all the titles became extinct except the earldom of Clanricarde which had been created with special remainder for the 13th earl in 1800. This passed to George Ulick, 6th marquess of Sligo.

CLANRICARDE, ULICK DE BURGH, Marquess of (1604–*c.* 1657), Irish statesman, one of the few influential Roman

Catholics to support the king in the civil war in Ireland, 1641–52, and a courageous opponent of the parliamentarians. He was born in London in 1604, son of Richard, 4th earl of Clanricarde, and Frances, daughter of Sir Francis Walsingbam and the widow of Sir Philip Sidney and of Robert Devereux, earl of Essex. Ulick married Anne Compton in 1622. When his father was created earl of St. Albans in 1628, Ulick became Lord Burgh, and he succeeded to his father's titles in 1635. The new earl strenuously opposed Thomas Wentworth (soon earl of Strafford) in the projected plantation of Connaught, and despite Strafford's objections Clanricarde was confirmed in his huge Connaught estates and privileges in 1640, the plans for plantation being finally abandoned in 1641.

After the outbreak of the civil war in Ulster (1641) Clanricarde succeeded in persuading the Galway gentry to remain neutral, in spite of the provocative policy of the lords justices which had led many Roman Catholics to join the Confederated Catholics at Kilkenny (*see* Ireland: *History*). When the people of Galway city, resentful of the English garrison's rough tactics, besieged the fort, Clanricarde negotiated the peaceful evacuation of the garrison, and his prestige, enhanced by his protection of English refugees, forced the lords justices to accept the solution. In 1643 Clanricarde was appointed one of the royal commissioners to negotiate with Kilkenny and arranged a truce; he was, however, unable to organize an expedition against the Scots who refused to accept it. In the peace negotiations of 1646 he urged the marquess of Ormonde to accept the demands that Catholics should retain the church lands they had occupied since 1641 and should be exempt from Protestant episcopal jurisdiction. In 1646 he was created marquess of Clanricarde. G. B. Rinuccini, the papal nuncio to Kilkenny, foiled his attempt to arrange an "engagement" between Thomas Preston and Ormonde. In 1648 Clanricarde unsuccessfully urged the nuncio to withdraw his censures on the truce between the confederates and Lord Inchiquin, but he managed to influence many confederates to accept his "declaration" against the parliamentarians. On the subsequent alliance of Kilkenny with Ormonde, Rinuccini withdrew from Ireland.

Ormonde, making no progress against Oliver Cromwell, left Ireland in 1650, appointing Clanricarde his deputy. While Clanricarde was supported by some of the Catholic clergy, he opposed those who had upheld Rinuccini and, in 1651, abrogated a treaty to confer a hereditary protectorate of Ireland upon Charles, duc de Lorraine, if he helped drive out "the heretics." Though lacking military ability and forces and handicapped by Charles II's disavowal in Scotland of the Ormonde treaty, Clanricarde courageously kept the field in Ireland even after the royalist defeat at Worcester (1651). On the fall of Galway in May 1652 he was forced to capitulate. He obtained fairly good terms for his army and was himself allowed to retire to England, where he remained until his death at Somerhill, Kent, in 1657 or 1658. Clanricarde was greatly respected by royalists and moderate Catholics, but not by the separatists or by the ecclesiastics, led by Rinuccini, who equated his diplomacy with treachery. After the Restoration his estates were restored to his heirs. His *Memoirs* were first published in 1722 with a supplement in 1757. (R. D. Es.)

CLANVOWE, SIR THOMAS (fl. 1400), English courtier, probably the author of *The Cuckoo and the Nightingale*, a courtly dialogue poem long attributed to Chaucer. Little is known of Clanvowe, who was at court in Richard II's reign and was a friend of Prince Hal (afterward Henry IV). He is named as one of 20 knights who accompanied John Beaufort to Barbary in 1390. His name is last mentioned in 1404.

The Cuckoo and the Nightingale, called in some manuscripts *The Book of Cupid, God of Love*, was first printed by William Thynne in his edition of Chaucer's works (1532), and continued to be ascribed to Chaucer until W. W. Skeat, in editing Chaucer's works for his edition of 1894–97, discovered Clanvowe's name on the best of the extant manuscripts and relegated the poem to his supplementary volume of pieces attributed to Chaucer, where he discusses its authorship. The poem is a debate between the cuckoo and the nightingale on the power of love: in treatment traditional, it shows delicacy and sweetness in its descriptions of spring, and is of interest also for its prosody, which reveals intelligent study of Chaucer's versification, although not without faults of execution.

Bibliography.—As well as the edition in Skeat's *Chaucerian and Other Pieces* (1897) based on Thynne's text, there is a critical edition by E. Vollmer, *Das mittelenglische Gedicht "The Boke of Cupid"* (1898). *See* also C. E. Ward, "The Authorship of *The Cuckoo and the Nightingale*" in *Mod. Lang. Notes*, xliv (1929).

CLAPHAM SECT, the name, probably coined by their first historian, James Stephen, given to a group of evangelical Christians (all of whom except the Unitarian Sir William Smith were Anglicans) who were prominent in England about 1790–1830. The group—drawn together by the banker Henry Thornton, who in 1792 invited William Wilberforce to share his home in Clapham—included Charles Grant, Edward Eliot, James Stephen, John Venn (rector of Clapham), Lord Teignmouth, Zachary Macaulay and Sir William Smith, as well as Thomas Gisborne, Thomas Babington and Hannah More, who did not live in Clapham. Most of them were members of parliament, nicknamed the "Saints," whose great achievement was the abolition of the slave trade and slavery. They also worked for the prevention of cruel sports, the suspension of the game laws and the lottery and better prison conditions. Though mostly conservative in outlook, they were ready to work with radicals and free thinkers such as Jeremy Bentham and James Mackintosh. The Church Missionary society, the British and Foreign Bible society and the Religious Tract society owed much to their initiative and support. The idea of trusteeship for backward peoples was born in the Sierra Leone company, of which Thornton was chairman. Hannah More's schools and her religious and political tracts were largely financed from Clapham pockets, and the group had its own journal, the *Christian Observer*, which Zachary Macaulay edited from 1802 to 1816. They wielded a powerful influence over English society because of their high sense of responsibility to God for their actions. Lord Macaulay, Florence Nightingale, Sir Leslie Stephen, A. V. Dicey and Virginia Woolf were among their descendants.

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CLAPPERTON, HUGH (1788–1827), Scottish explorer in west Africa who was the first European to bring back personal observations of the lands which at the beginning of the 19th century had become part of the Fulani empire. He was born at Annan, Dumfriesshire, on May 18, 1788. He served in the navy and then joined Walter Oudney and Dixon Denham (*q.v.*) in a government expedition across the Sahara to Bornu which they reached in Feb. 1823. Clapperton traveled to Kano, Katsina, Sokoto and Zaria and he and Denham returned (Oudney died in Jan. 1824) to England in June 1825. Their records were published in *Narrative of Travels and Discoveries in Northern and Central Africa in the Years 1822–24* (1826). Clapperton almost immediately returned to Africa and on Dec. 7, 1825, left Badagry for the Niger with his servant, Richard Lander (*q.v.*), and two other Europeans. The last two died within a month; Clapperton and Lander crossed the Niger and traveled via Kano to Sokoto, near which Clapperton died on April 27, 1827.

See H. Clapperton, *Journal of a Second Expedition Into the Interior of Africa* (1829); R. Lander, *Records of Captain Clapperton's Last Expedition to Africa*, 2 vol. (1830). (R. M. P.)

CLAQUE, an organized body of persons who, either for hire or other motives, band together to applaud or deride a performance and thereby attempt to influence the audience.

Historically the claque (Fr. *claquer*, "to clap") is a very old institution, dating back to performances in the theatre of Dionysus at Athens. Menander was frequently defeated by Philemon in the comedy competitions, not by virtue of any superiority in the latter's plays but because Philemon swayed the decision of the judges by infiltrating the audience with claques. Under the Roman empire claques were common in the theatres and law courts, and flatterers and legacy hunters would often serve as *claqueurs* at private performances sponsored by wealthy patrons of the arts. The emperor Nero established a school of applause and was followed on his concert tours by a claque of 5,000 knights and soldiers. In France during the 18th century the chevalier de la Morlière and the poetaster Dorat organized claques to support plays by themselves and others.

In the 19th century the claque became a permanent institution; almost every Paris theatre was forced to submit to its services, and the claque leaders, who received monthly payments from the actors and free tickets from the managements, were extremely influential. In addition to the leader, or *chef de claque*, there were the *commissaires*, who memorized the better parts of the play and called their neighbours' attention to them; the *rieurs*, who laughed loudly during comedies; the *chatouilleurs*, who kept the audience in good humor; the *pleureuses*, women who wept during melodramas; and the *bisseurs*, who shouted for encores. Claques have occasionally been employed in England, but never with the elaborate organization of the French claques.

The claque in the early 1960s was restricted largely to opera houses, to political rallies and to radio and television programs. (A. H. Sa.)

CLARE (Clara), **SAINT,** of Assisi (1194–1253), founder of the order of nuns called after her the Poor Clares, was born in 1194 of a knightly Assisi family. Francis of Assisi so inflamed her with a love for the poor and suffering Christ that she refused to marry as her parents planned but fled by night to the Porziuncola chapel below Assisi, where Francis received her vows. This date (March 18, 1212) marks the beginning of the Second Order of St. Francis. Many joined Clare, including her sister (St.) Agnes and, after her father's death, her mother and another sister. Within a few months the Poor Clares were housed in the church and convent of S. Damiano, near Assisi, where Clare was to remain as abbess until her death on Aug. 11, 1253.

Her great concern was to obtain a rule reflecting the spirit of Francis rather than the Benedictine rule, which Cardinal Ugolino (later Pope Gregory IX) had adapted for her rapidly growing order. Two days before her death Pope Innocent IV approved the definitive rule she had composed. Besides its "privilege of perfect poverty," which forbids the ownership of property even as a community, Clare's order is noted for its apostolic aim in that she considered the penitential prayer life of the Clares to be a spiritually vitalizing force for the church and society at large. This view was shared not only by the popes but by the grateful citizens of Assisi, who credited Clare with twice saving their city from the sword. On the first occasion Clare had the chaplain bring the blessed sacrament to the refectory window and saw the Moorish allies of Frederick II who were storming the walls fall back in consternation. Famed for miracles in life and after death, she was canonized in 1255. Her feast day is Aug. 12. In 1958 Pope Pius XII declared her patroness of television, alluding to an incident during her last illness when she miraculously heard and saw the Christmas midnight Mass in the basilica of S. Francesco on the far side of Assisi. *See* also Franciscans: *Second Order*.

See Ignatius Brady and Sister Mary Frances [McLaughlin], *The Legend and Writings of St. Clare of Assisi* (1953); Nesta de Robeck, *St. Clare of Assisi* (1951). (A. B. Wr.)

CLARE, the name of a famous English family which in the 13th century became the most powerful baronial interest in the kingdom. The founder of the house in England, Richard FitzGilbert (d. *c.* 1090), was descended from Godfrey, count of Brionne, a bastard son of Richard, duke of Normandy. He crossed to England with William the Conqueror in company with his brother, Baldwin of Exeter (d. *c.* 1100), who acquired great estates in the west country. Richard himself was given about 170 lordships in England, of which 95 were in Suffolk, attached to his castle of Clare, whence the family took its name. As chief justiciar in England, Richard played a large part in suppressing the rebellion of 1075. His marriage to Rohese, daughter of Walter Giffard, was to bring many Giffard estates to the Clares a century later.

Richard left several sons, one of whom, Robert (d. 1134), founded the baronial house of FitzWalter, extinct in 1432. The English inheritance of the Clares passed to the second son, Gilbert FitzRichard (d. *c.* 1115), who began his family's connection with Wales when Henry I granted him Cardigan. About the same time Walter de Clare (d. 1138), probably his brother, acquired the lordship of Striguil (Chepstow): he was also the founder of Tintern abbey (1131). The Welsh estates of Walter, and most of Gilbert FitzRichard's, passed to the latter's second son, Gilbert FitzGilbert (d. *c.* 1148), whom Stephen created earl of Pembroke in 1138, and thence to the earl's son, Richard Strongbow (*c.* 1130–76), conqueror of Ireland (*see* Pembroke, Richard de Clare, 2nd earl of). This branch of the Clares became extinct in the male line when Strongbow died in 1176.

The English estates of Gilbert FitzRichard descended to his eldest son, Richard (d. 1136), who was himself succeeded in turn by his two sons, Gilbert (d. 1152), created earl of Hertford by Stephen (*c.* 1138) but more commonly known as earl of Clare, and Roger (d. 1173), who quarreled with Thomas à Becket over Tonbridge castle, the Clare stronghold in Kent. Roger's son, Richard (d. 1217), inherited through his great-great-grandmother Rohese a share of the wide Giffard estates. His marriage with Amice, heiress of William, earl of Gloucester, brought him, among other estates, the lordship of Tewkesbury (many of the Clares were buried in the abbey there), wealthy manors in Gloucestershire and the great marcher lordship of Glamorgan. Earl Richard and his son, Gilbert (d. 1230), were prominent among the baronial leaders who forced King John to agree to Magna Carta; it is some indication of the family's influence and connections that no less than 13 of the barons involved in the events of 1215 were kinsmen of the Clares, and that almost all were enemies of the king. Gilbert was recognized, in right of his mother, as earl of Gloucester in 1217; he married Isabel, daughter and coheiress of William Marshal, earl of Pembroke, and in 1245 their son, Richard (1222–62), acquired the Kilkenny estates in Ireland and the lordship of Usk and Caerleon in south Wales as Isabel's share of the Marshal inheritance. The English estates of the Clares now extended into more than 20 counties, and the earl of Gloucester was the greatest lord in south Wales: in Glamorgan especially he was almost an independent prince.

Thus Earl Richard succeeded to a position of immense influence. Matthew Paris described him as "young, graceful, eloquent, careful and well-skilled in the laws" but marred by avarice (*Chronica majora,* under the year 1253). Potentially he held the balance between Henry III and Simon de Montfort, yet in politics he proved vacillating and uncertain. He supported the barons against the king in 1258, but quarreled with Montfort in 1259, only to resume their association as his friendship with the king cooled. His son, Gilbert (1243–95), the "Red Earl," was at first a strong supporter of Montfort; but his desertion of him in 1265 proved a vital factor in the subsequent royalist triumph. In his later years Gilbert was much occupied in the Welsh wars. (*See* Gloucester, Gilbert de Clare, earl of.)

Gilbert had married Edward I's daughter, Joan of Acre. After her death (1307), their son Gilbert (1291–1314) succeeded to the earldom of Gloucester. As nephew of Edward II and brother-in-law of Piers Gaveston, this gallant and generous young man played the part of moderator in the struggles of Edward's early years. He represented the king's party among the ordainers, acted as regent in 1311 and 1313, and helped to negotiate a settlement after Gaveston's death in 1312. His death without issue at the battle of Bannockburn brought to an end the direct male line of the Clares.

The partition of his estates among his three sisters became a matter of some political importance. Hugh Despenser the younger, husband of the eldest sister, Eleanor, who received Glamorgan and Tewkesbury as her share, tried to deprive his brothers-in-law of all the Clare lands in south Wales, a plan that led to the breakup of the "middle party" and contributed to the outbreak of civil war. The Despenser share later descended to the Beauchamp and Neville earls of Warwick. The youngest sister, Elizabeth, lady of Clare (d. 1360), foundress of Clare college, Cambridge, transmitted her portion to Edward III's son, Lionel, who for this reason was created duke of Clarence, and thereafter to the Mortimers, earls of March. (C. D. R.)

CLARE, JOHN (1793–1864), one of the best-known poets of the English countryside, was born at Helpstone, a village between Stamford and Peterborough, in Northamptonshire, on July 13, 1793. He was the only son of a farm labourer in times when the English peasantry were under duress through the enclosure of common land. His grandfather was a wandering fiddler who for a short time was the village schoolmaster. Clare's schooling and access to books were scanty. But he had a prodigious memory; and his poetic gift, which showed itself by the time he was 12, was nourished by his father's and mother's store of folk ballads. The frail, dreamy, shy, brilliant boy determined to be a poet. On his mother's sugar bags and with a ha'p'orth of pencils bought at Stamford or Deeping Fair, he wrote, and re-wrote, verses reminiscent of John Cunningham, Allan Ramsay and James Thomson. In 1817 he tried to get a volume of his poems published by subscription but failed. One of the prospectuses came to the notice of John Taylor, the London publishers of Keats' works; and in 1820 Clare's first book, *Poems Descriptive of Rural Life and Scenery*, was printed. This caused a stir in London literary circles and ran into four editions within a year. Through it and with Taylor's help Clare acquired a small annuity, just over £40 a year. His next volume of poetry, *The Village Minstrel and Other Poems* (1821) sold very few copies; and his third, *The Shepherd's Calendar; with Village Stories, and Other Poems* (1827) though containing better poetry, met the same fate. In 1820 Clare had married Martha Turner, daughter of a neighbouring farmer, the "Patty of the Vale" of his poems. By her he had a family of seven. He was financially responsible for his father, who had become disabled by rheumatism. Clare added to his small annuity by doing field-work and gardening. But poetry, poverty and patronage took their toll of his health. He visited London during the nine days' wonder that his first book occasioned and became the friend and correspondent of Charles Lamb, J. H. Reynolds, Alan Cunningham, George Darley and H. F. Cary. But at Helpstone Clare lived in extreme isolation and spiritual loneliness. Yet by 1824, while seeing clearly the penalty which, under such circumstances as his, a life dedicated to poetry might inflict, he had become a dedicated poet, with a very individual voice.

He made three other visits to London. In 1832 he left the cottage at Helpstone, his "old home of homes," to rent a two-acre piece and a good cottage at Northborough, a village three miles away, in the Fens. He wrote incessantly. Without success he tried, in 1832, to have a fourth volume of poems printed, *The Midsummer Cushion* (a title of his own choice at last). In 1835, his last book, *The Rural Muse*, was published. Though praised by such men as Derwent Coleridge, Henry Nelson Coleridge, Charles Elton and John Wilson of *Blackwood's Magazine*, and full of better poetry than Clare's three preceding volumes, *The Rural Muse* sold scantily.

Years of poor food, poverty and worry could not fail to diminish Clare's tough resilience. He had begun to be beset by terrors and fancies. One of the fancies was that his lost childhood love, Mary Joyce, daughter of a wealthy farmer, had been his first wife; Patty, he thought, was his second. In 1837, again through the agency of his first publisher, John Taylor, Clare was put under the care of Dr. Matthew Allen, at a private asylum at High Beech, Epping. There, under good conditions, the poet stayed four years. But, improved in health and driven by homesickness, he walked the 80 miles to Northborough in July 1841, penniless, eating grass by the roadside to stay his hunger. He has left a moving account in prose of that extraordinary journey, addressed to "Mary Clare, Glinton." He was at home about seven months. At the end of 1841 he was certified insane. He spent the final 23 years of his life at St. Andrew's asylum, Northampton, writing with strangely unquenched lyric impulse. He died there on May 20, 1864.

Clare belongs to that group of poets called the English Romantics. His early work, written between 1814 and 1827, is emotional, intensely detailed, descriptive evocation of the place and time of his boyhood, rural Northamptonshire in the early 19th century. His later work, between 1827 and 1864, consists of singularly pure lyrics, among the chief of which are "Love Lies Beyond The Tomb," "Invite to Eternity," "I Am" and "A Vision." He fulfils the criterion that the whole of a major poet's work has greater significance than the sum of the separate poems. But his reputation has been slow to mature, and the full body of his apprentice work, with some 500 "Ha'penny Ballads" of his St. Andrew's years, remained unpublished in the late 1950s.

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(J. W. T.)

CLARE, JOHN FITZGIBBON, 1ST EARL OF (1749–1802), lord chancellor of Ireland, was a powerful supporter of a repressive policy in Ireland and, later, of legislative union with Great Britain. Educated at Trinity college, Dublin, and at Christ Church, Oxford, he was called to the Irish bar in 1772. He entered the Irish house of commons as member for Dublin university in 1778. Fitzgibbon was appointed attorney general in 1783. An able lawyer, he was clear and downright in debate and readily voiced his opinions in unconciliatory terms. He strongly opposed Henry Flood's reform bill introduced in 1783, and from that time forward he was in fact the leading spirit in the Irish government and the stiffest opponent of any concession to popular demands.

In Jan. 1787 Fitzgibbon introduced a stringent bill for repressing the illegal Irish agrarian association known as the Whiteboys. His influence with the majority in the Irish parliament defeated Grattan's proposed reform of the tithe system in Ireland, Fitzgibbon refusing even to grant a committee to investigate the subject. On the regency question of 1789 (*see* PITT, WILLIAM) Fitzgibbon, in opposition to Grattan, supported the doctrine of William Pitt in a series of powerful speeches which proved him a great constitutional lawyer. He intimated that the choice for Ireland might in certain eventualities rest between complete separation from England and legislative union. While he exclaimed as to the latter alternative, "God forbid that I should ever see that day!" he admitted that separation would be the worse evil of the two.

In 1789 Fitzgibbon was appointed lord chancellor in succession to Lord Lifford, being raised to the peerage as Baron Fitzgibbon. His removal to the house of lords greatly increased his power. "He was," wrote William Lecky, "by far the ablest Irishman who had adopted without restriction the doctrine that the Irish legislature must be maintained in a condition of permanent and unvarying subjection to the English executive." Though at the outset of his parliamentary career he had been prepared to agree to a modification of the penal laws he was firmly opposed to allowing the Roman Catholics to have any political power. When the British cabinet forced the Irish executive to accept the Roman Catholic Relief bill of 1793, Fitzgibbon, though he recommended that the house of lords pass the bill, strongly denounced the policy it embodied. Also in 1793, he was responsible for the enactment of the Convention act which severely restricted radical agitation.

When it was decided that Lord Fitzwilliam should be lord lieutenant, Pitt insisted that Fitzgibbon should remain as lord chancellor. Fitzgibbon, who disapproved of Fitzwilliam's Roman Catholic policy, was probably the first to suggest to George III that he would violate his coronation oath if he consented to the admission of Catholics to parliament. When Lord Camden, Fitzwilliam's successor in the viceroyalty, arrived in Dublin on March 31, 1795, Fitzgibbon's carriage was violently assaulted by the mob, he himself was wounded and in the riots that ensued his house was attacked. In June 1795 he was created earl of Clare. On the eve of the rebellion of 1798 he defended the strict measures taken by the government, but he was neither cruel nor immoderate and was inclined to mercy in dealing with individuals. He attempted to save Lord Edward Fitzgerald by promising to facilitate his escape from the country. After the rebellion he threw his great influence on the side of clemency.

In Oct. 1798 Clare, who since 1793 had been convinced of the necessity for a legislative union between Great Britain and Ireland and was equally determined that the union must be unaccompanied by Catholic emancipation, crossed to England and pressed his views on Pitt. On Feb. 10, 1800, Clare in the house of lords moved the resolution approving the union in a long and powerful speech, in which he reviewed the history of Ireland since 1688, attributing the evils of recent years to the independent constitution of 1782 and speaking of Grattan in language of deep personal hatred. He was not aware of the assurance which Cornwallis had been authorized to convey to the Catholics that the union was to pave the way for emancipation, and when he heard of it after the passing of the act he bitterly complained that he had been deceived. After the union Clare became more violent than ever in his opposition to any policy of concession in Ireland. He died in Dublin on Jan. 28, 1802. (R. B. McD.)

CLARE (Chláir), a county in the province of Munster, Republic of Ireland, is bounded on the north by Galway bay and County Galway, east by Lough Derg, the river Shannon and counties Tipperary and Limerick, south by the estuary of the Shannon and west by the Atlantic ocean. Its land area is 1,231 sq.mi. In 1961 the population of County Clare was 73,710, compared with about 286,000 in 1841. More than two-thirds of the inhabitants live outside villages and towns, of which the largest are Ennis (*q.v.;* 5,678), the county town, and Kilrush (2,861). Administration is by a county manager advised by an elected county council. The cathedral of the Church of Ireland diocese of Killaloe (*q.v.*) is at the town of that name, while the Roman Catholic diocese has its seat at Ennis. County Clare sends four members to *dail eireann* (house of representatives).

The county is divisible into three parts. In the east, hills rising to 1,000–1,750 ft., formed of Silurian shales and slates and Devonian sandstones, include the Slieve Bearnagh, the Cratloe and part of the Slieve Aughty hills. These hills, though covered with peat bogs and almost uninhabited, are penetrated by wide valleys used for roads.

Central Clare is a lowland. Along the Shannon and Fergus estuaries there is a large area of corcasses, originally salt marshes, but now drained and embanked, of which some are used for tillage and some for pasture. The true limestone country of central Clare merges into the central Irish lowland around Galway bay. The scene is varied. Limestones form a number of craggy hills, 150–300 ft. high, of which some are covered by drift and provide good farmlands but others have thin soils and carry scrub woods of oak, ash, hazel and holly.

The drainage reaches the surface in a number of rivers, which appear for a few miles and then disappear, or even emerge for only a few yards in a collapsed cave. There are many "turloughs," or limestone hollows in which water lies for varying periods; some are quite small, but others are as much as a mile across and 30 ft. deep. There are also a number of permanent lakes, some of which fluctuate considerably in size with the changing level of the water table.

West Clare is made up of plateaus and lowlands of Carboniferous rocks. The Burren area, facing Galway bay, consists of slabs of limestone, almost horizontal, with little vegetation except in sheltered places. Along the coast there is a remarkable limestone pavement, with deep cracks harbouring such plants as the maidenhair fern, yews, hawthorns and junipers, and others which rarely show an inch above the surface. Where soil occurs, plants such as the alpine gentian and white-flowered *Dryas* have a luxuriant development. The stony desert appearance of the Burren plateau is seen dramatically in the valley south of Ballyvaughan, which has steep, terraced rock faces above a flat, grassy valley. There are several famous caves around Slieve Elva, including Pollnagollum, more than 4½ mi. long. South of the Burren area, varied shales and sandstones have acid soils with rushy grasslands and there are extensive peat bogs at the higher levels, culminating in Slieve Callan (1,266 ft.). A fine flagstone reaches the sea at various points in cliffs; the Moher cliffs are more than 600 ft. high for several miles.

There are mild winters with mean January temperatures of 42°–43° F. and rainy summers with July means of 58°–59°. The rainfall is everywhere abundant, averaging 40–60 in. a year.

More than two-thirds of the county is in crops and pasture and Clare may therefore be regarded as an extension to the Atlantic of the central Irish lowland rather than as part of the mountainous west with restricted areas of farming. Though by no means rich agriculturally, Clare has not the poverty of Connemara, across Galway bay. The main resources are cattle and sheep, the latter especially on some of the limestone pastures. The farms are mainly medium-sized, averaging 40–50 ac. The chief crops are oats and potatoes.

Ennis has flour milling and other industries. Kilrush is a market centre and was once a busy port, while Ennistimon, with a creamery, is a remote market centre in the west. Most places are trading villages, though at Lisdoonvarna visitors come to drink the spa waters. Iron, copper, lead and silver were once mined east of Ennis, particularly the lead sulfide at Tulla, and also in the Burren district north of Corofin. A thin coal seam in west Clare is not worked, but there are slate quarries at Broadford and elsewhere. The county contains Ireland's first and largest hydroelectric power station at Ardnacrusha on the Shannon (*q.v.*).

Lough Derg is so effective a barrier that most of the road traffic from the east enters the county at Killaloe, O'Briensbridge and near Limerick, while the only rail connection is through Limerick. This railway runs through Ennis northward to Galway. The trans-Atlantic Shannon international airport is on reclaimed land at Rineanna, 12 mi. S.E. of Ennis. (T. W. Fr.)

History.—Clare is rich in evidences of prehistoric human occupation, particularly from the Bronze Age, and has many megalithic monuments. About 2,000 fortified enclosures or forts can still be seen in the county. The many early Christian remains include those at Inishcaltra, Kilrush, Dysert, Holy Island and Drumcliff, at all of which there are round towers. Notable among the castles which record the conflicts of later times is mainly 15th-century Bunratty castle. The peninsula of Clare was disputed land between Connaught and Munster, being annexed to Munster (*q.v.*) in the 4th century. It suffered Norse incursions, but no permanent Scandinavian settlement. It took a central place in Irish history when Brian Boru (Boroimhe), king of Munster, with his headquarters at Kincora near Killaloe, became high king of Ireland at the beginning of the 11th century. His family, the O'Briens, remained lords of Thomond, or north Munster, later corresponding roughly to the modern County Clare (*see* Thomond, Earl and Marquess of). Although Thomond was invaded by Anglo-Normans from the 12th century, the O'Briens managed to maintain their position, receiving the title of earl of Thomond from Henry VIII. Clare was made a shire under Elizabeth I and was treated as part of Connaught under Cromwell, later reverting to Munster. Spanish point, on the west coast where ships of the Spanish Armada were wrecked in 1588 derives its name from the many Spaniards buried there. It was in Clare in 1828 that Daniel O'Connell won the critical election victory which led on to Catholic emancipation. East Clare was one of the first constituencies to elect a Sinn Fein candidate, namely Eamon de Valera in 1917. (Hu. S.)

See James Frost, ***The History and Topography of the County of Clare*** (1893).

CLARE ISLAND (Claira), in County Mayo, Republic of Ireland, covers 6.3 sq.mi. and stands at the entrance to Clew bay. Pop. (1956) 239. On the northwest, quartzite hills rise to 1,507 ft. with a fine scarped cliff (Knockmore), and on the east and south there is a limited amount of farm land, divided into holdings of about 7 ac. under a land settlement scheme of the Congested Districts board. Exposure stunts all trees to 6–8 ft. There is motor boat transport from Roonah Point about 3 mi. away which is 20 mi. W. by road of Westport, the nearest town. Gráinne Uaile or ni Mháille (Grace O'Malley), the 16th-century queen of the island, is buried in the island's Carmelite abbey (founded 1224). (T. W. Fr.)

CLARENCE, DUKES OF. The early history of this English title is identical with that of the family of Clare, earls of Gloucester, who are sometimes called earls of Clare, of which word Clarence is a later form. The first duke of Clarence was Lionel of Antwerp (*see* below), third son of Edward III, who was created duke in 1362 and whose wife Elizabeth was a direct descendant of the Clares, the honour of Clare being among the lands which she brought to her husband. When Lionel died without sons in 1368 the title became extinct, but in 1412 it was revived in favour of Thomas (*see* below), second son of Henry IV. The third creation took place in 1461, and was in favour of George (*see* below), brother of Edward IV. When this duke was attainted in 1478, his title was forfeited. There was no other creation of a duke of Clarence until 1789, when William, third son of George III, was made a peer under this title. Having merged in the crown when William became king in 1830, the title of duke of Clarence was revived in 1890 in favour of Albert Victor (1864–92), elder son of King Edward VII, then prince of Wales, only to become extinct for the fifth time on his death in 1892.

Lionel of Antwerp (1338–68), duke of Clarence, third son of Edward III, was born at Antwerp on Nov. 29, 1338. Before he was four years of age he was betrothed to Elizabeth (d. 1363), daughter and heiress of William de Burgh, earl of Ulster (d. 1333), and he entered nominally into possession of her great Irish inheritance. Having been named as his father's representative in England in 1345 and again in 1346, Lionel was created earl of Ulster and joined (in 1355) an expedition into France, but his chief energies were reserved for the affairs of Ireland. Appointed governor of that country, he landed at Dublin in Sept. 1361. In Nov. 1362 he was created duke of Clarence and in the following year his father made an abortive attempt to secure for him the succession to the crown of Scotland. His efforts to secure an effective authority over his Irish lands were only moderately successful, and after holding a parliament at Kilkenny, which passed the celebrated Statute of Kilkenny in 1366, he threw up his task in disgust and returned to England. At Milan, on May 28, 1368, he married Violante, only daughter of Galeazzo Visconti, lord of Pavia, who brought him a rich dowry. Several months were then spent in festivities, during which Lionel was taken ill at Alba, where he died on Oct. 17, 1368. His only child Philippa (1355–81), a daughter by his first wife, married in 1368 Edmund Mortimer (1352–81), 3rd earl of March, and through this union Clarence became the ancestor of Edward IV.

Thomas (1389–1421), duke of Clarence, was born on Sept. 29, 1389. He paid two visits to Ireland, where he was nominally lord lieutenant, 1401–13. For a short time, in 1412, he replaced his elder brother, afterward King Henry V, as the chief figure in the government. He favoured an alliance with the Orléanists and led an unsuccessful expedition to France in Aug. 1412. But, after Henry V's accession in 1413, the duke served his brother faithfully and took part in the preparations for the French war. He was at the siege of Harfleur, but was invalided home before Agincourt and acted as regent in 1416. During the invasion of Normandy, in 1417, Clarence led the assault to Caen, and, after Henry V's return to England in 1421, he remained in France as the king's lieutenant. He was killed at Bauge, in Anjou, while rashly attacking the French and their Scottish allies on March 22, 1421. At the time of his death he was heir to the throne. His marriage with Margaret Holland was childless and his titles became extinct.

George (1449–78), duke of Clarence, younger son of Richard, duke of York, was born in Dublin on Oct. 21, 1449. Soon after his elder brother became king as Edward IV in March 1461, he was created duke of Clarence, and his youth was no bar to his appointment as lord lieutenant of Ireland in 1462. In 1466 Clarence was a suitor for the hand of Mary of Burgundy. Later he came under the influence of Richard Neville, earl of Warwick, and, in defiance of the king, was married to the earl's elder daughter, Isabel, at Calais in July 1469. With his father-in-law he supported the rebels in the north of England. When their treachery was discovered, Clarence fled to France in March 1470. Returning to England with Warwick in September, he supported the restoration of Henry VI, and the crown was settled upon himself in case the male line of the Lancastrian dynasty became extinct. But soon after Edward IV returned to England in March 1471, a public reconciliation between the brothers took place, and Clarence then fought for the Yorkists at Barnet and Tewkesbury. After Warwick's death in April 1471, Clarence claimed the whole of the vast estates of the earl, and in March 1472 was created by right of his wife earl of Warwick and Salisbury. However, in 1474 Clarence had to accept a partition of the Warwick estates with his younger brother Richard, duke of Gloucester (later Richard III), who had married Warwick's younger daughter Anne. Isabel Neville died in Dec. 1476, and Clarence soon sought to marry, as his second wife, Mary of Burgundy, now duchess. To this marriage Edward IV objected. He became convinced that Clarence was aiming at his throne. The duke was thrown into prison, and in Jan. 1478 the king unfolded the charges against his brother to the parliament. He had slandered the king; had received oaths of allegiance to himself and his heirs; had prepared for a new rebellion; and was in short incorrigible. Both houses of parliament passed the bill of attainder, and the sentence of death which followed was carried out secretly in the Tower of London on Feb. 18, 1478. Soon after the event the rumour gained ground that he had been drowned in a butt of malmsey wine. Two of the duke's children survived their father: Margaret, countess of Salisbury (1473–1541), and Edward, earl of Warwick (1475–99), who passed the greater part of his life in prison and was beheaded in Nov. 1499. (T. B. P.)

CLARENDON, EDWARD HYDE, 1st Earl of (1609–1674), English statesman and historian, who as Charles II's lord chancellor presided over the Restoration settlement, profoundly influenced the course of English history both as participant and interpreter. His failures and deficiencies in these roles do nothing to diminish his importance.

Edward Hyde was born on Feb. 18, 1609, the eldest son of Henry Hyde of Dinton, Wiltshire, and was educated at Magdalen hall, Oxford, and the Middle Temple. The death in 1631 of his uncle and patron, Sir Nicholas Hyde, justice of the king's bench, did not inhibit him from pursuing his career at the bar, for he had secured many influential friends, among them John Selden and Sir Kenelm Digby. His wide interests and a taste for good living, freely indulged, also brought him in touch with Ben Jonson, Edmund Waller and the literary and philosophical circle at Great Tew in Oxfordshire. In these years many of the characteristic weaknesses which seem typical of his later life were, on his own confession, fully formed. Argumentative, proud, reluctant to suffer fools gladly, he would seem to have nourished a very high opinion of his merits. He married in the winter of 1631/32 Sir George Ayliffe's daughter Anne, who died six months later, and in 1634 Frances, daughter of Sir Thomas Aylesbury, master of requests. This useful second match was soon followed by his appointment as keeper of the writs and rolls of common pleas, and he maintained a profitable practice at the bar.

Early Career.—His bar practice was abandoned not long after his entry into parliament in 1640, first as member for Wootton Bassett in the Short parliament, then for Saltash in the Long parliament. Emerging at once as a critic of ship money and other recent oppressions, he was drawn into the attack upon the jurisdiction of the prerogative courts. He was to the fore in most of the lasting legislation of 1641—the abolition of the courts of wards, Star Chamber and high commission—but he stopped short of any measures which might permanently damage the balanced relationship of king, lords and commons, and in this spirit opposed parliament's efforts to dictate the king's choice of ministers. From the first he was known to be a defender of the Anglican hierarchy and as such was interviewed and commended by Charles I, but it was as a parliamentarian and not a courtier that he opposed the execution of the earl of Strafford and vigorously resisted the Root and Branch bill. The passing of the Grand Remonstrance, a searching indictment of Charles and his father, made any accommodation between king and parliament increasingly difficult, and henceforth Hyde chose to work behind the scenes as an adviser of the crown. In conjunction with his friend Lord Falkland and with Sir John Colepeper, who were made members of the council, he attempted to recommend moderate measures to Charles. Such a course, consistently pursued, might have undermined support for John Pym's radical leadership in the house of commons, but Charles's unsuccessful attempt to seize five members of the commons (Jan. 1642) brought Hyde near to despair, for although war was not yet inevitable, few men could now trust the king's sincerity. In this situation Hyde's efforts to found a settlement upon what had already been achieved were likely to fail, but his constructive moderation, far from being mere compromise, successfully attracted many parliamentarians to the royal camp. Henceforth Hyde's pen was the most influential factor in deferring an appeal to the sword. In drafting royal declarations he presented a strong case founded on respect for those fundamental laws of the constitution which now seemed most seriously threatened by parliament. His view of the interdependence of king, lords and commons, embodied in the king's answer to the Nineteen Propositions of June 1642, although criticized by some royalists for its weak "spirit of accommodation" which "wounded the regality," gained wide currency on both sides.

Chancellor of the Exchequer.—Hyde joined the king at York in May 1642. He was formally expelled from the house of commons in August and was later excepted from pardon as an evil counselor. He was never a combatant in the ensuing war, and although present at Edgehill remained principally at All Souls college, Oxford, from Oct. 1642 until March 1645. On Feb. 22, 1643, he was made a privy councilor and knighted, and on March 3 was appointed chancellor of the exchequer. As a member of the council of war he was nominally involved in the direction of the royalist campaign, but he was unable to bring much influence to bear upon the militant enthusiasms of the army leaders. In the privy council, on the other hand, he was a member of the "junto," or secret committee, which considered business before it was laid before the council. To emphasize the legality of royal proceedings and to secure financial grants by constitutional means, he advised the summoning of a parliament at Oxford in Dec. 1643, but its success was limited and by Dec. 1644 he agreed to the recognition of the Westminster body's title to be a true parliament. In Jan. 1645, at Uxbridge, Hyde conducted one last strenuous effort at negotiation, but all his labours could not reduce the parliamentary demands for control of the militia and Presbyterian church government to a form acceptable to the king. The intransigence of parliamentarians and the bitterness of royalists now created a situation in which there was little room left for the scrupulous constitutionalism of Hyde, and his appointment as guardian to the prince of Wales was a convenient means of disposing of him.

On March 4, 1645, Hyde left the king for Bristol, and after royalist defeats in the west, accompanied Prince Charles to Jersey in April 1646. Retaining his distrust of schemes to draw upon foreign assistance, he also strongly disapproved of the queen's orders for the removal of the prince to France. He thwarted an attempt to sell Jersey to the French but otherwise was unable to influence events. Instead he began the first draft of his *History of the Great Rebellion* in the hope that his interpretation of past errors might serve to instruct the king for the future.

During his sojourn in Jersey, Hyde enjoyed a period of relative tranquillity in the agreeable company of Sir George Carteret, the governor of the island, but on the outbreak of the second phase of the Civil War he began his travels again, leaving Jersey on June 26, 1648 to join the queen and prince at Paris. In attempting to follow Prince Charles on his mission to the fleet in the Thames he and Lord Cottington were seized and plundered by Ostend privateers, and it was not until September that he joined the prince at The Hague. There Hyde, like the rest of the court, was obliged to be an impotent spectator of the king's last efforts to save his throne and his life.

With Charles II in Exile.—Hyde was no less helpless in guiding and counseling the new king. Disapproving strongly of Charles II's desertion of the marquess of Montrose and the subsequent alliance with the covenanting Scots, he was glad to escape from the quarrelsome court by accompanying Lord Cottington on a mission to Spain. But hopes of Spanish assistance in Ireland crumbled with the news of Oliver Cromwell's victory at Dunbar and the appearance of a strong parliamentary fleet in the Mediterranean, and in Dec. 1650 Hyde and Cottington were ordered to leave Madrid. After Charles's escape from Worcester (Sept. 1651), Hyde left his home in Antwerp to join Charles at Paris. Thenceforth he remained close to the king, accompanying him on his successive changes of residence, to Cologne in 1654 and to Bruges in 1656.

Hyde's chief service was to sustain Charles in his adherence to the Anglican Church and keep him from any course which might prejudice eventual reconciliation with his subjects. It was principally this hope, rather than plans for an armed reconquest, which directed Hyde's labours during the comfortless years of exile. In 1656 he was prepared to assist the overthrow of Cromwell by intrigue with Edward Sexby and the Levellers, but even in 1659, when the English situation was most discouraging, he held out against those violent schemes of royalist hotheads which would simply reunite the republican factions. His vast correspondence reveals how closely he followed events in England and, when the Presbyterian overtures for a restoration were eventually received, Hyde, appointed lord chancellor in Jan. 1658, was the statesman best fitted to answer them. The Declaration of Breda (April 4, 1660) was his work, embodying his consistent belief that only a free parliament, matching the king's gracious intentions with its own good will, could effect the healing work of reconciliation. In so far as his counsel was willingly accepted by the king the character of the Restoration settlement owed much to Hyde, though he cannot be called its architect. The subsequent course of the settlement diverged from his own plans in several respects.

Lord Chancellor.—Taking his place as lord chancellor in the house of lords on June 1, 1660, Hyde gave some direction to the legislative program of the Convention parliament. He pressed for a generous Act of Oblivion and a speedy provision of royal revenue, hastened the disbanding of the army and strove to create a spirit of accommodation among the religious leaders. To this latter end, Hyde (created Viscount Cornbury and earl of Clarendon on April 20, 1661) was not prepared to sacrifice the Anglican Church, the complete restoration of which was his main objective. In drawing up the royal declaration of Oct. 1660 he had proffered limited episcopacy and a revised prayer book, with the hope of reconciling Presbyterians to conformity with the established church, but the rigid attitude of some of those bishops with whom he had most in common made these efforts appear to be mere temporizing maneuvers. The failure of the Savoy conference between representatives of the Anglican and Presbyterian clergy created further difficulty for Clarendon at a time when he wished to resist the uncompromising Anglicanism of the first Cavalier parliament of 1661. This body was to pass the series of measures against dissenters unjustly known as the Clarendon code: the Corporation act, the Act of Uniformity, the Conventicle act and the Five-Mile act. In fact, Clarendon's attitude was far more friendly to a limited religious toleration than he was later willing to admit. Evidence exists that he was prepared to defend the king's declaration in favour of indulgence (Dec. 26, 1662) during the parliamentary session of spring 1663. The indulgence would have entailed an exercise of the royal prerogative in religious matters in a manner entirely approved of by Clarendon, and would have enabled both king and minister to keep the promise, made at Breda, to relieve tender consciences from the penalties of the law. But Clarendon, like Charles II, bowed to the opposition of parliament.

Clarendon's responsibilities and influence as virtual head of the administration were extensive. He dominated the privy council and its more important committees. He proposed to establish a council at Whitehall to govern Scottish affairs and sought to restore episcopacy in Scotland through the medium of Archbishop James Sharp. In Ireland, on the other hand, while anxious for an establishment upon a solid Protestant basis, he urged "temper and moderation and justice" in securing it. He supported the duke of Ormonde's wise and enlightened administration and earned much unpopularity by opposing the prohibition of the import of Irish cattle into England. He was a member of the council for foreign plantations, and one of the eight lords proprietors of Carolina in 1663. In 1664 he sent a commission to settle disputes in New England. In foreign affairs, however, his influence was more restricted, although he kept up direct contacts with English representatives abroad and supervised such negotiations as the Portuguese marriage treaty, the treaty with the United Provinces and the sale of Dunkirk. This latter episode unjustly earned him the charge of having initiated the scheme for his own profit, and his new house in St. James's was nicknamed "Dunkirk house." By the marriage of his daughter Anne to James, duke of York, in Sept. 1660 he became related to the royal family and was to be grandfather to two English sovereigns, Queen Mary II and Queen Anne, but, anticipating jealousy of this new distinction, he took little pleasure in it. Master of an increasing fortune, he was the principal target of those discontented Cavaliers for whom the

Restoration had offered no relief. Thus the principal charge brought against him in July 1663 by the earl of Bristol, of "having arrogated to himself a superior direction of all his Majesty's affairs," was to be expected. This attempt at impeachment failed, but it foreshadowed the attack of 1667.

Eclipse and Fall From Power.—It was in the emergence of younger politicians such as Sir Henry Bennet and William Coventry that Clarendon perceived the greatest threat to his position, and the appointment of the former as secretary of state in 1662 marked an important phase in his own eclipse. Another critical stage was reached in the parliamentary session at Oxford in Oct. 1665 when Bennet (now Lord Arlington) and Coventry overruled the chancellor in supporting Sir George Downing's scheme for the parliamentary appropriation of supply. Intended as a means of improving the king's capacity to raise loans, it was correctly seen by Clarendon as an infringement of royal freedom to administer finances. Under the stress of the Dutch War, which Clarendon had sought to avoid, it was accepted by Charles as a desperate expedient.

By now Clarendon's influence had waned considerably. The easy intimacy reflected in lighthearted notes exchanged between king and chancellor during privy council meetings had given way to habitual coldness on the part of Charles. Ever since Clarendon had expostulated with the king for resuming relations with Lady Castlemaine soon after his marriage, the temperamental and moral gulf between them had widened. Mocked by the king's mistresses and his more accommodating advisers, Clarendon could not fail to appear a censorious busybody. Severe attacks of gout sharpened his temper and incapacitated him for business. The death of his friend the lord treasurer, the earl of Southampton, in May 1667 was yet another serious blow, and by the end of the Dutch War Clarendon stood virtually alone except for the support of his son-in-law, the duke of York.

There were two stages in Clarendon's fall. In Aug. 1667 Coventry and Arlington secured his dismissal from the chancellorship in the interests of administrative efficiency. In October the commons began his impeachment, encouraged by the hostility of Charles to his old adviser and led by the ambitious supporters of the duke of Buckingham—Sir Richard Temple, Sir Robert Howard and Sir Thomas Osborne. The charges, such as having urged government with the help of a standing army, lacked foundation and the house of lords was not prepared to accept them, but by November, under the threat of trial by a special court of the king's selection, Clarendon recognized the hopelessness of his position and fled.

The rest of Clarendon's life was passed in exile in various parts of France, often under conditions of great hardship. At Evreux, on April 23, 1668, he was the victim of a murderous assault by English sailors who attributed to him the nonpayment of their wages. For some time he was not allowed to see any of his children; even correspondence with him was made treasonable by the Act of Banishment. Bearing these troubles with great fortitude, he found consolation in religious duties and daily composition of his *Contemplations on the Psalms.* To the end of his days Clarendon hoped for pardon and permission to return to England, but he died at Rouen on Dec. 9, 1674. He was buried in Westminster abbey a month later. He left two sons, Henry, 2nd earl of Clarendon, and Lawrence, earl of Rochester, and a daughter, Anne, duchess of York. A third son, Edward, predeceased him.

Clarendon the Historian.—After his banishment Clarendon began work on his *Life,* writing at first without the aid of any documents. In 1671, however, his son Lawrence was allowed to visit him and brought manuscripts which enabled Clarendon to take up his *History* once again. Into this he inserted some of the recently written autobiographical material. Consequently the accuracy of the finished *History of the Great Rebellion and Civil Wars in England,* edited by W. D. Macray, six volumes (1888) varies considerably according to the date and circumstances of its composition, books viii to xv (with the exception of book ix) being particularly weak. The deficiencies of the *History,* and the *Life* which was constructed from the remnants of autobiographical material, do not always derive from lack of documentation. Clarendon, for all his judicious moderation and the magisterial dignity of his prose, occasionally suffered from a conspicuous lack of objectivity. Among the portraits which are the chief ornament of his writings, his accounts of opponents, such as Sir William Coventry, are distorted, and his analyses of the events in which he had been a participant are at variance with the judgments which guided him at the time. Yet such blemishes were natural in a historian who had been deeply involved in a major revolution; conversely, his merits as a statesman were those of a man whose contemplation of the past had sharpened his vision of the future.

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CLARENDON, GEORGE WILLIAM FREDERICK VILLIERS, 4th Earl of (1800–1870), English statesman and a distinguished foreign secretary, notably during the Crimean War, was born in London on Jan. 12, 1800, and had—as Charles Greville once said—"the unspeakable advantage of being plain George Villiers and having to fight his own way in the world" as a young man. He was educated at Christ's Hospital and at St. John's college, Cambridge. In 1820 Lord Castlereagh appointed him attaché at St. Petersburg, where he served till 1823; but lack of funds then forced him into becoming a commissioner of customs, in which post he served at Dublin and Paris. Strong intelligence, an agreeable presence and a gift for languages brought him to the attention of those in power, and in 1833 Lord Palmerston made him British ambassador at Madrid.

For six years he wrestled with the intricacies of Spanish politics, while the queen of Spain was a minor, the country torn by civil war and his home government too preoccupied to afford him full support. In 1838 he succeeded an uncle as earl of Clarendon. Early in 1839 he returned to England and married. He refused to go to Canada as governor general, but was persuaded to enter Lord Melbourne's cabinet as lord privy seal, becoming also chancellor of the duchy of Lancaster for the last few months of the government. This spell of office was chiefly notable for a painful opposition to a colleague, since Clarendon thought that Palmerston's policy on the Egyptian question was dangerously hostile to France, and he was delighted when the government resigned in 1841. He took the board of trade when the Whigs resumed office in 1846 and a year later reluctantly accepted the vice-royalty of Ireland, then in the throes of famine. He insisted on being armed with a coercion act, and so was able both to keep the peace and to foster projects for relief. The land legislation he supported only crowded Ireland with selfish speculators, but this result was not apparent till after he had left office in 1852.

Early in 1853 Clarendon succeeded to the one post he coveted and became the only professional diplomat ever to serve as foreign secretary. The foreign office staff took to him at once—he was known there, for many years after his death, as "the great Lord Clarendon"—but he found foreign affairs in confusion. He was never able to get his head clear of the mass of dispatches and could do nothing to stop the country "drifting" (the word was his) into the Crimean War. He was hampered by his own mistrust of Lord Stratford de Redcliffe, the ambassador at Constantinople, and by time-wasting interference from his prime minister, Lord Aberdeen, before the war began. While it went on his talents for conciliation were mainly expended on keeping his colleagues in the cabinet together. He had already secured the friendship of Napoleon III and was able by judicious face-to-face argument to persuade the emperor not to go to the Crimea himself. The French tired of the war before the British, and Clarendon had to use the full range of his diplomatic skill to secure a fair peace at Paris in March 1856. He was offered, but refused, a marquessate on its conclusion.

In 1858 he resigned with Palmerston's cabinet and did not rejoin him in 1859, partly because Lord John Russell insisted on having the foreign office himself and partly because Clarendon disagreed with the Italian policy on which the new government was founded. He spent six years in retirement, advising his friends in office, before becoming chancellor of the duchy of Lancaster in 1864 and foreign secretary again on Palmerston's death in 1865. The fall of Russell's government released him after a few months, but he returned to the foreign office again, under Gladstone, at the end of 1868. He engaged in a wholly unsuccessful attempt, during the winter of 1869–70, to persuade Bismarck to reduce Prussian armaments, and died, as a result of overwork, in London on June 27, 1870, just when Europe had most need of him, three weeks before the outbreak of the Franco-German War. "If your father had lived," Bismarck said once to Clarendon's daughter Lady Emily Russell, "he would have prevented the war."

See Sir Herbert Maxwell, *Life and Letters of George William Frederick, Fourth Earl of Clarendon*, 2 vol. (1913). (M. R. D. F.)

CLARENDON, CONSTITUTIONS OF, 16 articles defining the relationship between church and state in England which Thomas Becket (*q.v.*), archbishop of Canterbury, Roger, archbishop of York, and 12 bishops promised to observe in Jan. 1164, in the presence of King Henry II and a large number of magnates at Clarendon near Salisbury.

The constitutions were presented as a simple record of some customs of the realm observed under earlier kings, specifically Henry I. This claim may not have been exact, but it accurately reflected Henry II's conservative purpose: to maintain a traditional order that was being threatened, partly by changing clerical opinions about the proper relationship of clergy to laity, partly by attempts to make ecclesiastical justice more effective and partly by the actions of litigants seeking the courts best suited to their immediate purposes. The constitutions defended other interests besides those of the crown, which in a few matters were not directly involved. Further, their object was not merely to defend interests; they were also concerned, *e.g.*, with the proper punishment of crime and the rights of accused persons.

Half of the clauses placed restrictions on the procedures of ecclesiastical judges and on the competence of church courts, limiting the demands such judges might make on excommunicated persons, and restraining them from proceeding against laymen on secret information. They reaffirmed the principle that the king's consent was required for the excommunication of his tenants in chief and officials and for placing their lands under interdict (a lesser restriction applied to royal towns, castles and manors), and they denied to church courts jurisdiction in disputes about advowsons, debts and land held in lay fee. The constitutions on these matters were not merely negative. If no one would come forward to accuse a layman suspected of an offense within the church's jurisdiction, the local bishop could require the sheriff to empanel a jury to declare a verdict. Church courts were assured of jurisdiction in disputes about land given to churches in frankalmoign; if dispute arose between a layman who claimed a property as lay fee and an ecclesiastic who claimed it as frankalmoign, it went to a jury whose verdict would decide whether further pleading should proceed in a lay or in an ecclesiastical court (the assize Utrum).

The judicial provision most vehemently contested at the time (clause 3) would have exposed to secular punishment clerks convicted in church courts of serious criminal offenses like homicide. This repeated a proposal made by Henry II at the council of Westminster in 1163. The object, to which some ecclesiastics were sympathetic, was to ensure, while conceding to clerks immunity from secular trial on these charges, that a clerk notoriously suspect of felony should not be—as some recent cases suggested—scandalously better placed than a layman to escape the consequences of crime. Becket ignored both the object and the form of the proposal, insisting on treating the issue in terms of ecclesiastical privilege and as part of the much wider problem of the standing of ecclesiastics in relation to secular jurisdiction.

Two articles (clauses 4 and 8) specially concerned England's relations with the papacy, prohibiting clergy from leaving the realm without royal permission and requiring royal permission for appeals to a pope in ecclesiastical causes. These customs, inherited from William I, had probably been called into being by the occurrence of papal schism, in which event English kings claimed the right to determine, with proper advice, which of the contending popes should be recognized in England as apostolic. The restrictions had been repeatedly enforced as papal schism recurred, most recently by Henry II in 1159 with the concurrence of Archbishop Theobald, who saw in them a guarantee that papal schism would not have chaotic repercussions in England. They were also a control on recourse to a recognized pope. That Henry II intended in normal circumstances to halt the increasing tendency of litigants to resort to papal authority in a widening range of cases at all stages of litigation is unlikely, but he certainly wanted safeguards for the customs of the realm and probably also some check on vexatious appeals.

Custody of vacant sees and monasteries of which the king was patron was reserved to the king in uncompromising terms (clause 12). The procedure to be followed in filling the vacancies was defined in accordance with the practice of Henry I's later years; it was a compromise between clerical demands for free election and royal desire to retain influence over the electors' choice. Ecclesiastics who held baronies of the king were reminded of the obligations they shared with lay barons (clause 11).

Henry II's attempt to secure at one stroke from prelates and pope overt and definitive assent to numerous debatable propositions failed. He did not, however, have to repudiate explicitly a single clause, though in practice he abandoned the attempt to punish clerks corporally for ordinary criminal offenses.

Bibliography.—For Latin text *see* William Stubbs (ed.), *Select Charters*, 9th ed. (1913); Eng. trans. in *English Historical Documents*, vol. ii, ed. by D. C. Douglas and G. W. Greenaway (1953). *See* also C. R. Cheney, *From Becket to Langton* (1956), probably the best guide to the major issues. Essential background is given in A. Saltman, *Theobald, Archbishop of Canterbury* (1956). (Er. S.)

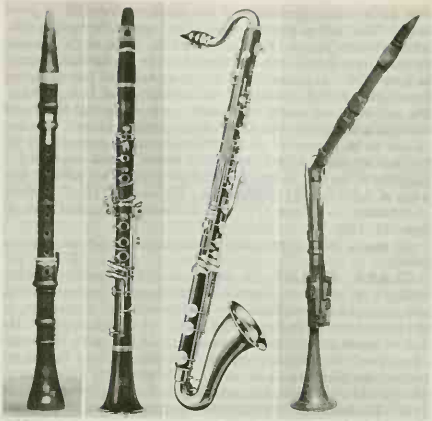
CLARETIAN MISSIONARIES (Congregation of Sons of the Immaculate Heart of Mary; Cordis Mariae Filii; C.M.F.), a Roman Catholic religious congregation founded by St. Anthony Claret on July 16, 1849, in Vich, Spain. The Claretian apostolate is all-embracing, but devotion to the Immaculate Heart is an essential element and a distinguishing characteristic. Claretian missionaries, numbering around 4,000, are established throughout the world. The mother house is in Rome. (J. J. O'B.)

CLARI, GIOVANNI CARLO MARIA (1677–1754), Italian composer of vocal music. Born at Pisa, Sept. 27, 1677, he was a pupil of G. P. Colonna, the chapel-master of S. Petronio, Bologna. Between about 1712 and 1736 he was music director at Pistoia, Bologna and Pisa. He was mainly known for his vocal duets and trios with *basso continuo*, first published in Italy in 1720. Later editions were brought out in London between 1740 and 1747 and in 1823 in Paris. They combined graceful melody with contrapuntal learning and were much admired by Charles Avison, Cherubini and Handel, who made considerable use of them although, surprisingly, in view of Clari's popularity in England, this was not fully realized until the 19th century. Clari also composed an opera, *Il savio delirante* (1695), 11 oratorios, mostly for Pistoia, and a large quantity of church music, some of which was reprinted in 19th-century collections. He died at Pisa, May 16, 1754. (Cs. Ch.)

CLARINET, a wood-wind instrument regularly employed in the orchestra and in military and dance bands. A distinguished repertory has been written for the clarinet as a solo instrument.

Construction and Characteristics.—The clarinet is usually made of African blackwood, with a cylindrical bore of approximately 0.6 in. terminating in a flared bell. All-metal instruments are made but are little used in first-class work. The mouthpiece, usually of ebonite, tapers toward the top and has a slotlike opening in one side over which a single reed, made from natural cane, is secured by a screw clip or ligature. In earlier times, the reed was secured by string lapping, as it still often is in Germany. The player grips the mouthpiece, reed downward, with his lips; the lower lip, which is retracted over the teeth, is held against the reed and either the upper lip or upper teeth held against the top surface. The ordinary clarinet is pitched in B flat and is 26½ in. long; its notes, made with the fingerholes and key mechanism, sound a tone (step) lower than written. The "stopped pipe" harmonics produced in an instrument of a cylindrical bore, coupled with a reed mouthpiece, account for (1) the deep-pitched fundamental register, approximately an octave below that of the flute; (2) the characteristic tone colour, due largely to the virtual absence of the even-numbered overtones of the harmonic series; and (3) the "overblowing" (effected by opening a thumb key) to an upper register at the 12th (third harmonic) above the fundamentals, instead of at the octave as in other wood-wind instruments. This last fact inevitably complicates the fingering system, though in practice without any adverse effect upon the flexibility of the technique. A high register, using fifth and seventh harmonics, extends the compass to a total span just exceeding three and one-half octaves upward from the D in the bass stave, or staff (written as E below middle C).

Historical Development.—On the authority of a volume of local biographical notices by J. G. Doppelmayr, published in Nürnberg in 1730, the invention of the clarinet is ascribed to J. C. Denner, a well-known flute-maker there at the beginning of the 18th century. Up to that time the single reed had been used only in organs and in folk instruments, though it is likely that an adaptation of a folk instrument, invented as a result of the quest for musical novelties, anticipated the clarinet by a few years; the predecessor was the "mock trumpet" or "chalumeau," which Denner, in the same source, is credited with having improved. The chalumeau was a small instrument played in the fundamental register only. Denner's *clarinette* was larger, equal in length and similar in build to a treble recorder and was intended for playing mainly in the upper register with the fundamentals as an adjunct, thereby making available a complete "trumpet" (*clarino*) compass, and with steadier clearer notes than those of the chalumeau. The earliest known music for it are tune books published by Estienne Roger in Amsterdam, of which second editions dating from 1716 exist. The instrument was played with the reed uppermost (playing with the reed downward is not described until after 1800, in Germany), had two keys and its lowest note was F below the stave. A short bell was added by 1720, and the important extension of the tube to carry the low E key (providing the upper B formerly imperfectly available) followed at an unknown date, about 1740–50. Early composers for it include Vivaldi (in mixed concertos) and Handel (overture for clarinets and horn). By the late 18th century the clarinet usually had five or six keys. It was built in various pitches to suit different tonalities, the music being transposed to preserve in all cases the same correspondence between the written note and the player's fingering for it. Clarinets were used in most large orchestras from about 1780, while concertos and chamber works, accumulating from the 1760s onward, culminated in the works that Mozart wrote for Anton Stadler, perpetual reminders of the beauties of the instrument at this still early stage.



BY COURTESY OF (LEFT CENTRE AND RIGHT CENTRE) C. G. CONN, LTD.; (RIGHT) THE METROPOLITAN MUSEUM OF ART, GIFT OF THE UNIVERSITY MUSEUM, UNIVERSITY OF PENNSYLVANIA, 1953; (LEFT) CONSERVATOIRE ROYAL DE MUSIQUE DE BRUXELLES (NO. 912)

(LEFT) DENNER CLARINET, FIRST TRUE CLARINET, EARLY 18TH CENTURY; (LEFT CENTRE) BOEHM CLARINET, 1844; (RIGHT CENTRE) BASS CLARINET, MODERN; (RIGHT) BASSET HORN, 1770

The modern clarinet was developed between 1800 and 1850. Further keys were first added to improve certain chromatic notes; Heinrich Baermann, for whom Weber wrote his concertos, used 8 keys, and Iwan Müller introduced his 13-keyed system with stuffed pads in about 1810. During the 1820s bores and mouthpieces were enlarged in conformity with general trends toward greater tonal power, and technological advances, including keywork mounted on pillars, T. Boehm's ring keys and A. Buffet's needle springs, led to the appearance of the modern designs in their main essentials during the 1840s. These exist in two main systems: (1) The "simple" or "Albert" system, deriving from the name of the Brussels maker E. J. Albert, represents a modernization of that of Müller. It is now obsolete in America and the Latin countries and has virtually become so in England. In Germany it remains in normal use, with a complex accretion of auxiliary keywork but with conservative features in bore, mouthpiece and reed, the last being smaller and harder than elsewhere, while the deep quality of the German tone is unmistakable. (2) The "Boehm" system patented by H. Klosé and Auguste Buffet in Paris (1844) and so-called because it incorporates much of Boehm's 1832 flute fingering system, bringing many technical advantages. It has remained virtually unchanged and has become standard in most countries. (It is quickly distinguished from the other system by the ring at the back for the thumb, and by the four, or occasionally five, keys for the right little finger.) A more elaborate "full Boehm" model is used mainly in Italy, where orchestral players transpose A clarinet parts on the B-flat instrument, instead of possessing also an A clarinet (which sounds a semitone, or half-step, lower), as is customary elsewhere. The vast technical capacity of the Boehm clarinet has been notably exploited in solo works written in the 20th century.

The Clarinet Family.—Clarinets of other sizes than the B flat and its sharp-key equivalent in A ($27\frac{3}{4}$-in. long) include the following. Octave clarinets in high A flat (14 in.), which are used in large continental bands; sopranino clarinets, a fourth above the ordinary sizes, which began with the F clarinet of the classical period and was replaced in the 19th century by the E-flat clarinet ($19\frac{1}{2}$ in.), often used in the orchestra from Berlioz onward and in Germany in conjunction with its sharp-key equivalent, the D clarinet (a popular size in the earliest days). The ordinary or soprano group has also included the C clarinet ($23\frac{1}{2}$ in.), for which there are many parts in classical compositions, now normally played on the B-flat clarinet, though a tendency of German orchestration has been to preserve the C clarinet for its bright, incisive quality. Alto (or tenor) clarinets followed the late 18th-century bulb-belled *clarinette d'amour* in A flat, G or F, and the more successful basset horn in F with compass extension down to its low C; the wider-bore alto clarinet, at first in F, now normally in E flat, was introduced in France about 1820 and as today used in many large American and continental bands is made with curved metal socket or "crook" and upturned metal bell.

The bass clarinet, an octave below the ordinary, was built only experimentally in the 18th century, but after 1810 was developed in a multitude of designs in many countries, and was first employed in the orchestra by Meyerbeer. The modern form, with twice-curved crook, owes much to Adolphe Sax's design of 1838, to which the upturned bell was added subsequently. The operas of Wagner perhaps did most to secure its permanent place in the orchestra. Contrabass clarinets are made in E flat or in B flat an octave below the bass clarinet and are increasingly used in special orchestrations.

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CLARK, ABRAHAM (1726–1794), American patriot and signer of the Declaration of Independence was born at Elizabethtown, N.J., on Feb. 15, 1726. Benefiting little from formal education, he became a surveyor and also managed transfers of property. Clark had a gift for politics and served in many public offices in New Jersey. He championed the cause of the colonies against Great Britain and was elected to the continental congress in June 1776. As a member of that body he voted for separation from Great Britain and signed the Declaration of Independence. He was re-elected to the continental congress several times and was also a delegate to the Annapolis convention (1786). He was chosen to be a member of the Philadelphia convention of 1787 but was unable to attend because of illness. Clark opposed the adoption of the new federal constitution until he was assured that a bill of rights would be added to it. He served in the U.S. house of representatives from 1791 until his death at Elizabethtown on Sept. 15, 1794.

See Dumas Malone, *The Story of the Declaration of Independence* (1954). (J. R. Al.)

CLARK, CHAMP (in full, James Beauchamp) (1850–1921), U.S. politician, speaker of the house of representatives, and unsuccessful candidate for the presidential nomination in 1912, was born in Anderson county, Ky., on March 7, 1850. He was educated at local public schools and at Kentucky university (Lexington) and Bethany college (Bethany, W.Va.) before attending the Cincinnati Law school. He moved to Pike county, Mo., in 1876, and settled permanently at Bowling Green, Mo., in 1880. He followed the pattern for political success in the rural America of his time, serving successively as editor of a country newspaper, city attorney, county prosecuting attorney and member of the Missouri legislature. He served 13 terms in the U.S. house of representatives (1893–95, 1897–1921) where he attained membership on the committee on ways and means and on the powerful rules committee. As Democratic floor leader for four years he led his party in the March 1910 revolt against Joseph Cannon, speaker of the house, and then served as speaker of the house from 1911 to 1919. He performed effectively as speaker of the house under the revised rules, which materially reduced the speaker's powers.

Clark's opinions and voting record were consistently progressive and represented the views of the south and west on national issues. He was for years a devoted follower of William Jennings Bryan. In 1912, he showed surprising strength in the pre-convention contests for delegates and in the Democratic convention itself. He led in the early balloting but was unable to secure the necessary two-thirds vote. The convention eventually nominated Woodrow Wilson. Clark's failure to receive the nomination, for which he held Bryan responsible, was a bitter and lasting disappointment. He was defeated for re-election to the house in 1920 and died in Washington, D.C., on March 2, 1921.

His son, Bennett Champ Clark (1890–1954), practised law in St. Louis, Mo., and served as U.S. senator from Missouri (1933–45). (T. S. By.)

CLARK, FRANCIS EDWARD (1851–1927), U.S. Congregational clergyman and founder of the Christian Endeavor movement, was born at Aylmer, Que., on Sept. 12, 1851. He graduated at Dartmouth college in 1873 and at Andover Theological seminary in 1876, and was pastor successively of the Williston Congregational church in Portland, Me., and of the Phillips Congregational church in South Boston, Mass. In Feb. 1881, at Portland, Clark organized the Young People's Society of Christian Endeavor, which grew rapidly into a world-wide organization. In 1887 he resigned his ministry in South Boston to give his attention to the United Societies of Christian Endeavor, at first as president and later as president emeritus. Ultimately he served as president of the World's Christian Endeavor union and as editor (later honorary editor) of the *Christian Endeavor World*. Clark made several journeys around the world in his promotion of the Christian Endeavor movement. He died at Newton, Mass., on May 26, 1927.

He was a prolific writer and his many publications are listed in the autobiographical *Memories of Many Men in Many Lands* (1922). They include *The Children and the Church* (1882); *Christ and the Young People* (1916); and *The Gospel Out-of-Doors* (1920). (S. E. Md.)

CLARK, GEORGE ROGERS (1752–1818), American frontier military leader, was born in Albemarle county, Va., on Nov. 19, 1752. He received little formal schooling but learned surveying from his grandfather. He participated as a scout in Lord Dunmore's war against the Indians in 1774. Thereafter he resumed his surveying work for various employers along the Ohio river. He became interested in the development of the Kentucky country around Harrodsburg and cast his lot with those who opposed an independent colony of Transylvania and favoured maintaining a connection with Virginia.

When the American Revolution broke out Clark saw the need for an organized militia to operate against the British and Indians along the frontier. Elected by a mass meeting of the pioneers to present their problems before the Virginia government, Clark and John Gabriel Jones went to Williamsburg, Va., in 1776. They persuaded the council and assembly to make Kentucky a separate county and to assume some responsibility for its defense. Clark returned with a supply of powder and assumed chief command of the frontier militia at a critical moment, for the Indians were already making raids against the settlers. Convinced that the Indians were instigated and supported in their raids by British officers stationed at the forts north of the Ohio river, Clark worked out a plan of offensive operations. His plans were approved by Virginia, and he was authorized to enlist troops.

In May 1778 he was at the falls of the Ohio with about 175 men. The expedition proceeded to Ft. Kaskaskia on the Mississippi river, in what is now the state of Illinois. Ft. Kaskaskia and Cahokia, also on the Mississippi, were defended by small British garrisons, which depended on the support of the French inhabitants. The French being willing to accept the authority of Virginia, both settlements were easily taken. Clark gained the friendship of Father Gibault, the priest at Kaskaskia, and through his influence the French at Vincennes on the Wabash were induced to change their allegiance. However, Lieut. Gov. Henry Hamilton, the British commander at Detroit, Mich., recovered Vincennes. After a strenuous march across flooded bottom land in freezing weather, Clark in Feb. 1779 surprised Hamilton and forced him to give up Vincennes. The way was now open to Detroit, British bastion in the west, but it was deemed prudent to wait for reinforcements promised from Virginia. When the reinforcements were delayed Clark withdrew to Ft. Nelson which he had built at the falls of the Ohio, and made that his base for the rest of the war.

In 1780 he helped defeat a British expedition sent against the Spanish settlement at St. Louis; the same year he made a swift campaign against the Shawnee Indians and destroyed their towns, Chillicothe and Piqua. Clark, now appointed brigadier general of the western forces, again planned to move against Detroit and was promised supplies and reinforcements by Virginia for the expedition. Months went by and they did not come, for Virginia was bankrupt. Again in 1782 Clark led an offensive against the Shawnees in the Miami valley, destroying villages and crops.

When peace came in 1783 Clark's conquests doubtless influenced the award to the United States of the country northwest of the Ohio river. His offensive movements had also been of importance in defending the frontier from Indian raids and British expeditions. Clark and his men during all these years received no pay for their services. Furthermore, Clark found himself responsible for debts incurred for supplies, since Virginia, despite its promises, never reimbursed him. The rest of his life was shadowed by the demands of creditors. Clark was appointed an Indian commissioner after the war, and in 1786 he played a leading part in negotiating a treaty with the Shawnees. The same year he led an expedition against the "Wabash confederacy," his last military command. James Wilkinson, a traitor in the pay of Spain (though not so known at that time), coveted Clark's office of Indian commissioner and his military command, set out deliberately to misrepresent him, and was entirely successful. He was appointed Indian commissioner in the place of Clark, who was discredited and relieved of his command. Thereafter Clark became involved in a scheme to found a Spanish colony west of the Mississippi, and in 1793 he accepted a French major general's commission in the Genêt project (*see* Genêt, Edmond Charles). In 1798 he chose exile with the Spanish at St. Louis rather than give up the French commission. In the following year he returned to Louisville, in the vicinity of which he lived in retirement until his death on Feb. 13, 1818. His best biographer suggests that his relations with the Spanish and French "may be fully understood only when they are interpreted as phases of the expansion of the frontier."

Bibliography.—The definitive biography is James A. James, *The Life of George Rogers Clark* (1928). *See* also John D. Barnhart (ed.), *Henry Hamilton and George Rogers Clark . . .* (1950) and T. C. and M. J. Pease, *George Rogers Clark and the Revolution in Illinois, 1763–1787* (1929). (T. A. Ln.)

CLARK, JOHN BATES (1847–1938), often called the dean of U.S. economists, was born in Providence, R.I., Jan. 26, 1847. He was educated at Brown university, Amherst college, Heidelberg and Zürich, and became imbued with the ideas of the German historical school. Returning to the United States, he taught at Carleton, Smith and Amherst colleges, and finally at Columbia university (1895–1923). The first period of his economic thought, influenced by the historical school, culminated in *The Philosophy of Wealth* (1885). In "revolt," as he said, "against the spirit of the old political economy," he rejected competition as the rule of distributive justice. Nevertheless, he outlined independently an "effective utility" theory of competitive value, resembling that of Jevons and the Austrian school somewhat earlier.

A second period culminated in 1899 in his chief work, *The Distribution of Wealth*, marked by the rejection of the old categories of production factors, but ultra classical in accepting competitive price (which he called the specific productivity of agents) as the just rule of distribution. Despite some contemporary protests, Clark's views dominated economic theorizing in the United States for a generation, and left lasting effects in clearer conceptions of a universal law of economic variation, of a price system and of the categories of productive agents.

Clark's later work is noteworthy for his original and practicable proposals for the correction of monopolistic abuses, presented in final form in *The Control of Trusts* (1912), but never fully realized in public policy. (F. A. F.)

CLARK, MARK WAYNE (1896–), U.S. soldier, was born at Madison Barracks, N.Y., May 1, 1896. After graduating from the United States Military academy at West Point, N.Y., in 1917, he served overseas in World War I. Clark first achieved prominence as chief of staff of the army ground forces early in 1942. Later that year he executed delicate and difficult assignments in connection with the North African invasion, including a dramatic submarine trip to North Africa for a secret meeting with French officers. His stature as a field commander in World War II rested primarily on his leadership of the U.S. 5th army (Jan. 1943–Dec. 1944) during the hard-fought Italian campaign. In the last six months of the war he commanded the 15th army group (Dec. 1944–June 1945) and received the surrender of German forces in Italy. After the end of the war in Europe he assumed command of U.S. forces in Austria before returning home to command the 6th army and later the army field forces. In May 1952, during the Korean war, Clark was given command of all United Nations troops in Korea, holding that post until after an armistice was signed in July 1953. Upon his retirement from military service in Oct. 1953, Clark became president of a military college, the Citadel, in Charleston, S.C. He wrote *Calculated Risk* (1950) and *From the Danube to the Yalu* (1954).

CLARK, WILLIAM (1770–1838), U.S. frontier soldier, explorer, governor and Indian agent, was born in Caroline county, Va., Aug. 1, 1770. The redheaded William was a younger brother of Gen. George Rogers Clark (*q.v.*), conqueror of British posts in the west during the American Revolution. In keeping with family tradition, William Clark entered military service in 1789 and subsequently participated in several Indian-fighting excursions, including Gen. "Mad Anthony" Wayne's campaign against the Maumees and the victorious battle of Fallen Timbers in 1794.

Following a period of separation from the army, during which he was associated with "Mulberry Hill," which estate near Louisville, Ky., he inherited from his father in 1799, Clark received an invitation to share with Meriwether Lewis in the leadership of what was to become known as the Lewis and Clark expedition (*q.v.*). This Jefferson-inspired expedition was organized in 1803 near St. Louis and during the next three years made its way to the Pacific ocean and back via the Missouri and Columbia rivers. The journals kept by Clark and other members of the expedition provided the nation with its first comprehensive description of this region. In the years that followed, Clark served in the Louisiana territory as superintendent of Indian affairs and as governor of Missouri territory with headquarters at St. Louis. There he died Sept. 1, 1838.

Bibliography.—A monumental source to which Clark made a large and significant contribution is Reuben G. Thwaites (ed.), *Original Journals of the Lewis and Clark Expedition, 1804–1806*, 8 vol. (1904–05). The best biographical account is John E. Bakeless, *Lewis & Clark, Partners in Discovery* (1947). (O. O. W.)

CLARKE, ALEXANDER ROSS (1828–1914), the outstanding British geodesist of the 19th century, was born at Reading on Dec. 16, 1828. Passing out head of his term at the Royal Military academy, Woolwich, he was appointed to the royal engineers in 1847. His mathematical bent led to his being posted to the ordnance survey, Southampton, in 1850 where he remained until he retired in 1881, except for a break between 1851–54. In 1856 he became head of the trigonometrical and leveling department and was responsible for the reduction of the principal triangulation of the British Isles. He did this with extraordinary speed, publishing the results in 1858 in *Ordnance Trigonometrical Survey of Great Britain and Ireland*. He published in 1861 the reduction of the first geodetic leveling of Great Britain, and in 1863 the account of the triangulation joining England, France and Belgium, part of which he had himself observed. For the measurement of an international arc of triangulation stretching from Ireland to Russia, Clarke was entrusted with the comparison of the standards of length used by the several countries. This he did in a specially designed room at the ordnance survey, publishing his results in 1866. He wrote *Geodesy* (1880), which remained one of the best textbooks on the subject in any language in the second half of the 20th century. He will be best remembered for his determinations of the earth's dimensions in 1858, 1866 and 1880. These three figures of the earth were taken into use in parts of Africa and in North America.

He was elected fellow of the Royal society in 1862 and received its gold medal in 1887. He was created a companion of the Bath in 1870 and promoted brevet colonel in 1877. On his retirement in 1881 he moved to Reigate, Surrey, where he died on Feb. 11, 1914. (K. M. P.)

CLARKE, CHARLES COWDEN (1787–1877), English editor and critic best known for his work on Shakespeare, was born at Enfield, Middlesex, on Dec. 15, 1787. A friend of Charles Macready, Dickens and Mendelssohn, he became a partner in music publishing with Alfred Novello, whose sister, Mary, he married in 1828. Six years later he began his public lectures on Shakespeare and other dramatists and poets. Those published include: *Shakespeare Characters; Chiefly Those Subordinate* (1863); *Molière Characters* (1865); others on *Shakespeare's Contrasted Characters* and *Shakespeare Numskulls*; on the *Poets of the Elizabethan Era*; and on *Four Great European Novelists*. In 1863 he edited George Herbert's poems and in the next 14 years produced new editions of nearly all the English poets. After his wife had compiled her *Shakespeare Concordance* (issued in 18 monthly parts, 1844–45; one vol., 1845), they collaborated in an edition of Shakespeare (issued in weekly parts and completed in 1868) and *The Shakespeare Key: Unlocking the Treasures of His Style* (1879). Clarke was mainly interested in character study, as was his wife, whose *The Girlhood of Shakespeare's Heroines* appeared in 1851–52, and their work takes its place in the main tradition of character analysis from Maurice Morgann through William Hazlitt and Samuel Coleridge to A. C. Bradley. In 1856 the Clarkes left London for Nice and subsequently Genoa, where Charles died on March 13, 1877, Mary on Jan. 12, 1898. (G. A. O.)

CLARKE, EDWARD DANIEL (1769–1822), English mineralogist and traveler who collected and brought to England valuable statues, manuscripts and minerals, was born at Willingdon, Sussex, on June 5, 1769, and educated at Tonbridge and Jesus college, Cambridge. In 1799–1802 he traveled through Scandinavia, Finland, Russia, Asia Minor and Egypt. At Alexandria after its surrender he helped to secure for England the collections made by the French savants. He returned home via Greece with large collections of minerals and antiquities. He was ordained in 1805 and became Cambridge university's first professor of mineralogy in 1808 and its librarian in 1817. He was a founder of the Cambridge Philosophical society (1819) and active in the Bible society. He died in London on March 9, 1822.

He gave his Greek marbles (now in the Fitzwilliam museum) to Cambridge university in 1803. The Bodleian library, Oxford, bought his manuscripts in 1808, Richard Payne Knight his coins in 1810 and Cambridge university his minerals after his death. His principal work is *Travels in Various Countries . . .*, six volumes (1810–23).

See W. Otter, *Life and Remains of . . . E. D. Clarke* (1824) and, for a lively character sketch, H. Gunning, *Reminiscences of the University*, 2 vol. (1854). (J. C. T. O.)

CLARKE, JAMES FREEMAN (1810–1888), U.S. Unitarian clergyman, reformer and author, was born at Hanover, N.H., on April 4, 1810. He was graduated from Harvard college in 1829 and from the Harvard divinity school in 1833. His first pastorate was in Louisville, Ky., from 1833 to 1840. In 1841 he returned to Boston to establish the Church of the Disciples, of which he was minister from 1841 to 1850 and from 1854 until his death. Clarke served also as secretary of the American Unitarian association, 1859–61, and as professor of natural religion and Christian doctrine at Harvard, 1867–71. Throughout his career Clarke was closely involved with many of the most significant movements and personages of his day. While at Louisville he edited the *Western Messenger*, a short-lived liberal magazine in which he printed original works of his friends Ralph Waldo Emerson, Oliver Wendell Holmes, Orestes Brownson and Nathaniel Hawthorne. He was a charter member of the Transcendental club, in which his closest associates were Emerson, Margaret Fuller and Theodore Parker. Clarke was a many-sided though mild reformer. He was an antislavery advocate and crusader for civil service reform; in the latter role he was influential in securing the presidential election of 1884 for Grover Cleveland. As a theologian Clarke was both Unitarian and reformed Calvinist, and through his many published sermons and his editorship of such magazines as the *Christian World* (1843–48) and the *Monthly Journal of the American Unitarian Association* (1859–61) he did much to popularize these beliefs. Clarke published over 1,000 pieces in periodicals and 32 books, of which the most notable are his *Ten Great Religions*, two volumes (1871–83) and *Memoirs of Margaret Fuller Ossoli* (1852) edited with Ralph Waldo Emerson and W. H. Channing. He died in Jamaica Plain, Mass., on June 8, 1888.

See Clarke's *Autobiography, Diary and Correspondence*, ed. by Edward Everett Hale (1891); Arthur S. Bolster, Jr., *James Freeman Clarke, Disciple to Advancing Truth* (1954). (A. S. Br.)

CLARKE, JEREMIAH (*c.* 1674–1707), English organist and composer of church and sacred music. He became a boy chorister at the Chapel Royal under John Blow, whom he succeeded as master of the choristers at St. Paul's cathedral (1703). In 1700 with William Croft he became a gentleman extraordinary at the Chapel Royal and in 1704 was joint organist there with Croft. On Dec. 1, 1707, Clarke shot himself while mentally deranged.

Clarke's sacred music is sometimes in the dramatic style of Henry Purcell and sometimes in an archaic style. His occasional anthems include "Praise the Lord O Jerusalem," written for the coronation of Queen Anne in 1702, and "The Lord is my strength" for the victory of Ramillies in 1706. His secular odes include the original setting of John Dryden's "Alexander's Feast" (1697). The famous *Trumpet Voluntary*, once wrongly ascribed to Purcell, was originally either a harpsichord piece, *The Prince of Denmark's March*, or an orchestral rondeau, both by Clarke. He also wrote incidental music for plays, solo songs and harpsichord music. (C. A. L.)

CLARKE, MARCUS ANDREW HISLOP (1846–1881), Australian author, best known for his novel *For the Term of His Natural Life*, was born in London on April 24, 1846. On June 7, 1863, he arrived in Australia, where his uncle, James Langton Clarke, was a county court judge. At first a clerk in the Bank of Australasia, he then learned farming on a station near Glenorchy, Victoria, but he was already writing stories for the *Australian Magazine* when in 1867 he joined the staff of the *Melbourne Argus*. He became secretary (1872) to the trustees of the Melbourne public library, and later (1876) assistant librarian. He helped to found the Yorick club in 1868, which soon numbered among its members Adam Lindsay Gordon, Henry Kendall and George Gordon McCrae. He died in Melbourne on Aug. 2, 1881. *For the Term of His Natural Life* (1874), a tale of the convict system, began to appear in serial form in the *Australian Journal* in March 1870.

See H. Mackinnon (ed.), *The Austral Edition of the Selected Works of Marcus Clarke* (1890); B. Elliot, *Marcus Clarke* (1958). (C. M. H. C.)

CLARKE, MARY ANNE (*c.* 1776–1852), mistress of Frederick, duke of York, second son of George III, caused a public scandal by her abuse of patronage. She was probably born in London in 1776 and married, before she was 18, a stonemason called Clarke whom she soon left. In 1803 she became the mistress of the duke of York, the commander in chief. The duke's promised allowance was not regularly paid, and to escape from her financial difficulties Mrs. Clarke trafficked in her protector's position, receiving money from promotion seekers, military, civil and even clerical, in return for her promise to secure them the good services of the duke. Her activities caused Colonel Wardle, M.P., to bring in 1809 charges of abuse of military patronage against the duke, which were investigated by the house of commons. The duke was shown to have been aware of what was being done, but to have derived no pecuniary benefit himself. He resigned his appointment as commander in chief (he was reappointed in 1811), and ended his connection with Mrs. Clarke, who subsequently obtained from him a considerable sum in cash and a pension as the price for withholding the publication of his numerous letters to her. She died at Boulogne on June 21, 1852. (A. Al.)

CLARKE, SAMUEL (1675–1729), English theologian, philosopher and exponent of Newtonian physics, regarded by his contemporaries as one of the foremost intellects of his country in his time, was born at Norwich, on Oct. 11, 1675. He was educated at Caius college, Cambridge. After ordination, he became in 1698 chaplain to Bishop John Moore of Norwich and in 1706 a chaplain to Queen Anne, who in 1709 presented him to the rectory of St. James's, Westminster. In 1704–05 he gave two sets of Boyle lectures later published as *A Demonstration of the Being and Attributes of God* (1705) and *A Discourse Concerning the Unchangeable Obligations of Natural Religion* (1706). In the first set he attempts to prove the existence of God by a method "as near mathematical as the nature of such a discourse would allow"; in the second he argues that the principles of morality are as certain as the propositions of mathematics and thus can be known by reason alone. These lectures had a considerable influence on English 18th-century thought. Thus David Hume's criticisms of religion partly resulted from his dissatisfaction with Clarke's attempt to prove God's existence. In moral philosophy the "intellectualist" theory of Clarke found supporters in William Wollaston and Richard Price but its shortcomings were pointed out by Joseph Butler, Francis Hutcheson and Hume, all of whom in part developed their moral theories in reaction against Clarke.

Of Clarke's other theological works, the most important was *The Scripture Doctrine of the Trinity* (1712). This started a violent and prolonged controversy, in which many of his opponents accused him of Arianism. The fact that Clarke never obtained further preferment was almost certainly due to this publication.

Clarke, who had become a friend and disciple of Isaac Newton at Cambridge, did much to help the spread of Newton's views. He made a Latin translation (1697; 4th ed. 1718) of Jacques Rohault's *Traité de physique*, the standard Cartesian textbook, and added to it a large number of footnotes explaining how Newton had improved on Rohault; in 1706 he published a Latin translation of Newton's *Opticks;* and in 1715–16 he acted as Newton's spokesman in an interesting exchange of letters with Leibniz (first published 1717; modern editions 1956 and 1957). Although this correspondence began with Leibniz's criticisms of certain theological implications which he found in Newton's scientific writings its main importance lies in the discussion of the notions of space and time. Clarke defends Newton's view that space and time have some sort of absolute existence, while Leibniz claims that they are only relations between objects or between events.

Clarke died suddenly at Leicester on May 17, 1729. A collected edition of his *Works*, four volumes, was published in 1738–42. (H. G. Al.)

CLARKE, THOMAS SHIELDS (1860–1920), U.S. painter and sculptor, was born in Pittsburgh, Pa., on April 25, 1860. He studied at Princeton and for a year at the Art Students' league, New York, then (1883) went to Paris, where he studied under Gustave Boulanger, Jean Gérôme, Pascal Dagnan-Bouveret and the sculptor Henri M. Chapu.

Among his better-known works are "The Cider Press," a bronze in Golden Gate park, San Francisco, Calif.; four caryatids for the appellate courthouse, New York city; and the paintings "Night Market in Morocco" and "A Fool's Fool." He died in New York on Nov. 15, 1920. (D. H. W.)

CLARK FORK, a river of the northwestern U.S. is the eastern segment of a system which drains the Clark Fork-Pend Oreille basin of northeastern Washington, northern Idaho, western Montana, and two areas in British Columbia, Can. Rising near Butte, Mont., the Clark Fork flows in an irregular course north and northwest for about 360 mi. before it empties into Pend Oreille lake (*q.v.*) in northern Idaho. From this point to the Columbia the stream is called the Pend Oreille river. Principal tributaries are the Blackfoot, Bitterroot, St. Regis and Flathead rivers, the latter being the largest and most important. Typically, the river and its tributaries consist of long, narrow stream sections confined by mountainous terrain with cultivable intermontane valleys and prairie sections scattered along their courses. The Bitterroot and Flathead valleys contain extensive irrigated areas.

The river basin is noted for its extensive mineral deposits, forests, attractive lakes and streams, comfortable summer climate and spectacular mountain scenery. Glacier National park, the National Bison range wildlife preserve and a number of national forests are in the Clark Fork-Pend Oreille basin. (G. V. Sk.)

CLARKSBURG, a city of West Virginia, U.S., seat of Harrison county, is on the West Fork of the Monongahela river in the north-central part of the state, midway between Cincinnati, O., and Washington, D.C. Located in the midst of a rich farming country, it is also a centre of coal, oil and gas production and has a well-balanced variety of manufacturing plants, including glass, zinc, caskets, brick, chinaware, electrodes, machinery and evaporated milk.

Clarksburg was settled in 1765 and incorporated in 1785. It was named for George Rogers Clark, the noted Virginia soldier and explorer. In 1772 Thomas Nutter, an early settler, built a fort 3 mi. from Clarksburg, around which developed the town of Nutter Fort, a suburb of Clarksburg. The towns of Broad Oaks, Stealey Heights, Adamston and North View were consolidated into Clarksburg in 1917 and a new charter was issued by the legislature of West Virginia in 1921.

The city has a council-manager form of government which went into effect at that time.

Clarksburg was the birthplace of Thomas Jonathan "Stonewall" Jackson, the Confederate military leader. John W. Davis, Democratic candidate for president in 1924, and Howard Gore, secretary of agriculture in the cabinet of Calvin Coolidge and governor of West Virginia (1925–29), were also residents of Clarksburg.

For comparative population figures *see* table in West Virginia: *Population*. (K. K. McC.)

CLARKSON, THOMAS (1760–1846), English antislavery agitator who was one of the most active leaders of the abolitionist campaign, was born on March 28, 1760, at Wisbech, Cambridgeshire, the son of a schoolmaster. Educated at St. Paul's school and St. John's college, Cambridge, he was ordained a deacon but soon abandoned all idea of exercising his profession. He was first drawn to the subject of slavery in 1785 by the reading he did in preparation for a Latin prize essay (*see* Slavery). The publication of an English translation of this essay brought him in touch with Granville Sharp and others, and with them he formed a society for the abolition of the slave trade and became a member of its committee of 12. Gaining the sympathy of William Wilberforce, William Pitt, Charles James Fox and Edmund Burke, Clarkson spent his days traveling from port to port collecting evidence which was used in his *Summary View of the Slave Trade and the Probable Consequences of its Abolition* (1787) and in the parliamentary campaign led by Wilberforce. The abolitionist cause made no parliamentary progress after the beginning of the French war, however, many members feeling that the trade was necessary both as a source of national wealth and as a training ground for the navy.

Clarkson was forced to retire from his exhausting work in 1794 because of ill-health, but from 1804 he was again active and in 1807 a bill for the abolition of the slave trade was passed. Soon afterward Clarkson published his *History . . . of the Slave Trade*, two volumes (1808). From 1807 he agitated for the enforcement of the act and for international abolition. Finally, in 1815, Lord Castlereagh secured the condemnation of the trade by the other great powers. When the question of practical measures for abolition was unsuccessfully discussed at the congress of Aix-la-Chapelle in 1818, Clarkson personally presented an address to Alexander I of Russia who communicated it to the sovereigns of Austria and Prussia. In 1823 the Anti-Slavery society was formed and Clarkson became a vice-president, but he took little active part in the final victory, the Emancipation act of 1833. Until his death at Ipswich on Sept. 26, 1846, Clarkson continued to publish works attacking slavery. He also wrote *Memoirs . . . of William Penn*, two volumes (1813).

See E. L. Griggs, *Thomas Clarkson* (1936). (A. Al.)

CLASS, SOCIAL, an aggregate of persons, within a society, possessing approximately the same status. The class system, or the system of stratification of a society, is the system of classes in their internal and external relationships. It is the set of relationships constituted by the granting of deference to individuals, roles and institutions in the light of their place in the systems of power, property, occupation, etc. (*See* also Social Anthropology: *Status and Stratification.*)

Deference is an action of respect or honour, associated with the feeling of equality or inferiority. By logical extension, sentiments of disrespect or disesteem, feelings of contempt and superiority, are also comprehended in the conception of deference. Deference is an act of implied judgment of the worth and dignity of a person, office or institution, made in the light of a scale of values. It is simultaneously an act of judgment regarding the person judged and the person judging.

Bases of Class.—The deference which defines class position is granted to persons, offices and institutions in accordance with the deferring person's perception, which may be erroneous and which is almost always fragmentary and vague, of the characteristics of the person, office or institution being judged. A man is judged in accordance with the judging person's perception of his income and wealth, his occupation, his level of achievement within his occupation, his standard of living (including the location of his residence), his ethnic characteristics, his kinship connections, his educational level, his relationships to the main centres of the exercise of power in the society as a whole and in the particular institutions in which he functions, such as business firms, churches, universities, armies, governmental departments, etc., and his associates, formal and informal. (His wife and children are usually granted deference corresponding to his status.) These various characteristics are not always evaluated in the same way in all societies. For example, in the United States the significance of kinship connection is less important than it is in China or Great Britain in affecting a person's social status (*i.e.*, the rank which is accorded to him by the members of the society). Similarly, ethnic characteristics are more important in the United States than they are in France or Brazil, although they are diminishing in their significance in the United States. Education has less significance as a basis of discrimination in the United States than it has in Germany, the Netherlands or Sweden. Occupation is probably less important as a basis of deference in the United States than it is in Germany, and it continued to decline in the 20th century.

Within each category (*e.g.*, occupation), variations occur in the rankings which result from the feelings and judgments of deference. Scientists, for example, have moved up considerably on the scale in western countries, while the clergy has been undergoing a gradual decline over several hundred years. The military profession rose in the deference hierarchy in the United States after 1940, as it does everywhere when the society is militarily endangered.

The judgment which underlies the act of deference is a synthetic judgment which assesses simultaneously a large number of relevant characteristics. A process similar to that of averaging occurs. Hence, a very wealthy man who keeps low company and whose occupation is disreputable might rank lower in most people's opinion than a less wealthy person whose occupation is most estimable and who is an intimate of the great and worthy. In a society which regards the kinship bond as one of the primary ties, close blood relationship to a great person might compensate for a moderate income and a mediocre professional accomplishment in setting one person above another who is wealthier and more successful but who has no eminent ancestors.

Class System.—The class system is an imperfect equilibrium of innumerable individual acts of deference, both "pure" and "mixed" with elements of the occupational, property and political systems. The class system might be extremely inequalitarian, as in the ante-bellum South, or it might be highly equalitarian, as in modern Norway. The members of the society might classify themselves and each other into a set of status classes which shade off into one another, or the classes might be sharply defined and distinguished from one another.

In an inequalitarian society, the acts of deference will express sentiments of great inferiority or superiority. The deference of the lower classes will be full of self-abasement before the superiors, and the latter will treat the former as barely human. European feudal society was like this. In contrast, there can be societies with a much higher degree of equalitarianism, in which the highest and the lowest both feel themselves to be part of a common community or humanity and in which accordingly there are not such sentiments of profound and far-reaching superiority and inferiority. Few persons in these societies feel themselves to be very much better or worse than anyone else. The modern western countries, and above all those societies which grew up on the frontiers without an inheritance of an elaborate inequalitarian class structure—namely, Canada, the United States, Australia and New Zealand—tend in this direction.

Although logically it is possible for any number of classes to be formed in a given society, once individuals of approximately similar status are grouped into classes, this does not, in fact, happen. There is a tendency for the society or its parts to act as if there were relatively few classes. Such classes as are recognized are not, of course, internally homogeneous, and persons within them make many distinctions which are not seen or acknowledged by those who are not in intimate contact with them. They are moreover practically never defined in the minds of most of those who refer to them. Persons who are especially "conscious" or sensitive about their own social status will try to define quite precisely the boundaries separating, among the persons with whom they come into face-to-face contact, those with whom they will associate and those with whom they will not associate on the grounds of their class status. Such "status-sensitive" persons are in most societies in varying but almost always small minorities, and even they do not have precise conceptions of the boundaries between classes other than those adjacent to their own class. Most of the class system is rather dimly differentiated in the minds of their members. Thus, the status judgment is not a precise judgment; it is only vague and approximate, in terms of higher and lower.

Boundaries are more precise in societies with an official system of stratification (*i.e.*, a titled nobility, a system of "estates" and a body of sumptuary legislation designed to demarcate class boundaries) and with relatively undeveloped mercantile, administrative and professional middle classes (like France in the 17th century or Russia before 1917). Even in such societies, however, the official stratification system covers in a differentiated manner only a small proportion of the social hierarchy. For the rest of the society, although retaining significance it is too undifferentiated to suffice. In consequence, a further system of stratification of the type discussed in the preceding paragraph emerges spontaneously.

The sharpness of the boundaries of status groups is at its height in a caste system, because endogamy, or intermarriage, is a requirement there to an extent unattained in other types of stratification systems and the inheritance of occupations in a static economic system and the strength of kinship ties add their force to already powerful status sentiments. There is of course a tendency for all status groups to be endogamous, but where personal affection is accorded some sway and where other considerations, such as personal beauty and personal merit, enjoy relative autonomy in competition with status considerations in the selection of marriage partners, this endogamy is always far from complete.

In all large societies, and particularly in those undergoing a moderate rate of change creating new roles, a considerable amount of upward mobility and some downward mobility is inevitable. It is especially pronounced in societies in which there are special institutional arrangements for training and selection and for the inculcation of standards of judgment which accord a high value to improved class status. This tends to raise problems relating to claims to higher status on the part of the recently ascended and denial of these claims by those with whom the recently risen persons seek to associate as a confirmation of their higher status. The denial of claims to deference of the "parvenu," because he is too new, or too crude, or too rich, or too contaminated with foreign connections or for whatever reasons, is a fertile source of alienation in society and a powerful factor in the promotion of change.

This phenomenon brings to the fore another property of the status system which merits mention. The discussion hitherto has proceeded as if there were, vagueness notwithstanding, a consensus in every society regarding the criteria for the granting of status as well as consensus in the assignment of the status of particular persons and institutions. This is not so. There is some disagreement and a great deal of sheer unconnectedness in the status judgments of all large societies. The groups which enjoy higher status positions in their own eyes and in the eyes of those adjacent to them will usually have a stronger view of their claims and merits than will those groups that feel themselves to be inferior. The "lower" classes, while acknowledging the superiority of their "betters," do so with reluctance and ambivalence. And in some instances some of the members of these classes deny outrightly that superiority. Ethically radical and politically revolutionary attitudes constitute the extreme form of denial of the claims of the "superior" to their superior status. (*See* FRIENDS, SOCIETY OF: *History*.)

The human mind finds inferiority hard to accept in unadulterated doses, and some persons find it harder to take than others. In the lower and middle classes there is often a tendency to deny the validity of the criteria by which the upper classes have enjoyed their superior status. For example, in 18th-century France there was a widespread denial by the mercantile and professional classes of the legitimacy of kinship connections and of heredity as a basis for deference, while they praised the criteria of occupational proficiency and personal merit such as honesty, diligence and intelligence. (This outlook was proclaimed by the constituent assembly of the French Revolution in the Declaration of the Rights of Man and Citizen, which declared "careers open to talent.") Ambivalence and resentment are widespread without, however, going so far as revolution—and even revolutionaries cannot completely expunge from their minds all the status criteria of the society they are revolting against, as is shown by the re-establishment of many of the prerevolutionary status patterns in the Soviet Union. Those whom the prevailing system of evaluation relegates to a lower status, even while sharing and acknowledging that status, simultaneously resent and deny it. The proportions of acknowledgment and denial vary among individuals and among societies, but it is safe to assert that it practically never approximates either extreme in any large society.

The imperfection in the integration of the class system is furthered by the limited range of attention and interest of a large proportion of the population. As a result, they do not participate as much in the larger class system as they do in their local class subsystem, comprising largely the persons with whom they have face-to-face contact.

Status System and Social Organization.—The conflict of classes is a reality of all large societies and cannot be eliminated. It is inevitable for the reasons given in the foregoing section. The lowly status is injurious to the sense of dignity of many persons, especially when it is reinforced by resentment against authority, however legitimate, and the desire for goods and services which cannot be acquired on the basis of income earned through the sale of services or goods in the market. The modern labour unions and employer's associations are responses to these facts. But even in societies in which labour unions are either not allowed or are shorn of the functions which they have developed in free societies, the conflict of classes persists, though it must operate through other institutions or even surreptitiously.

The conflict of classes is not always of constant intensity. It varies among societies and periods, and even at any one time in a given society only an extremely small proportion of the population will be much absorbed by the class conflict in its more active and organized form. (In the Bolshevik Revolution in St. Petersburg, only a few thousand persons were actively engaged.) Much of the population participates by assent, a much smaller number participates by the payment of dues to organizations which promise to bring advantages to the class or some sector of it, and a far smaller number plays an active part in the organization. Thus what the Marxists call "class consciousness," which would be more precisely called "aggressively alienated class identification," is a rather uncommon phenomenon, even in modern industrial societies. Normal class conflict is fully compatible with a high degree of responsible citizenship and a considerable measure of social order.

Tensions and misunderstanding among classes are in some large part linked also to variations in class culture. The fact of differential access to income, personal security and knowledge, which normally are correlated with status, affects the way in which people behave and think at different levels of the stratification system. Thus, in every country for which data exist, the poorer people are, the more likely they are to vote for the more left-wing political party, that group which most favours redistributing the benefits of society, using governmental powers to enhance the position of the lower economic classes. Similarly, groups whose social status is relatively low because of their ethnic or religious background tend to vote disproportionately for the more leftist parties. (*See* also VOTING BEHAVIOUR: *Influence of Social Status.*) Status is also correlated with participation in local political and other community activities. The lower-income and less-educated groups are much less likely to vote in elections or to belong to voluntary associations than are those more privileged along these status-linked lines. Status groups also tend to vary in religious affiliation. In countries with a number of denominations, it is possible to distinguish among them according to the relative social status of their members. Studies of the audience for different mass media indicate that newspapers, magazines, television or radio programs all tend to differ among themselves according to the status of their audience. Investigations of family behaviour patterns, such as the Kinsey studies of sexual behaviour, indicate large variations in type and extent of sexual practices in different classes, in the birth rates (on the whole the more privileged have smaller families though the difference is declining) and in the way in which infants are treated. Studies of mental illness suggest differences in the extent of such morbidities at various levels in the class structure. The lower-status groups have a much higher incidence of schizophrenia than the higher strata. There is no important area of behaviour in which it is not possible to find large statistical differences between levels up or down the class structure.

Class status and the individual's identification of himself in terms of a particular class status clearly play a permeative role in social life. Within the family, they affect parents' hopes for their children's future careers, spouses, friends and associates. They influence the extent to which a parent will exert himself to improve his economic lot so that the family will not only have more conveniences and amenities but so that it can also enjoy a higher status. It influences in large part the mother's decisions in the domestic economy and in the expenditure of income on various types of household articles. It affects the choice of place of residence and the choice of friends and associates. It is seldom the exclusive factor in such choices, but it is also seldom entirely absent. (*See* also STANDARD OF LIVING.)

Face-to-face relationships are of particular significance in the stratification system. It is in such relationships that individuals perceive their own status in the judgments of others. It is in such relationships that they can exhibit their own claims to the deference of others by acting, speaking and dressing in a certain manner. This is the reason why more discriminating and sensitive judgments are rendered about the nearby social environment than about those sectors of the society which are more remote. Yet considerations of class status do not overwhelm all other considerations in face-to-face relationships. The more human beings see of each other, the more they respond to each other as persons. They judge each other as persons worthy of being liked or disliked, of being loved or hated. Relationships which commence with status considerations foremost often develop into relationships in which personal affection or dislike becomes preponderant. Because personal relationships tend to begin in a situation of homogeneity in class status, friendships and marriages tend to fall within narrow ranges in class status. To the extent that they do not, they bring the classes rather closer together.

Face-to-face relationships, whether status or personal elements preponderate, play an important role in the status system as a whole. For those who are in the lower part of the status system, face-to-face relationships, usually with persons of approximately similar status, reduce the danger of denial of their status dignity out of resentment or contempt by those who are respectively lower or higher; while for those at the top of the status hierarchy, the tendency for like to associate with like confirms self-esteem and diminishes the danger of direct denial.

Thus, through the individual's sense of civic membership and his belief in its justice, and through his face-to-face relationships and his limited focus of attention, inequalities in class status, which are an inevitability of large, differentiated societies, are rendered more tolerable to the sense of individual dignity. Society tends to be maintained in a state of equilibrium among the classes although those lower in position always endeavour to improve their lot through individual or collective action. *See* CASTE (INDIAN); COMMUNISM; SOCIALISM; *see* also references under "Class, Social," in the Index volume.

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(E. A. Ss.; S. M. L.)

CLASSICAL EDUCATION. The teaching of Latin and Greek to enable pupils to read and use those languages is a discipline that has been handed down from the earliest times. The main justification for this lies in the intrinsic merit of the great humanitarian writers of the classical periods when the civilizations of Greece and Rome were at their peak. That these works have withstood the test of time is felt to be ample testimony to their worth. Moreover, as the civilization of western Europe has its roots in Greece and Rome, an understanding of origins is deemed to be a valuable preparation for the proper appreciation of modern problems. Many religious, political and social institutions had their birth in classical times. The ideas associated with their genesis were often presented with such striking clarity that they are eminently suitable for young minds.

But it is not only the literature that has its value. The directness and precision of the Latin and Greek languages, the orderly logic of Latin and the flexible beauty of Greek, impart a training in clear thought and expression that it would be difficult to surpass. The close and concentrated study of words the meaning of which must be clearly understood before they can be translated, where a facile rendering is fraught with danger, whether one is translating into or out of English, gives a constant practice in English comprehension and composition unequaled by similar exercises in modern languages. (T. W. M.)

In the discussion that follows, the subject is treated under the United States, England and Scotland, continental Europe, Latin America and the orient. While in the western world the expression "classical education" pertains to Latin and Greek studies, in the oriental world it is used to refer to the ancient traditions of learning of the various countries being discussed.

Related material and bibliographies will be found under Education, History of; Examinations; Secondary Education; Universities.

IN THE UNITED STATES

Classical education in the United States began with the founding of Harvard (*q.v.*) college and the Boston Latin school in about 1638. Following the English model (probably Cambridge), the only requirement for entrance to Harvard was the ability to read and speak Latin and some knowledge of Greek forms, and this was also the aim of the Latin school. All lectures were in Latin, the curriculum consisted almost wholly of the classics and students were required to speak Latin on the campus. The subsequent progress of classical education has been divided roughly into three periods: the prerevolutionary period, the period to the close of the Civil War and the modern period.

During the first period admission requirements remained much the same as at Harvard; even arithmetic was not required until 1693, and then not universally. In the colleges the classics remained supreme, although arithmetic, geography and anatomy were included in the curriculum of William and Mary in 1693, and physics in that of Yale in 1701. Also, the forerunner of the University of Pennsylvania, under the influence of Benjamin Franklin, made considerable provision for science, and an impressive program in science and history was announced by Columbia in 1754, which, however, was not adhered to.

The middle period was one of great educational expansion. Many new colleges and secondary schools were founded, and the states began to make provision for higher public education in the state universities. Public high schools also began to multiply. The curriculums of the colleges were greatly extended, and the appearance of new subjects in the requirements for entrance involved provision for them in the preparatory courses. At first Greek and Latin, later Latin alone, were obligatory on all candidates for degrees, and while in some academies, notably those for girls, and in the state universities, the tendency was to greater freedom, still the general tone of education was cultural, interpreted as classical. The modern period has been one of revolution, both in ideals and practices. The carrying out of the theory of universal education and the rapid growth of industrialism demanded greater provision for vocational and scientific training. The public high schools still clung closely to the classical tradition but they showed the new influence in the great broadening of their curriculum. Where this was not done, vocational and trade schools discarded the classics for a more immediately practical training. In higher education, either separate scientific and technical schools were established or increased provision was made for science in the colleges and universities, and modern languages and the social sciences vied with the natural sciences in pressing their claims.

Room for the new subjects could be obtained only at the expense of the classics. The first to be seriously affected was Greek, which, though vigorously defended, had by 1928 been eliminated almost entirely from the curriculum of the secondary schools and was studied by very few undergraduates in college. Latin also was severely curtailed and at one time seemed likely to go the way of Greek. Following World War I, however, there took place some reaction in favour of Latin in colleges; it did not continue to hold as large a place in the schools as formerly, although it was still included among the requirements for entrance to college. The number studying Latin dropped from 50% of students enrolled in 1900 to 7% by the 1950s. It is not, however, the Latin of former days. Under the attacks of the new psychology and the advocates of practical studies the teaching of Latin, which formerly had been largely a mechanical preparation for entrance examinations, was adapted rather to the immediate needs of the pupils studying it. In 1920 the General Education board arranged with the American Classical league to conduct an investigation of the classics (chiefly Latin) in the secondary schools. In the report, published in 1924, the aims of the teaching of Latin were set forth as follows: to read and understand Latin; to increase the pupil's ability to understand the Latin element in English, and to read, speak and write English; to develop historical and cultural background, correct mental habits and right attitudes toward social situations; to increase the ability to learn foreign languages; and to give an elementary knowledge of the principles of language structure. In the furtherance of these aims extensive recommendations were made as to curriculum and methods of instruction. These were very generally adopted and the textbooks were accordingly reconstructed to carry them out. The rapid increase in enrollments in the high schools in the decades following, however, changed their character and the future of Latin seemed precarious.

(G. L.; I. L. K.)

IN ENGLAND AND SCOTLAND

In England a classical education survived from the quadrivium and trivium of the ancient schoolmen (*see* Education, History of: *The Western World: The Renaissance*) with varying continuity. Greek was not always available, and the concentration on Latin grammar in the past might well have put an end to this form of education. In spite, however, of continual attacks from critics, up to the end of the 19th century the classics held pride of place in education, particularly in the public schools (*i.e.*, private schools) where tradition was not easily upset and where an empirical appreciation of their value caused them to be strongly entrenched. In Scotland, too, the classics have traditionally been strong and the study of Greek held in high esteem. Nevertheless as education became increasingly the responsibility of the state and the demand that education should be made to serve the state's economic interests became harder to resist, more time was being devoted to science and technology at the cost of the classics. The independence of the public and direct-grant schools afforded them greater immunity from this pressure than could be expected in schools maintained by local education authorities. Nevertheless, some enterprising teachers in state schools were striving successfully to keep alive, and even to inaugurate, classical courses.

Moreover, there are a number of bodies interested in keeping the classics alive. The Classical association (founded 1903) is pledged to secure that the classics shall occupy a prominent place in any system of public education. The association and also the Societies for the Promotion of Roman and Hellenic Studies, which cater more to specialists, keep the classics before the public eye. This they do by their journals, *Greece and Rome* (twice yearly, 1931–), *The Classical Review* (quarterly, 1887–), *The Classical Quarterly* (twice yearly, 1907–) and the *Proceedings* of each of the three societies, as well as by a triennial conference at Oxford or Cambridge at which British and foreign scholars lecture. The Classical association also holds an annual three-day conference at the universities. The Association for the Reform of Latin Teaching is particularly interested in methods of teaching Latin and Greek.

The Orbilian society publishes an interesting Latin newspaper, *Acta Diurna* (1946–), based on the events of 2,000 years ago, as well as charts, maps and other visual aids. The Virgil and Horatian societies exist to foster an interest in the works of those poets.

Organization of Classical Teaching.—Latin is begun in grammar schools at the age of 11 or 12 and pursued for a five- or four-year course to the age of 16 when the ordinary level of the general certificate of education is taken. In the first two years the work consists of the piecemeal mastery of the grammar, accidence and syntax, with exercises illustrating each fresh point in English and "synthetic" Latin. This Latin reading is usually made up to illustrate the life, history or legends of the Greeks and Romans. In the third year pupils are slowly introduced to the easier authors, such as Caesar and Ovid, and the simpler speeches of Cicero. At the ordinary level candidates are expected to show a reasonable proficiency in translating simple Latin into English and straightforward English into Latin. Greek is usually begun two years after Latin by a smaller number of boys. In the sixth form a two-year course leading to an advanced level comprises the reading of authors, translation at sight, prose composition, sometimes verse composition, and ancient history. Latin only may be taken as part of a group of arts subjects, or Latin, Greek and ancient history as the full classical course.

There are three methods of teaching Latin: the traditional, the direct and the Mason Gray method. The direct method relies on constant oral practice to teach constructions, with hardly any translation into English. The Mason Gray method uses extensive reading, ample commentary and, eschewing the slow analytical method of the traditionalists, recommends taking in whole Latin sentences at a time. In the main the traditional method prevails. The whole question of classical teaching was very comprehensively treated in the handbook issued by the Incorporated Association of Assistant Masters, *The Teaching of Classics* (1954). Refresher courses for teachers, at which methods of teaching are demonstrated, are frequently organized by the societies already mentioned. Pronunciation of Latin is a fiercely controversial question, but there is real concern, whatever the pronunciation, that the recitation of Latin and Greek should be encouraged, to which end the Classical association, helped by the Virgil and Horatian societies, organizes reading competitions for school children throughout the country.

Classics at the universities—the number of graduates in classics at Oxford and Cambridge roughly equaled those in the final honour schools of all the other universities—were still fairly strong by the latter half of the 20th century. The honours examinations, "greats" at Oxford and the classical tripos at Cambridge, contributed the largest number of successful candidates in the administrative branch of the civil service. Many business firms were anxious to have as trainees graduates with a good grounding in classics, and this, too, has given support to the teaching of classics.

IN CONTINENTAL EUROPE

It is difficult to generalize about classical education in continental Europe, with its various educational systems. In general the pure classical course had been retained into the second half of the 20th century for those taking Latin and Greek up to university standard, and Latin was still considered important or obligatory where modern languages or other humanities were studied. A universal Latin requirement had, however, given way before the demands of science and other modern subjects.

In France, after the first two years, in which a pupil might or might not take Latin according to his aptitude, a choice of four courses lay open to him, all leading to the *baccalauréat*. Latin was associated with three of these courses: the full classical course; the modern course with Latin and two modern subjects; and the science or mathematical course with Latin. A prognostic year to select pupils for Latin proved unpopular and was dropped. In spite of the encroachments of science, parents were generally ambitious for their children to take Latin.

In Germany schools of the type known as the classical *Gymnasium*, where emphasis is on Latin, Greek and one modern language, were less frequent than formerly. The *Realgymnasium*, however, the commonest form of secondary school, included a course of Latin, and an opportunity for studying Latin was provided in the *Aufbauschule*, schools for country children with no secondary school within reach. Again, it may be said that while classics were not so strong as in the 19th century, ancient languages still represented a considerable element in German education.

In the Netherlands the classics flourished. Latin and Greek were still compulsory at the university for students of law, letters, history and theology. In the *Gymnasium* there was a six-year Latin and five-year Greek course, while in the *Lyceum* Latin and Greek were studied in the last four years. In both types of school there was a bifurcation of pupils into the A-certificate stream with more, or the B-certificate stream with less, classics, the latter being one method of being admitted to a science course at the university. The classical course at the *Lyceum*, being shorter, was much more intensive. The position in Belgium was not dissimilar. Greek and Latin were taught in all secondary schools, but with most emphasis in the *athénées royaux*. Greek and Latin were considered to be the structural element in the *humanités anciennes*, between which two groups a "finishing" student must necessarily choose before embarking on an advanced course.

In Norway and Sweden the classics had lost some ground. Few school children took Greek in Norway, where it was alternative to English. There was one Latin stream in the grammar schools, and no Latin requirement for modern languages or science, although it was compulsory at the university for arts, medical and theological students. Classics in Sweden had not recovered the position they lost after World War I.

In Italy children leaving elementary schools to go to the *scuola media* (*i.e.*, those not going to trade schools) studied Latin for three years. They then proceeded to one of four types of school: the *liceo classico*, where Latin and Greek were studied for five years; the *liceo scientifico*, with Latin for five years; the *istituto magistrale*, for prospective elementary schoolteachers, with four years of Latin; or the *istituti tecnico-commerciale*, without Latin. By the mid-20th century it had been suggested that Latin be removed from part of the *scuola media*. Public opinion favoured something more useful; but there was likely to be considerable opposition to the project.

Classical teaching on the continent tends to be more formal and more regulated than in Great Britain. *Lecture expliquée* seems a favoured method, and translation from the national language into Latin almost completely abandoned. (T. W. M.)

IN LATIN AMERICA

In Latin-American countries less attention is given to the study of classical languages than in other countries whose culture is derived from the classical heritage. In the first place, secondary schools in most Latin-American countries were established at a time of reaction against schools maintained by the teaching orders which had emphasized the classical basis in secondary education. Second, universities have consisted in the main of loosely associated faculties for professional preparation and were only just beginning, at mid-20th century, to permit the study of liberal arts subjects, either in existing faculties of philosophy as in Buenos Aires, or in more recently created faculties elsewhere. In these, provision had been made for the study of Latin and Greek. Third, the secondary-school curriculum had developed by an accretion of subjects and, unlike the European countries and the United States, little provision had been made for options or for differentiated courses. Consequently, when the list of subjects to be carried became too burdensome, a solution was found by dropping those subjects, especially Latin, which the pupils found too difficult and the utility of which was not recognized by the parents.

The situation in general may be illustrated from the practices of some of the leading Spanish American countries. In Argentina a movement to make Latin an optional subject began as early as 1870 and was realized in 1886; in 1891 proposals began to be made to drop it and by 1901 it disappeared entirely except in three schools that enjoy special privileges of autonomy. Greek had disappeared as early as 1863. In Chile Latin ceased to be required for graduation from a secondary school in 1877 and gradually disappeared. In 1925 an inquiry elicited the opinion that room should be found in certain schools for the study of Latin with or without Greek. It is significant, however, that all students in the Instituto Pedagogico, the institution for training secondary-school teachers, had to take Latin if they wished to become specialists in Spanish or any modern foreign language. In Uruguay Latin grammar was taught in the first two years of the secondary-school course in 1889 but was dropped in 1909. Latin was required in Mexico for entrance to the law faculty of the university; classical roots replaced Latin in other schools.

In Brazil, Latin, long required for four years, was no longer required of students taking the scientific option, the majority. Greek was studied in a small number of schools where the full classical course was offered.

The secondary-school situation was reflected in the universities, where specialization in classical studies is unusual. But courses were offered in Latin or Greek by a small number of professors at the universities of Buenos Aires and La Plata in Argentina, in the Instituto Pedagogico of the University of Chile and in the University of Concepción in Chile, and in the private Colegio Mayor de Nuestra Señora del Rosario in Colombia. Latin, if not Greek, was still cultivated by the ecclesiastical orders and it was under the direction of their members that those interested in the classics could pursue their studies beyond the level of the secondary schools. (I. L. K.)

IN THE ORIENT

India.—In ancient India education was a means to spiritual salvation, and its purpose was both to train one in *dharma* (the principles of moral and ethical living) and to gain intuition of truth and experience of Brahman (reality), thereby attaining *moksha* ("spiritual liberation"). Knowledge of the *Vedas* (*see* INDIAN PHILOSOPHY) was the basis of the educational system, entailing mastery of pronunciation, metre, grammar, etymology, rituals and astronomy. The student at about the age of 12 years went through a ceremony of initiation and went to live with his teacher. Manual tasks and begging for alms were part of his training, the most important moral factor of which was celibacy. Thus he was prepared for his life as a householder, a retired contemplative and a homeless renouncer of ordinary life. Members of the three higher castes were entitled to study the *Vedas*, though only Brahmins could perform sacrifices. Mere book learning was regarded as a waste of time: the student had to hear the truth as spoken by the teacher, deliberate on it to clear possible doubts and then meditate on it, as a result of which he intuited the truth.

In ages later than those of the *Vedas* and the *Upanishads*, much attention was paid to the training of students in the moral and religious duties of the householder, and the six systems of Hindu philosophy and also literary works were studied. Although modern schools tended to follow western systems, the traditional pattern of education remained current and instruction was oral.

Buddhist Education.—The teaching of the Buddha as recorded in the Pali canon was meant for people who renounced the world and ordinary life to seek *nirvana* (the uprooting of desire for existence). The subjects taught at the Buddhist monasteries were *Suttanta, Abhidhamma* and *Vinaya* (texts relating to the doctrines, their philosophical interpretation and the discipline of the monks). As Buddhist philosophy developed, other subjects such as logic and the various systems of Indian philosophy were also included in the curriculum. On attaining moral excellence, purity of intellect and sufficient understanding of the teaching, the monks were instructed in the methods of meditation leading on to the supreme knowledge that nothing had an intrinsic nature of its own and that everything was in ceaseless flux. (*See* BUDDHISM; GAUTAMA BUDDHA.)

Monks also educated the lay followers of the Buddha in the essentials of morality and the way shown by the master; sometimes they instructed the laity in medicine and other professional crafts.

China.—The Confucian teachings were the bases of Chinese classical education, whose aim was not so much the acquisition of knowledge as the formation of the character and virtues of a good citizen, the ideal state being freedom from bigotry and arrogance. The main idea of the Confucian philosophy of government was that each person has an appointed place in the society and that good government depends on maintaining the right relationships between the people in a community and the universe around them. Since this theory was largely accepted by the rulers, it became necessary for the administrators to study it and its philosophical background, and the emperor Wu began a system of examinations for the selection of administrators who were experts in the famous five (or six) classics (*see* CHINESE LITERATURE). Entry into the civil service was the way to economic prosperity and social prestige, and all males except the sons of actors, harlots and policemen could compete. There were three examinations, the last of which was so difficult that few passed it, but even those who failed became acquainted with the classics and spread their knowledge among the population. The civil service examinations were terminated in 1905 and, although the classics continued to be studied afterward, they were no longer held in the same respect.

Four other books greatly influenced Chinese education and the formation of the Chinese character: *Ta Hsüeh* ("Great Learning"), *Chung Yung* ("Happy Mean"), the *Lun Yü* ("Analects") and *Meng Tzu* ("Mencius"). It should be noted that the classics of Buddhism, which spread to China early in the Christian era, exerted great influence and, though not part of the state educational system, were assiduously studied by both monks and laymen of culture.

Japan.—Confucianism and Buddhism shaped Japanese culture. Shintoism contributed little, for it developed from a primitive native cult and had no deep metaphysical and ethical background. With the introduction of the "Analects" of Confucius and the *Thousand Character Classic* from Korea in the 3rd century A.D., Japan began to be civilized and the nobility started to model itself on the Chinese social hierarchy. In the early Heian period, the classics held the chief place in the university curriculum. Between the middle of the 7th century, when attempts were made to organize everything on Chinese lines, and the end of the 13th, civil war between feudal lords and the assumption of power by the military class caused a decline in learning, but the study of classics remained the basis of education. During the Tokugawa period the neo-Confucian philosophy of Chu Hsi and Wang Yang Ming was officially sponsored and very popular, and the 11th shogun founded the Institution of Lectures on the Japanese classics. As a result of widespread educational reforms in 1872, the study of the classics was considered a hindrance to civilization, *i.e.*, western ways of thought and life, but by the turn of the century ideas of filial piety and loyalty, legacies of the Chinese teachings, were again officially declared the cornerstone of Japanese morality and again the classics assumed importance. After World War II, however, this situation changed. (*See* JAPAN: *Education.*)

Buddhism was introduced into Japan in A.D. 552 from Korea and enjoyed the patronage of the imperial family and the military rulers. In the same way many Chinese Buddhist sects spread to Japan and their basic texts were studied by both monks and laymen.

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CLASSICAL SCHOLARSHIP, the study, in all its aspects, of the civilization of ancient Greece and Rome. Its province in time is the period about 1500 B.C.–A.D. 500; in space that area covered by the conquests and spheres of influence of Greece and Rome at their widest extent. The following is a historical account of classical scholarship from antiquity to modern times. *See* also biographies of most of the scholars discussed in this article.

Antiquity and The Middle Ages.—Down to the Renaissance, Greek and Latin scholarship tended to pursue independent courses (though the latter was in antiquity heavily influenced by the former): it is therefore convenient to consider them separately.

Greek Scholarship.—From at least as early as the 6th century B.C. the exposition of the poets formed the staple element of Greek education. The sophists of the 5th century were accustomed to explain the poets: some of them took an interest in etymology, phonetics, the correct meaning of words and the classification of the parts of speech. Plato shared their interest in literary criticism and in grammar; but both subjects were more systematically treated by Aristotle. His pupils collected great quantities of information about the early poets, little of which has survived. During the Hellenistic age scholarship flourished at the two great centres of Alexandria and Pergamum. It was a Peripatetic. Demetrius Phalereus (fl. 300 B.C.), who impelled Ptolemy I to found the great library at Alexandria. The Pergamene school stood in a close relationship to the Stoic philosophy. The grammarians of the school, influenced by the grammatical studies of the Stoics, notably Zeno and Chrysippus, upheld anomaly as the leading principle in grammar against the Alexandrian advocacy of analogy. At Alexandria the chief emphasis was on literary scholarship. From the time of Philetas and his pupil Zenodotus, the first librarian, the Alexandrian scholars concerned themselves with the interpretation (*glossae*) of the rare words in early poetry. The generation of Zenodotus sorted and classified those authors whose works could be obtained; the poet Callimachus drew up lists of the chief authors, with biographical and bibliographical information, in the 120 volumes of his *Pinakes*. Zenodotus classified the epic and lyric poets, Lycophron the comedians, and Alexander Aetolus the tragedians. Manuscripts of the poets were collected, and the first critical editions, complete with variant readings and critical signs, were produced; also the first commentaries. Dictionaries were compiled, including special lexicons of particular authors or dialects; and all kinds of information about literature was amassed in a variety of separate treatises, as can be seen, for example, in the work of two of the librarians, Aristophanes of Byzantium and his pupil Aristarchus of Samothrace. Eratosthenes of Alexandria laid the foundations of ancient chronology, and Apollodorus of Athens carried the work further. During the last century B.C. the learned compiler Didymus Chalcenterus packed the accumulated erudition of his predecessors into immense lexicographical works and extensive commentaries. Dionysius Thrax produced the first Greek grammar, and Tryphon (a younger contemporary) the first vocabulary of the language of prose and the first work on syntax. Tryphon's researches were no doubt prompted by the demand for manuals of correct Attic usage that resulted from the Atticist revival, whose effects can be discerned from the 1st century B.C. on. Apollonius Dyscolus, writing probably under Hadrian, produced a detailed treatment of syntax that acquired great authority, and his son Aelius Herodianus the standard treaties on accentuation. But the age of the Antonines saw the beginning of decline. Scholarship was increasingly dominated by the needs of rhetoric, and more and more of the chief authors dropped out of circulation, surviving only in selections made for use in schools. All over the eastern half of the Roman empire the Greek classics continued to be read; but such scholarly work as was done became increasingly mechanical. During the 7th century the Arab conquest cut off from Greek civilization Syria, Palestine and Egypt; and soon afterward the disastrous effects of the controversy over the use of icons led to the dark age of literature in the Byzantine empire, which lasted until the 9th century.

The 9th century saw a revival of interest in classical literature under the patronage of princes of the church like the patriarch Photius and Arethas, archbishop of Cappadocian Caesarea. These men collected the surviving manuscripts and caused them to be copied; for the purpose of rapid reproduction the Byzantine minuscule script was evolved (*see* PALEOGRAPHY) and critical signs were introduced.

Anthologies of prose and poetry, and lexicons, etymologies and other learned compilations were produced. In the 11th century Platonism was revived by Michael Psellus, the statesman and scholar, and Aristotle continued to be studied. During the 12th century Eustathius, archbishop of Thessalonica, one of the greatest Greek scholars of the middle ages, produced a commentary on Homer of great learning, and made some excellent conjectures in the text of Athenaeus. The sack of Constantinople during the fourth crusade (1204) brought the first period in the history of classical literature at Byzantium to an end. After the recovery of the empire about the middle of the century, classical studies were carried on no longer by the rich and famous, but by a restricted circle of poor scholars. The monk Maximus Planudes was responsible for many learned compilations, and for a remarkable series of Greek prose translations of Latin writers; Thomas (Magister) and Manuel Moschopoulos about 1300 and Demetrius Triclinius a generation later practised textual criticism on the Greek poets, not without success. During the 15th century learned Greeks like Manuel Chrysoloras and Demetrius Chalcondyles began to make their way to Italy, where they gave instruction in their language; and after the sack of Constantinople in 1453 the number of Greek immigrants increased.

Latin Scholarship.—Roman scholarship from the first imitated Greek: Alexandrian techniques were applied to the editing of Latin texts, and the categories and nomenclature of Latin grammar followed Greek models. Many of its characteristics can be traced back to M. Terentius Varro, the great polymath who left his mark on almost every branch of study. The early empire was the period of the greatest prosperity in scholarship as in other things, the era of commentators such as C. Julius Hyginus, Palatine librarian, and Q. Asconius Pedianus; of editors such as M. Valerius Probus; of grammarians such as M. Verrius Flaccus and C. Suetonius Tranquillus; and of Pliny the Elder, whose encyclopaedic *Naturalis Historia* was a major source book for the middle ages. The 3rd century A.D. was a time of troubles and was unpropitious for learning; and the scholars of the 4th and 5th centuries, such as Nonius Marcellus, Aelius Donatus, Servius and Priscian were a race of epitomators and compilers living on inherited capital. The study of Greek in the west was declining; and the earlier literature of Rome was threatened with extinction. The domination of rhetoric over education and literature (*cf.* Quintilian's *Institutio oratoria*) favoured a few authors: Virgil, Horace and Terence enjoyed the protection of critics and commentators, while Quintus Ennius and Gaius Lucilius, being left to shift for themselves, disappeared except for the fragments preserved in quotations. During this period the book in the form of the vellum or parchment codex was superseding the papyrus roll, and an author deemed unworthy of the trouble of recopying was doomed to oblivion.

The partition of the western empire into separate kingdoms did not entail a complete breach with the past. The invaders desired civilization on the Roman model, and Latin continued to be the language of literature and the church. Rich and ancient libraries still survived. In the schools, always conservative, the study of pagan literature continued. Enlightened churchmen perceived that through the profane classics lay the only road to higher learning. But interest in classical antiquity for its own sake was no part of the scheme of things; classical texts were copied, directly or indirectly, in the service of the church. In the 6th century Cassiodorus enjoined on his monks the copying of books at Vivarium and laid down strict rules for the conduct of the scriptorium. In the 8th century the emperor Charlemagne, working through men such as Alcuin, instituted a program of church reform which was attended by a revival of interest in classical literature, and during this so-called "Carolingian renaissance" many authors were recopied from manuscripts now lost in the clear hand from which our Roman type descends. Servatus Lupus is the nearest approach to a humanist scholar that the middle ages can offer. Throughout the medieval period the range of ancient authors generally and closely studied was limited; the chief source books for general knowledge of antiquity, besides Pliny, were compilations like the *Origines* of Isidore of Seville. Some Latin translations of Plato and Aristotle were available, but Greek was for the most part unknown.

The Revival of Learning.—The "revival of learning" which took place in Italy during the 14th and 15th centuries was only one aspect of the complex phenomenon of the Renaissance (*q.v.*). It must be stressed that in its origins the movement was utilitarian: it aimed at exploiting classical antiquity in the service of modern man. The early humanists were not scholars in the strict sense of the word, but literati and educationists. Their interest lay in the glorious past of Rome and Italy and the lessons that it had to offer the present; though Greek manuscripts and Greek professors were entering Italy well before the fall of Constantinople in 1453—indeed it is probable that by that date all that survived of Greek literature had been saved from the advance of the Turk—the advanced study of Greek made no real headway until the 16th century. In this connection the great plan of Pope Nicholas V for translating the chief Greek prose writers into Latin is significant. Nor was the invention of printing an effective agent in the revival, for by 1470, when the Latin *editiones principes* were issuing from the press, the Renaissance had spent itself. But the humanists were active in unearthing the buried ore which succeeding centuries were to refine. Sporadic local discoveries of forgotten authors or works had occurred throughout the middle ages; now they were made in scores by Poggio and his contemporaries, and the hundreds of humanistic manuscripts in Italian libraries bear witness to their prompt dissemination. At the same time the material remains of Roman civilization, which appealed directly to Italian sentiment and pride, received attention. Cyriacus of Ancona, "the Schliemann of his time," even traveled to Greece in search of inscriptions, and Flavio Biondo instituted the study of Roman topography. Professional standards of scholarship begin to appear in the work of two men. Lorenzo Valla had the historical sense of the true critic. His exposure of the so-called "donation of Constantine" (*q.v.*) as a forgery marks him as a forerunner of Richard Bentley. A good Latin style was then esteemed as a passport to an official career; but Valla's *De Elegantiis*, on Latin usage, is a book which professional Latinists may still consult with profit. It is a work of scholarship and exact observation, appealing over the head of Priscian to the ancient authors. Politian, contrasted with J. J. Scaliger or Isaac Casaubon, appears a dilettante; nevertheless, though his scholarly production was small he set a hitherto unknown standard of attainment in pure scholarship. He demonstrated the only solid foundation for the critic: a certain feeling for style, based not merely on taste, but on observation and practice in the ancient languages.

The Growth of Scholarship (1500–1800).—By the beginning of the 16th century the "new learning" had been established in the countries north of the Alps by men like Thomas Linacre, William Grocyn, Rodolphus Agricola and Johann Reuchlin, and above all by Erasmus. From about 1500 begins a gradual exploration, growing ever more exact and scientific, of classical antiquity, primarily through the literary sources, but increasingly aided by ancillary disciplines such as archaeology, epigraphy and numismatics. It was now that the printing press came into its own. Though by 1500 most of the major Latin authors were in print (of Greek, by contrast, a mere handful), the standard of editing did not match the splendour of the typography, and the manuscript still enjoyed a cachet lacking to the printed book. In 1500 Aldus Manutius, the first of the great scholar-printers, changed the face of scholarship and of publishing by the foundation of his "Neacademia," dedicated among other things to the issue of large cheap editions of the Greek and Latin classics. Scholars corrected his proofs; Erasmus himself saw the second edition of his *Adagia* through the press. Aldus was imitated by Johann Froben and Sebastian Gryphius. Successive improvements in the technique of editing and book production during the 16th century converted the printed book from an expensive facsimile of a medieval manuscript to a working tool.

In the 16th century Italy can boast a number of notable antiquaries and one great critic, Pietro Vettori (Petrus Victorius); but though the French conceded Italian supremacy in Latin studies they justly claimed the primacy in Greek. Guillaume Budé, the great jurist, laid the foundations; in the next generation Denis Lambin (Lambinus) did valuable work on Cicero, Lucretius and Horace. Jean Dorat, called Auratus, and Adrien Turnebus did pioneer work in the study of Greek poetry, and inspired such poets of their own time as Pierre de Ronsard and Joachim du Bellay with admiration for Greek literature. The great printer Robert Estienne printed the first critical edition of the Greek New Testament (1550) and many other learned publications; his son Henri excelled him with a whole series of important editions including many *editiones principes* of Greek authors, mostly edited by himself, and a Greek *Thesaurus*, also his own work and not in its original form superseded until the early 19th century. Two men, J. J. Scaliger and Isaac Casaubon, demand especial notice. Scaliger, like Erasmus, saw that classical learning should be a unity. The diversity of his works is not that of the dilettante but of the explorer: each separate edition opened up a new path, that of Festus to old Latin, that of Manilius to ancient astronomy. He assisted Janus Gruter (1560–1627) by compiling the indices to his great *corpus* of inscriptions, *Inscriptiones antiquae totius orbis Romani*, and encouraged the collection of the dispersed fragments of classical literature. His greatest achievement was to bring order into the chaos of ancient chronology in the *De emendatione temporum* and the *Thesaurus temporum*. Contrasted with Scaliger's outstanding historical sense and power of divination is Casaubon's sheer erudition. He too perceived that antiquity must be studied as a whole, also—and this too Erasmus understood—that the study must begin from Greek. His published work, small in proportion to his learning, was soon absorbed into the common stock of knowledge, but his example was instrumental in turning scholarship into a science. "Philology had meant composition and verbal emendation; it now meant the apprehension of the ideas and usages of the ancient world" (Mark Pattison).

Both Scaliger and Casaubon were Huguenots; both ended their days abroad. Scaliger's migration to Leiden in 1593 is symbolic. As scholarship declined in 17th-century France (where the series of the Delphin classics marks the summit of strictly classical achievement), so it flourished in the Netherlands: this was the century of G. J. Vossius, J. G. Graevius, C. Salmasius and Hugo Grotius. The best work was done in Latin: Nicolaus Heinsius possessed a sense of Latin poetic style (based on assiduous composition) which has never been surpassed, and his series of editions, founded on extensive study of the manuscripts, earned him the title of "saviour of the Latin poets." His prose counterpart was J. F. Gronovius. Their letters testify to the same ample conception of classical studies that animated Scaliger and Casaubon; but by the beginning of the 18th century stagnation had set in. Unwieldy variorum editions, uncritically compiled, dominated the scene, and the study of antiquities, divorced from both linguistic scholarship and modern science, degenerated into the mere amassing of facts.

Little had been heard for a century and more of English classical scholarship: once the study of Greek was firmly established there had set in the persistent English preoccupation with education. John Selden, author of *De diis Syris* (1617), is the most notable of a small number of exceptions, and he was not an academic. In 1691 Richard Bentley inaugurated a new era by the publication of his *Epistola ad Millium*. Bentley possessed many of Scaliger's gifts and others besides. As with Scaliger, everything he did showed the way for his successors: his handling of the fragments of Callimachus, his unearthing of literary gold from the dust heaps of antiquity, his discovery of the digamma in Homer—which not even F. A. Wolf credited—his establishment of the metres of Terence, all were seminal and exemplary. The *Dissertation on the Epistles of Phalaris* (2nd ed., 1699) would be a monument of wasted labour if its only effect had been to disprove the authenticity of the letters; as an example of critical method it will be coeval with classical scholarship. Bentley projected far more than he could ever perform, and nobody until K. K. F. W. Lachmann fully appreciated his merits. It is particularly regrettable that his promised edition of the New Testament was abandoned, for though he oversimplified the problems he saw, as no critic for a century was to see, that the so-called "received text" must be jettisoned and the text totally reconstituted from the best authorities. An edition on such lines would have had a startling effect on the criticism of secular texts. Bentley was an isolated phenomenon: he had no disciples and founded no school. After his death the sphere of Greek studies in England contracted: Richard Porson was the best known, if not necessarily the best, of a number of scholars who made the Attic writers their province. Exact observation of usage lay behind his emendations and his few editions; the early *Letters to Archdeacon Travis* (1790), a masterpiece of wit and polemic, are an index of a promise that never fully blossomed in performance. The real strength of English scholarship at this period perhaps lay elsewhere, in the colossal achievement of the historian Edward Gibbon, the originality of Robert Wood, the first (apart perhaps from Giambattista Vico) to realize that there was more to Homer than words on a printed page; and the beginnings of Greek archaeology in the publications of the Society of Dilettanti (founded 1733), especially James Stuart and Nicholas Revett's *Antiquities of Athens* (1762–1816). In 1786 Sir William Jones began the study of Sanskrit which laid the foundations of comparative philology.

In the Netherlands, where Bentley's merits had received instant recognition, a remarkable series of Leiden professors, T. Hemsterhuis, L. K. Valckenaer, D. Ruhnken, D. A. Wyttenbach and C. G. Cobet, continued to advance the strictly philological side of Greek learning. Everywhere during this period great technical advances were made. J. A. Fabricius laid the foundations of classical bibliography. The great libraries founded by Renaissance potentates formed ever-growing repositories of material, which books such as Bandini's catalogues of the Laurentian manuscripts (1764–78) were now making available to the world. Dictionaries improved: in Greek, revisions of Henri Estienne's *Thesaurus graecae linguae* held (and hold) the field, but in Latin E. Forcellini's *Lexicon* (1771) superseded Robert Estienne's *Thesaurus*. Numismatics grew under the hands of Ezechiel Spanheim and J. H. Eckhel. Jean Mabillon, followed by Scipione Maffei, established Latin palaeography as a science; and what they did for Latin, B. de Montfaucon did for Greek. Now at last criteria were available for the accurate dating of manuscripts and systematic recension of classical texts could begin. In archaeology the 18th century saw the beginnings of excavations in the buried cities of Herculaneum and Pompeii, and of the exploration of the remains of Etruscan civilization. In history "source-criticism" (*Quellenkritik*) begins in the work of B. G. Niebuhr. But technical progress was not enough. A new spirit was needed to arouse classical studies to take their place in the modern world, and it came from Germany.

The so-called "new humanism" that transfigured German intellectual life in the late 18th century was complex, acting through scholarship, education, philosophy and literature. Educationally a leading part was played by the University of Göttingen, where J. M. Gesner, the inventor of the seminar, and C. G. Heyne introduced a new approach, an attempt to understand and enter into the spirit of the past, as displayed not only in its literary but also in its artistic monuments. J. J. Winckelmann first attempted to isolate and describe what was essentially Hellenic in Greek art and to relate the development of art in antiquity to the rest of its culture. Winckelmann's lead was followed by G. E. Lessing, and the new Hellenism spread through such men as J. G. von Herder, Goethe, the von Schlegel brothers and W. von Humboldt. The modern era in scholarship may be taken to begin with the remarkable career of F. A. Wolf, author of the *Prolegomena ad Homerum* (1795) and first founder of a classical journal in the vernacular, who defined the "science of antiquity" (*Altertumswissenschaft*), in terms still valid, as the "knowledge of man in antiquity," and mapped out its constituent disciplines.

The 19th Century.—This was the period during which, in the words of Ulrich von Wilamowitz-Moellendorff, "the scientific conquest of antiquity was completed." New techniques of study were perfected, large new finds of material were made, and above all with the emergence of scientific archaeology began the systematic uncovering and recording of the most important sites and monuments of the ancient world. As classical studies expanded they tended to become "compartmentalized": by the end of the century the traditional "scholar," deeply versed in the polite literature of the ancients but usually in very little else, had been replaced by the figure of the highly (and sometimes narrowly) trained specialist. Important advances were made, however, as a result of fruitful interaction between separate disciplines within the classical field and between the classics and other branches of study; but the science of antiquity as defined by Wolf, whose conception of classical studies dominates the scene from now on, was too vast a field for an individual to master. Some few men, of whom Wilamowitz was perhaps the greatest, have nevertheless managed to see classical studies as a whole; and this ideal, however impossible of realization, must continue to inspire workers in the field if the subject is to maintain its unity and meaning.

During the 19th and 20th centuries the multitude of active and important classical scholars is so vast that it must suffice to mention only a comparatively few of the more prominent names and trends.

In Greek literary scholarship the greatest figure of the generation after Wolf was G. Hermann, who applied a critical method based on a strict Kantian logic to the study of Homer, Pindar, tragedy and late epic, and laid the foundations of the modern study of Greek metre. In his youth Hermann had crossed swords with Porson; but as he outlived, so he outshone, his English rival, and his pupils included C. A. Lobeck, F. W. Ritschl, T. Bergk and M. Haupt. Hermann's pursuit of verbal criticism and his insistence on the central importance of literary studies brought him into conflict with men more representative of the tendencies of the time and the increasing interest in a historical criticism which embraced mythology and religion, institutions and social studies, art and monuments, as well as literary texts. The most notable representatives of this school were A. Boeckh, who, apart from his important work on poetry, made great contributions to the study of Greek public economy and chronology, and began the systematic collection of Greek inscriptions; K. O. Müller, a pioneer of the study of Greek and Roman origins and mythology, and the author of an important history of Greek literature; and F. G. Welcker, who applied a wide knowledge of Greek art and religion to the interpretation of Greek literature, and did as much as any man to shape the new wide conception of classical scholarship which was maturing at this time. The comparative study of language inaugurated by F. Bopp, though at first regarded with mistrust by scholars like Hermann, gradually revolutionized the philology of the ancient languages. In the realm of Latin literary scholarship the most important name is that of F. W. Ritschl, who laid the foundations of the modern knowledge of early Latin in general and of Plautus in particular, and whose pupils included O. Ribbeck.

Knowledge of ancient literature must always rest on the standard of editing and criticism of the extant Latin and Greek texts, which have come down from antiquity in a corrupt and sometimes mutilated state. In the early years of the century important advances were made in this vital department of classical studies. Cardinal A. Mai published a number of hitherto unknown Latin and Greek texts from newly discovered palimpsests, including a large part of Cicero's *De republica*. The French Revolution and the Napoleonic conquests had resulted in a vast body of formerly unknown or inaccessible manuscript material, particularly Greek, being acquired by public collections in European capitals, especially Paris. These treasures were exploited by Wolf's pupil I. Bekker, an admirable Hellenist, who besides editing many previously unknown Greek texts, was able by the aid of superior and older manuscripts to produce better editions of standard classical authors than those then current: his editions amount to nearly 100 volumes. But the formulation of a technique of systematic recension, *i.e.*, analysis and evaluation of a manuscript tradition, was left to be achieved by the genius of K. Lachmann, whose edition of Lucretius (1850) is still, as Wilamowitz-Moellendorff observed, the critical primer. Lachmann's work was seconded and extended by M. Haupt and by the Danish Latinist and critic J. N. Madvig, whose editions and miscellaneous critical writings are standard works of reference to this day. Unfortunately the methods of these men were taken up and applied with exaggerated and unreflecting rigour by less naturally gifted scholars, with the result that work in this department of scholarship came to be distinguished in certain quarters by a blind confidence in "scientific method" needing no intelligence in its handling, which has proved a will-o'-the-wisp still having power to mislead. Madvig had realized the importance, restressed by enlightened scholarship today, of allowing for inequalities and anomalies in the style of individual authors; but these warnings were lost on those who, in the exuberant confidence of their powers, proceeded to wholesale athetization, such as Ribbeck's condemnation *en bloc* of the later satires of Juvenal, on a scale unknown since J. Hardouin. It was this rigid insistence on analogical methods of criticism which marred the achievements of the great Dutch critic C. G. Cobet and set a bad example to lesser aspirants.

The second part of the 19th century was a period of great collective and individual enterprises, which have equipped the modern scholar with many of his most essential tools, in the shape of collections of fragments, of inscriptions, of papyri and of works of art; and of reference books such as catalogues of manuscripts, dictionaries, handbooks and encyclopaedias. Among technical advances it is pertinent to mention here the increasing part played by photography, both in making facsimiles of manuscripts and documents available to scholars, and in enabling the accurate publication of monuments and works of art. Individual achievements were the collections of fragments of the Greek comic poets by A. Meineke; of the fragments of the Greek tragic poets by A. Nauck; of the fragments of the Latin dramatists by O. Ribbeck; of the Greek dramatists by K. W. Dindorf, editor of many other important texts; and of the Latin grammarians by H. Keil. Collective projects are the great *Thesaurus linguae Latinae* (1900 *et seq.*), the definitive Latin dictionary; Pauly-Wissowa's monumental *Real-Encyclopädie* (1839–) of the ancient world; Iwan Müller's handbook of antiquity, an indispensable series of histories and monographs; and the great epigraphic collections. Prominent in such enterprises, particularly in the *Corpus inscriptionum Latinarum*, of which he was the begetter, was T. Mommsen, who, starting from the field of Roman private law, made immense contributions to Roman history, literature, epigraphy, and every branch of Roman studies. A position in the world of Greek studies almost comparable to that of Mommsen in Roman studies was achieved by his son-in-law, Wilamowitz, who like him broke down the barriers between the different branches of the subject and made outstanding contributions to all. The narrower tradition of Hermann was maintained by the great grammarian and textual critic F. Blass. The great Greek histories of G. Busolt and K. J. Beloch, and the history of the ancient world of E. Meyer incorporated the results of immense research. E. Zeller and H. Diels did valuable work on Greek philosophy, and the new study of comparative religion had an important effect on Greek studies, as can be seen in the work of H. Usener and E. Rohde. In Latin studies the most notable names during this period are those of J. Vahlen and F. Leo; and great advances were made in Latin palaeography and the history of the transmission of Latin texts by L. Traube and his pupils. In the realm of archaeology the most remarkable impetus was given by an amateur, H. Schliemann, who excavated Troy, Mycenae and Tiryns; from about 1880 onward the exploration of important Roman, Greek and near eastern sites was intensified and the chronology of preclassical Greek history and of the earlier neighbouring civilizations of Crete and Mycenae was established. In this process American schools and scholars played a fruitful and increasing part.

A development particularly associated with Germany is the movement toward what may be termed "professionalism" in classical scholarship during the second half of the century. This manifested itself in a number of ways. Though Wolf's example in founding a classical periodical conducted in the vernacular had been followed elsewhere (*e.g.*, the English *Classical Journal,* 1810–29), classical journals written primarily by professional scholars for other professional scholars did not begin to proliferate freely until after 1850. Coupled with this were the increased importance of universities, seminars, and academies (with their own published proceedings); and the growing habit of early publication in the shape of the Ph.D. dissertation, the academic "program" and the technical monograph. Increasing specialization was accompanied by a steady rise in technical standards of argument and presentation and a tendency to the employment of a learned jargon intelligible to fellow workers in the field, but barely intelligible to others: a phenomenon by no means confined to classical studies, but particularly noticeable through the contrast with the older scholarly literature. A revolution of questionable value that went hand in hand with this process was the replacement of Latin by vernaculars as a medium of publication (with certain traditional exceptions, such as the preface and apparatus of a critical text), and its virtual disappearance as a vehicle of scholarly intercourse. The consequence has been that since about 1850 a scholar wishing to keep abreast of developments in his subject must be able to read, at least, English, French, German and Italian; and in some fields Russian must now be added to this list. The changes here described had more immediate results on the continent of Europe and in the United States (where the Ph.D. degree was early transplanted); in England their effects were delayed, in part by the regrettable insularity which had characterized English scholarship since the days of Scaliger, in part by the continued concentration of the older universities on teaching and a consequent tutorial distrust of a powerful and effective professoriate and of "research." Only a few men, notably Thomas Arnold, quickly recognized the importance of German historical and critical scholarship. The most noteworthy contribution to ancient historiography in England was made by the banker George Grote, whose great history of Greece brought fresh air and contemporary relevance into the subject. In the latter part of the century, however, English scholarship began to awaken to a sense of its responsibilities: I. Bywater did important work on Aristotle and other Greek philosophers; Sir R. C. Jebb produced a polished commentary on Sophocles; and H. A. J. Munro, an eminent critic of Latin poetry, stood as intermediary between Lachmann, whose work he continued, and Housman.

The 20th Century.—The history of classical scholarship in the first 60 years of the 20th century is that of the 19th century writ large; the amount and complexity of the work done, as well as the nearness of the events and persons concerned, forbids any but a general survey. World War I dealt a severe blow to classical studies, but their recovery was more rapid than might have been expected. World War II had a worse effect, especially in Germany, the main home of the classics, whence even before the outbreak of war Nazi tyranny had driven many scholars into exile, especially in England, where they made a notable contribution to a period of great achievement. These setbacks apart, the history of classical studies has continued to be a history of expansion and progress, marred only by what has now become, perhaps, an excessive preoccupation with specialized research for its own sake to the neglect of the needs of the student and the interested layman.

Wilamowitz continued to be active: his last great work, on Greek religion, appeared in the year of his death (1931), and members of his circle did valuable work in the spirit of his comprehensive outlook. Wilhelm Schulze and J. Wackernagel used the methods of comparative linguistics to increase knowledge of Greek and Latin; and they were followed by E. Löfstedt and the Swedish school of Latinists, who, though concentrating for the most part on late Latin, provided by careful and acute linguistic observation a further valuable check on the excesses of the analogical school of textual criticism mentioned above. A. E. Housman had already initiated a reaction away from the conservatism and methodological rigidity of the late 19th century in a series of editions of Latin poets that are standard works of reference; and G. Pasquali, a pupil of Leo and Wackernagel, emphasized the limitations of Lachmannian methods in a seminal book on the tradition of classical texts. Among historians F. Jacoby began his vast edition of the fragments of the Greek historians; and M. Rostovtzeff made a great contribution to the social and economic history of the ancient world. A particularly fruitful technique now extensively employed was that of prosopography. The way in which research may and indeed must transcend the conventional limits of individual disciplines may be seen in the history of the so-called "Homeric question" during this period: the combined efforts of scholars in fields as diverse as linguistics, archaeology, Hittite studies, folklore and comparative oral literature have materially advanced the understanding and knowledge of the poems, though an inevitable concomitant of this understanding has been that all prospects of a "solution" to the question have receded indefinitely.

New discoveries have come mostly, where expected, from archaeology and from the study of papyri. The first considerable papyrus finds had been published during the last two decades of the 19th century, adding to the knowledge of ancient literature, administration and law, and altering certain accepted notions about textual criticism. During the 20th century they have appeared in ever-increasing numbers, above all from the hoard found at Oxyrhynchus; in the 1950s the first complete play of Menander, the *Dyscolus*, was discovered. In 1953 Michael Ventris proved to the satisfaction of most people that the language of the Mycenean archives is Greek, a discovery whose implications for early Greek history are not yet fully explored.

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CLASSIFICATION is the arrangement of things in classes according to the characteristics that they have in common. Sometimes similar objects are brought together in space, but classification may occur also when the only act of arrangement done by the classifier is the giving of a common name to things of the same kind. In a complex classificatory scheme the *infimae species*, or lowest classes, are subordinated to higher classes, and these again to others still higher until the *summum genus*, or most inclusive category of the system, is reached. It should be noticed, however, that in biology the terms "species" and "genus" are not used, as here, in a relative sense, but indicate classes of two fixed levels; *i.e.*, below orders but above varieties. For a discussion of the classificatory scheme used in biology *see* Taxonomy.

When, as often, the *summum genus* is given from the beginning, the problem of classification is the same as that of logical division. Exhaustiveness and exclusiveness can be secured at each level by dichotomy; *i.e.*, by dividing each class into two subclasses, one of things that have a certain character and the other of things that do not. This method has advantages for certain purposes such as the construction of a flora, but it does not satisfy the demand that kinds which are co-ordinate should be placed on the same level in the classificatory scheme. It has often been said that a logical division should proceed throughout according to one principle, and this is true if it is taken to apply to the division of any one genus into species, for otherwise there can be no guarantee that the species will be mutually exclusive. There is no reason, however, why a librarian should not first divide his books into large groups according to size and then subdivide each group according to subject matter. In contexts such as this there may indeed be many different ways of classifying the same things, all in a sense artificial, but all equally correct for their special purposes. The situation is rather different in science, where we assume the existence of natural kinds.

Classification is important for science because it is a prerequisite of all attempts to discover order in the world. (*See* Scientific Method.) It started already with the beginnings of speech; but the groupings expressed in ordinary language do not go much beyond the practical needs of the men who use it, and scientists must therefore make their own vocabulary, either by adaptation of what they find in ordinary speech or by constructing new words from old roots. The classifications which they produce in this way sometimes surprise the layman, as for example when they distinguish spiders from insects and place them with crabs in the phylum of arthropods. The reason is that they are especially interested in those groupings which help most in the presentation of knowledge as a system. In biology, for example, the modern phylogenetic classification of organisms according to common ancestry is clearly bound up with attempts to systematize and explain the information collected by natural historians. But the notion of natural kinds is to be found already at the very beginning of the study of nature. Men have a use for words such as "lead" only because they find certain recognizable features such as grayness, weight and fusibility occurring frequently together. If there were no such combinations of observable features to attract attention, there could be no natural science. For the laws that are formulated in science are generalizations about the properties of things belonging to such kinds. In short, there is no clear line of demarcation between the work of scientific classification and the practice of induction (*q.v.*).

(W. C. K.)

CLAUBERG, JOHANN (1622–1665), German philosopher and theologian, the leading representative of Cartesianism in his country, was born at Solingen in Westphalia on Feb. 24, 1622. After studies at Bremen he went to Groningen university in Holland, where Tobias Andreae introduced him to the philosophy of René Descartes. Traveling abroad to complete his education, he met Claude Clerselier, Jacques du Roure and Louis de La Forge in Paris (*see* Cartesians), attended the lectures of M. Amyraut and L. Cappel at Saumur and paid a visit to England. Back in Holland in 1649, he went to Leiden for several months to hear the Cartesian J. de Raey before taking up the professorship of philosophy and theology at the Calvinist academy of Herborn, in Nassau. At Herborn he distinguished himself as the foremost Cartesian in Germany, but soon met with opposition from his colleagues, especially the professor of rhetoric, C. Lentz (Lentulus). Appointed master of the Duisburg *Gymnasium* in 1651, Clauberg took many of his Herborn pupils with him. His commission to teach philosophy and theology at Duisburg (1653) was followed by the opening of the university there (1655), with him as rector. He taught there till his death, on Jan. 31, 1665.

Clauberg upheld the Cartesian method against Lentz and the Leiden theologian J. Revius in his *Defensio cartesiana* (1652) and against Revius again in his *Initiatio philosophi* (1655). His expositions of the *Meditations* and of the *Principles of Philosophy* of Descartes show him as a lucid though sometimes prolix commentator. In his *Logica vetus et nova* (1654), a work several times reflected in the *Port-Royal Logic*, he "links the ancient with the modern precepts." Moreover, his *Ontologia sive Metaphysica de ente* (1660) is fundamentally the same as his pre-Cartesian *Ontosophia* (1647), only the Aristotelian prolegomena being omitted.

In his *Exercitationes centum de cognitione Dei et nostri* (1656) Clauberg proceeds from the proof of God's existence by the idea of the infinite to an account of being and knowledge that shows a pronounced inclination to Christian Platonism. Platonism likewise inspires his solution, in *Corporis et animae in homine conjunctio* (1663), of the specifically Cartesian problem of the union of soul and body: the soul, incapable of movement, cannot create any movement in the world of bodies (in which the quantity of movement remains constant) but can guide such movements according to its will, thus being not their physical but their moral cause; and, conversely the movements of bodies are only "procatarctic" or antecedent causes to the soul, providing the "occasion" for it to call forth some idea. The harmonious functioning of this concourse depends ultimately on God's providence.

Clauberg believed in the excellence of the German language as Descartes had believed in that of French. He published a work on German philology, *Ars etymologica Teutonum* (1663), and wrote one work in German, on the difference between the old and the new philosophies. A collected edition of his philosophical writings, by J. T. Schalbruch, appeared in 1691.

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CLAUDEL, PAUL LOUIS CHARLES MARIE (1868–1955), French poet and playwright, one of the most significant figures in French literature in the first half of the 20th century and the outstanding representative of the Catholic literary revival, was born at Villeneuve-sur-Fère-en-Tardenois, Aisne, on Aug. 6, 1868. He entered the diplomatic service in 1890. After holding consular posts in the United States, China and Europe, he was appointed minister at Rio de Janeiro (1917) and Copenhagen (1919) and then ambassador at Tokyo (1921), Washington, D.C. (1927), and Brussels (1933). In 1935 he retired and settled in Paris and at his Château de Brangues (Isère). Throughout a successful diplomatic career he felt no conflict between his prolific writing activity and his official duties, which he regarded as "une ohligation de conscience." The experience he gained in various parts of the world—in the east, for example—was of considerable value to his thought and writing. In 1946 Claudel was elected to the French Academy. He died in Paris on Feb. 23, 1955.

Claudel's literary work comprises almost every form except the novel, but drama and lyrical poetry preponderate. He wrote his first play, *L'Endormie*, when he was 14 and completed his last, *Le Soulier de satin*, at 56. His lyrical production covers much the same span, continuing to his 67th year. His articles and essays are innumerable and touch on all kinds of subjects. In addition, he wrote many professional dispatches and reports.

His best-known and most impressive lyrical works are the *Cinq grandes odes* (1910). Later volumes consist of poems written at various times and lack the unity that holds the odes together. He very early adopted the long, unscanned, usually unrhymed line—a strong and supple form well suited to the all-embracing character of his inspiration—which became known as the *verset claudélien* and is his peculiar contribution to French prosody. Its origin is in Rimbaud's *Les Illuminations,* a work which profoundly influenced him from the age of 18.

Claudel is more alive to what strikes the senses than to what appeals to the intellect; lyrically, rather than intellectually, aware of the oneness and manifoldness of nature, he aims at grasping reality in a single instant and in its wholeness. He thus stands in contrast to the tradition of French literature and thought which has always been more concerned with analysis than synthesis, with delineation of detail rather than comprehensive vision. Nevertheless, his personality is too strong for him to overlook the importance of what is individual and his imagination too concrete for him to be concerned only with the universal—witness the firmly drawn characters of his plays. The unifying principle of these opposing tendencies is his Christian faith (he was converted to Roman Catholicism after a religious experience on Christmas day, 1886). He is the most Christocentric great French writer since the 17th century. Whatever his subject, God is felt to be present. His religion, which enables him to apprehend the infinite diversity of creation in an ordered hierarchy and counteracts the expansiveness and luxuriance of his own nature, is for him a way of life which gives meaning to everything. Nostalgia for what is lost, flight from reality, are, thanks to this outlook, sentiments foreign to him.

The outlook is plainly expressed in Claudel's articles and essays, and in his correspondence with Jacques Rivière, Francis Jammes and André Gide; it infuses most of his poetry, implicitly in the odes, explicitly in much of *Corona benignitatis anni Dei* (1914) and *Feuilles de saints* (1925); and it reaches fullest expression in the plays. In the early *Tête d'or* (1889) and *La Ville* (1890) and in the first draft of *La Jeune Fille Violaine* (1892), it is still grasping after intelligible embodiment. It speaks clearly in *Le Repos du septième jour* (1896), is less apparent in the tragic and autobiographical *Partage de midi* (1905), and brings forth its finest fruit with the second *La Jeune Fille Violaine* (1898) and, especially, *L'Annonce faite à Marie* (1910), probably his masterpiece. *L'Annonce* is a drama of renunciation, enacted on two planes—the natural one of everyday life, and the spiritual one of heroic physical suffering, accepted with utter dedication to God—which intersect thanks to the highly individualized characters.

The trilogy concerned with Sygne de Coûfontaine, Turelure and their descendants was for long the best-known part of Claudel's dramatic output. The first of its plays, *L'Otage* (1909), is based on an imaginary episode in Napoleon's conflict with the pope. The third, *Le Père humilié* (1916), has for its setting Rome in the last days of papal temporal power. But after 1943, when a stage version of it was performed, *Le Soulier de satin* (1919–24) attracted most attention. For many of the poet's admirers, it is his greatest play, though its enormous size and piecemeal construction deny it the formal beauty of *L'Annonce*. Set in the late 16th century, it covers many years and is laid in many lands, ranging from Prague to Panamá, as well as on board ship in the Mediterranean and mid-Atlantic. Its diverse episodes are given unity by the hero and heroine, Don Rodrigue and Doña Prouhèze, who scarcely ever meet and whose love will never find fulfilment this side of the grave. The play is both a drama of personal destiny and an evocation of a period in world history, with Spain and Spanish America as focal points. Reduced from its original four *journées* to two long acts, it has been played with increasing success and has come to rival *L'Annonce* in fame and popularity.

Whatever the appeal, or otherwise, of Claudel's philosophical message, his mastery and original use of language, as well as the gravity of his themes, his passionate sincerity and generous encyclopaedic vision, all make him one of the great classics of French and European literature.

BIBLIOGRAPHY.—(The years given, as above, are those of composition.) Claudel's most important works, other than those already mentioned, are the plays *Le Pain dur* (1923–14), *Le Livre de Christophe Colomb* (1927), with music by Darius Milhaud, and *Jeanne au bûcher* (1934), with music by Honegger; the collections of articles *Positions et propositions* (1928), *Figures et paraboles* (1935), *Contacts et circonstances* (1939) and *Visages radieux* (1947); the work of criticism *Art poétique* (1907); and the prose poem *Connaissance de l'Est* (1900). The *Correspondance, 1899–1926,* with André Gide, was published in 1949. Many of Claudel's works have been translated into English. *See* E. Beaumont, *The Theme of Beatrice in the Plays of Claudel* (1954); W. Fowlie, *Paul Claudel* (1958). (C. M. G.)

CLAUDE LORRAIN (CLAUDE GELLÉE or GELÉE) (1600–1682), the originator of the romantic tradition in French landscape painting, sometimes called Le Lorrain or simply Claude. He was born at Champagne, near Toul, Lorraine. At about the age of 12 he went to Freiburg im Breisgau and later to Rome to train as a pastry cook, and in this capacity became attached to Agostino Tassi, who had a reputation as a painter of seaports. At an unknown date he had instruction from a Flemish artist, Goffredo Wals, in Naples. In 1625 he made a roundabout journey to Nancy where he was employed for a year as assistant to Claude Deruet, the duke of Lorraine's painter, on work for the ceiling of the Carmelite church (now destroyed). In 1627 he returned to Rome and stayed there till his death on Nov. 23, 1682.

His fame as a landscape painter was established by the end of the 1630s and his numerous patrons, mostly from the Roman church aristocracy, included Pope Urban VIII. It is said that about 1634 Sébastien Bourdon copied one of Claude's landscapes in eight days. To guard against such copying and to record his most famous compositions, Claude made tinted outline drawings of most of his pictures in six paper books which he entitled the *Libro di verità* or *Liber veritatis*. This valuable record is at Chatsworth, Eng.; it was engraved in 1777 by Richard Earlom.

Claude's style is, in a manner of speaking, without history, for once he had found his idiom he did not stray outside it. He painted instinctively, not intellectually as did his contemporary Nicolas Poussin, and chose to paint only that which gave him abiding pleasure, namely the reach of golden sunlight on the country around Rome or on the waters of some mythical seaport.

Claude has been called the meeting point of the northern and southern landscape traditions. The northern tradition, that of Adam Elsheimer and Paul Bril, was the one in which Claude had been trained, for his master Tassi was a pupil of Bril. Entailing a dramatic approach to the subject, it depended on marked contrasts of light and dark, on huge tree masses dominating the scene. The southern tradition, represented by the Carraccis and by Domenichino, consisted of an intellectual approach to nature that was conceived as a matter of orderly recession and balanced masses. Claude began in the northern naturalistic manner, and his early works (*e.g.,* "View of the Campo Vaccino") show a meticulous attention to detail. He gradually emancipated himself from this and moved on to the southern or classical formula, but always kept the northern device of placing a dark tree or building in the foreground to deflect the eye to the source of light on the horizon.

In the 17th century pure landscape did not exist, so that all Claude's landscapes contain a story, either from the Bible, from Greek mythology or the modern romances of Tasso and Ariosto. His subjects have one thing in common: all are treated in an idyllic, as against a dramatic, manner, so that the protagonists do not obtrude themselves. An indifferent figure painter, he often delegated this part of his picture to a minor artist such as Jan Miel or Filippo

Lauri. As he grew older, the purely anecdotal part of his pictures became reduced in scale and in importance, and at the end of his life nature assumed crushing proportions. He abandoned the more conventional seaport scenes for pure landscape, which took on an intense and visionary quality as in "Aeneas Hunting in Libya" (1672, Brussels).

Claude's technique can be studied in any painting of his mature period (*c.* 1640–60). Structurally he relies on the simple device of a horizon set off by a vertical tree or building in the foreground, all the objects in between being fused by a masterly representation of sun, heat and light. The perspective is established not by compositional lines but by gradations of tone that are themselves governed by light.

Claude rarely painted from nature but he sketched in the open air and worked up the finished pictures in his studio. Perhaps the most precious of his drawings, which display great range and variety, are those rapid and delicate wash sketches that simply establish the relative positions of a tree and a hill. The finished pen drawings are more conventional and northern in style. The British museum contains several volumes of drawings as do the Louvre and the Albertina, Vienna. His etchings also are considered superior (*see* Etching: *History*). His paintings are to be found in major collections. *See* Painting: *Baroque Through Impressionist Painting: France; see* also references under "Claude Lorrain" in the Index volume.

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CLAUDIANUS, CLAUDIUS (Claudian) (*c.* 370–*c.* 404), the last important Latin poet of the classical tradition. An Alexandrian, Claudian came to Italy and, abandoning his native Greek, displayed his mastery of Latin in a poem celebrating the consulship of Probinus and Olybrius (395). A civil post which he held was hazarded by an epigram on his fellow-countryman and superior Hadrianus, but his obliging pen won him the protection of Stilicho, minister of the western emperor, Honorius. By assiduously praising Stilicho and denouncing his rivals at the court of Arcadius, the eastern emperor, Claudian gained the position of *tribunus et notarius*, the rank of *vir clarissimus* and (before 402) the honour of a statue. Serena, the wife of Stilicho, backed Claudian's successful suit to a wealthy African bride, but death evidently intervened while this happiness was fresh, for no composition of his can be assigned to a later date than 404, and Stilicho's victory over Radagaisus (405) has gone unsung. The poems in which Stilicho figures were collected and transmitted independently, and it may be surmised that this collection was made after Claudian's death in 404 and before Stilicho's downfall in 408.

Claudian's poems fall into three groups, the first (*Claudianus maior*), being the collection of poems just mentioned, together with epistles, idylls and epigrams. The longer poems comprise panegyrics on the consulships of Honorius (396, 398, 404), Mallius Theodorus (399) and Stilicho in 400 (in two books; a third commemorates Stilicho's entry into Rome); *Epithalamium* and *Fescennina* for Honorius' marriage with Stilicho's daughter, Maria (398); invectives against Rufinus (396) and Eutropius (399), the ministers of Arcadius; *De bello Gildonico* (398) and *De bello Gothico* (402). Among the minor poems may be mentioned the delightful *De sene Veronensi* ("Old Man of Verona"); *Deprecatio ad Hadrianum* (*see* above); *Epithalamium Palladii; Laus Serenae; Epistola ad Serenam; Gigantomachia.*

The other two groups are formed by the panegyric already mentioned on Probinus and Olybrius, which is not associated in the manuscripts with the first group until the 12th century, and the mythological epic, *De raptu Proserpinae* ("the Rape of Proserpine"), on which Claudian's medieval fame largely depended, also transmitted separately (*Claudianus minor*). The second book of the epic is prefaced by an elegiac epistle addressed to Florentinus, from which—if it is really connected with the poem, for it contains nothing to suggest that it is—it has been inferred that the subject was inspired by the efforts of Florentinus, the city prefect, to meet the shortage of corn created by Gildo's defection in Africa. On this assumption, it can be assigned to 397 and its unfinished state explained by the disgrace of Florentinus.

Though regarded in the middle ages as nearly the peer of the other rhetorical poets, Statius and Lucan, Claudian has not received the approbation of modern critics, partly because of his addiction to inferior themes, partly because of his employment of means too elaborate for such futilities. Yet he is not wholly without value as a historical source, and his mastery of rhetoric and the fertility of his invention compel admiration even in his excesses. His scathing invective is always impressive, and his preoccupation with Rome and its old religion reveals the sincerity of an unabashed pagan at a Christian court. Judged even by golden age standards, his diction and prosody are impeccable, but the smoothness of his verse produces tedium, and his graces generally have an engine-turned quality.

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CLAUDIUS, in ancient Rome the name of a famous gens (family). The by-form *Clodius* was regularly used for certain Claudii during the late republic, but otherwise the two forms were used indifferently. The gens *Claudia* contained patrician and plebeian branches; the chief representatives of the former were those bearing the cognomen (third name) Pulcher, of the latter those with the cognomen Marcellus (*see* Marcellus). The following members deserve particular mention:

Appius Claudius Sabinus Inregillensis, or Regillensis (consul 495 b.c.), so called from his birthplace Regillum (or Regilli) in Sabine territory, founder of the gens. His original name was Attus or Attius Clausus. About 504 b.c. he migrated to Rome, where he received patrician rank; his followers also were granted Roman citizenship and land beyond the Anio (mod. Aniene) river; this formed the centre of the Claudian *tribus*, one of the rural tribes (a political division) which took their names from old patrician families. His enforcement of the laws of debt while consul provoked the "secession" of the plebeians in 494. (*See* Roman History: *Patricians and Plebeians.*)

Appius Claudius Crassus (consul in 471 and 451 b.c.), a patrician conspicuous for his aristocratic pride and hatred of the plebeians. In 451 he was made one of the commission of ten (decemviri; *q.v.*) who had been appointed to draw up a code of written laws. By courting the people he secured his re-election as decemvir for 450, and the new decemvirs, under his leadership, began a reign of terror. According to tradition, his treatment of Virginia (*q.v.*) led to an insurrection of the plebeians who seceded to the Sacred Mount. The decemvirs were finally forced to resign (449) and Appius Claudius died in prison, either by his own hand or by that of the executioner.

See T. Mommsen, *History of Rome*, vol. i, appendix (Eng. trans. 1911).

Appius Claudius Caecus (4th century b.c.) was censor in 312 b.c. before he was consul, a reversal of the normal sequence of offices. He retained his censorship beyond the legal limit of 18 months, and filled vacancies in the senate with men of humble birth, including sons of freedmen. He distributed the landless (but not necessarily poor) citizens throughout all the tribes, rural as well as urban, thus increasing the effective voting power of the landless city population. This measure however was cancelled in 304 when the censors again restricted this class to the four urban tribes. He transferred the cult of Hercules in the Forum Boarium from the gens *Potitia* to public slaves. He gained enduring fame by the construction of a road from Rome to Capua (312) and an aqueduct; these were called by his name, the Via Appia and the Aqua Appia, an honour without precedent. The exclusive rights of the patricians were invaded in 304 when his secretary Gnaeus Flavius (*q.v.*) published the *legis actiones* (methods of legal practice) and the list of *dies fasti* (days on which legal business could be transacted). He was consul for the first time in 307, interrex in 298, consul again in 296 when he led an army into Etruria, praetor in 295, and once dictator. He opposed the admission of plebeians to priestly offices (300). Despite blindness and old age he dissuaded the senate from considering the eloquent appeal of Cineas the envoy of Pyrrhus (*q.v.*), king of Epirus, to make peace (*c.* 280). Tradition regarded his blindness, which might have been invented merely to explain his cognomen Caecus, as punishment for his transference of the cult of Hercules from the Potitii. Various opinions have been held about him: as a reactionary patrician who fought against the newer plebeian aristocracy, as a demagogue and would-be tyrant, as a politician seeking ascendance (but not tyranny) for himself and his supporters, or as a champion of the industrial and commercial classes. At least it is clear that he advanced the interests of the urban elements in both the senate and assemblies.

His speech against peace with Pyrrhus was the first that was handed down in writing, and laid the foundation for prose composition. He published aphorisms in verse and a legal work *De Usurpationibus*, and he may have been concerned in drawing up the *legis actiones* published by Flavius. He was also interested in grammatical questions, being responsible for introducing the distinction in Roman writing of the two sounds R and S, and the abolition of the letter Z.

See A. Garzetti, *Athenaeum*, vol. xxv (1947); E. S. Staveley, *Historia, Zeitschrift für Alte Geschichte*, vol. viii (1959).

Publius Claudius Pulcher (d. before 246), son of the above. As consul in 249 B.C. he attacked the Carthaginian fleet in the harbour of Drepanum (Trapani) in Sicily and was completely defeated. This was the only serious Roman naval defeat in the First Punic War, and it was commonly attributed to Claudius' treatment of the sacred chickens, which refused to eat before the battle. With the words, "Let them drink then," he had them thrown into the sea. Accused of treason and heavily fined, he died before 246.

Appius Claudius Pulcher (d. 130 B.C.), consul in 143 B.C., was later censor (136) and *princeps senatus* (senior statesman). He supported the program of his son-in-law Tiberius Sempronius Gracchus and served on the agrarian commission from 133 until his death in 130.

Appius Claudius Pulcher (d. 49–48 B.C.), served under his brother-in-law Licinius Lucullus in Asia in 72 B.C. In 57 he was praetor, in 56 propraetor in Sardinia, and in 54 consul with L. Domitius Ahenobarbus. Pompey reconciled him to Cicero whose return from exile he had opposed. While governor of Cilicia (53–51) he corresponded with Cicero but he resented the appointment of Cicero as his successor and avoided meeting him. When impeached by P. Cornelius Dolabella on a charge of treason, Claudius had to approach Cicero in order to obtain witnesses in his favour from his old province. He was acquitted on this charge and also on a charge of bribery. In 50 he was censor and expelled many senators. When Caesar crossed the Rubicon (49) he fled from Italy. He was appointed by Pompey to the command in Greece, but died before the battle of Pharsalus (48). He wrote a work on augury, the first book of which he dedicated to Cicero.

See Cicero, *Letters, Ad Familiares*, iii (ed. R. Y. Tyrrell and L. C. Purser 1899–1918); L. A. Constans, *Un Correspondant de Cicéron, Ap. Claudius Pulcher* (1921). A full account of all the Claudii will be found in Pauly-Wissowa, *Real-Encyclopädie der classischen Altertumswissenschaft*, iii. 2 (1899). (H. H. Sd.)

CLAUDIUS I (Tiberius Claudius Nero Germanicus) (10 B.C.–A.D. 54), Roman emperor A.D. 41–54. A member of the patrician branch of the gens *Claudia*, he was born at Lugdunum (Lyons) on Aug. 1, 10 B.C. He was the son of Nero Claudius Drusus and the younger Antonia, the brother of Germanicus Caesar, a nephew of the emperor Tiberius and a grandson of Livia Drusilla, the wife of the emperor Augustus. Ill-health, unattractive appearance, clumsiness of manner and coarseness of taste did not recommend him for a public life. The imperial family seems to have considered him something of an embarrassment. He was long left to his own private studies and amusements. It was Livy who recognized and encouraged his inclination for historical studies. Claudius defended Cicero in a pamphlet and, having discovered that it was difficult to speak freely on the civil wars, he began a history of Rome with the principate of Augustus. He composed 20 books of Etruscan and 8 books of Carthaginian history, all in Greek, an autobiography and a historical treatise on the Roman alphabet with suggestions for orthographical reform—which as emperor he later tried not very successfully to implement. He also wrote on dice playing, of which he was fond. All his works are lost and their importance cannot be measured. The Etruscan history may have had original material: his first wife, Plautia Urgulanilla, had Etruscan blood and her family was probably able to put Claudius in touch with authentic Etruscan traditions. After divorcing Urgulanilla, he married in turn Aelia Paetina, Valeria Messallina, who was his wife at his accession, and finally Agrippina the younger. He had two children, Drusus and Claudia, by Urgulanilla; one daughter, Claudia Antonia (A.D. 27–66), by Paetina; and two children, Octavia and Britannicus Caesar, by Messallina. Drusus and Claudia died before he became emperor. As a young man Claudius was made a member of various religious colleges, but he became consul only under the reign of his nephew Gaius (Caligula; *q.v.*) in 37. There was, however, little cordiality between Claudius and Gaius.

Power came to Claudius unexpectedly after Gaius' murder on Jan. 24, 41, when he was discovered trembling in the palace by a soldier. The praetorian guards made him emperor on Jan. 25, and his Jewish friend Herod Agrippa I helped him in his first difficult dealings with the senate. By family tradition and antiquarian inclinations Claudius was in sympathy with the senatorial aristocracy, but soldiers and courtiers were his real supporters, while freedmen and foreigners had been his friends in the days of disgrace. Initially the attitude of the senate had at least been ambiguous. In 42 many senators supported the ill-fated rebellion of the governor of Dalmatia, Furius Camillus Scribonianus. Even later several attempts on Claudius' life involved senators and knights. Though paying homage to the dignity of the senate (to whose administration he returned the provinces of Macedonia and Achaea) and giving new opportunities to the equestrian class, Claudius was ruthless and occasionally cruel in his dealings with individual members of both orders. From the very beginning he emphasized his friendship with the army and paid cash for his proclamation as emperor.

Claudius' decision to invade Britain (43) and his personal appearance at the climax of the expedition, the crossing of the Thames, and capture of Camulodunum (Colchester) were prompted by his need of popularity and glory. But concern with the anti-Roman influence of Druidism, which he tried to suppress in Gaul, and a general inclination toward expanding the frontiers were other reasons (*see* Britain). Claudius planted a colony of veterans at Camulodunum and established client-kingdoms to protect the frontiers of the province; these were afterward a source of trouble such as the revolt in 47 of Prasutagus, client king of the Iceni, and later the general revolt instigated by his wife Boadicea (*q.v.*). He also annexed Mauretania (41–43), of which he made two provinces (Caesariensis in the east and Tingitana in the west), Lycia (43) and Thrace (46). Though he enlarged the kingdom of Herod Agrippa I, he later made Judaea a province on Agrippa's death in 44. In 49 he annexed Ituraea (northeastern Palestine) to the province of Syria. He was careful not to involve the empire in major wars with the Germans and the Parthians. Claudius supported Roman control of Armenia, but in 52 preferred the collapse of the philo-Roman government of Mithradates to a war with Parthia, when Vologaeses installed his brother Tiridates as ruler; Claudius left a difficult situation to his successor.

In the civil administration, many measures demonstrate Claudius' enlightened policy. He improved in detail the judicial system and in his dealings with the provinces he favoured a moderate extension of Roman citizenship by individual and collective grants:

in Noricum, for instance, five *civitates* became Roman *municipia* (*see* MUNICIPIUM). He encouraged urbanization and planted several colonies, for example at Camulodunum and at Colonia Agrippinensis (mod. Cologne) in Germany in 51. In his religious policy Claudius respected tradition; he revived old religious ceremonies, celebrated the secular games (47), made himself a censor together with L. Vitellius in 47, and extended in 49 the *pomerium* of Rome (the boundary of the area in which only Roman gods could be worshiped and civil magistrates rule). He protected the *haruspices* ("diviners") and probably romanized the cult of Attis. According to Suetonius in *Claudius* (25) on the occasion of troubles Claudius expelled the Jews from Rome for a short time: Christians may have been involved. Elsewhere he confirmed existing Jewish rights and privileges, and in Alexandria tried to protect the Jews without provoking Egyptian nationalism. A letter addressed to the city of Alexandria survives in which Claudius asked Jews and non-Jews "to stop this destructive and obstinate mutual enmity." Personally disinclined to accept divine honours, he did not seriously oppose the current trend and had a temple erected to himself in Camulodunum. His public works include the reorganization of the corn supply of Rome and a new harbour at Ostia which was later improved by the emperor Trajan.

Claudius' general policy increased the control of the emperor over the *aerarium* (*q.v.*) and the provincial administration, and apparently gave jurisdiction in fiscal matters to his own procurators in the senatorial provinces. He created a kind of cabinet of freedmen to superintend various branches of the administration, which included Narcissus, Callistus, Pallas and Polybius, on whom he bestowed honours. An impressive series of documents, such as the speech for the admission of Gauls to the senate recorded on a partly defective inscription at Lugdunum, the edict for the Anauni (an Alpine population who had usurped the rights of Roman citizenship and whom Claudius now confirmed in these rights) and the above-mentioned letter to the city of Alexandria (41 A.D.), survive as evidence of his personal style of government: pedantic, uninhibited, alternately humane and wrathful, and ultimately despotic. The inscription from Lugdunum is interesting by comparison with Tacitus, *Annals*, xi, 24, which gives an account of the same speech of which the inscription records the text. The speech as recorded in the inscription, in spite of irrelevance, inconsequence and fondness for digression (much of which is absent in the version of Tacitus) shows that he knew what he wanted and that he appreciated the latent forces of Roman tradition.

His marriage with Messallina ended mysteriously in 47 when she apparently conspired against him and married Gaius Silius. Messallina and Silius were killed, and Claudius married his niece Agrippina, an act contrary to Roman law, which he therefore changed. To satisfy Agrippina's lust for power Claudius had to adopt her son L. Domitius Ahenobarbus (later the emperor Nero) to the disadvantage of his own son Britannicus. The new commander of the guards Afranius Burrus was protected by Agrippina. Roman tradition is unanimous in stating that Claudius was poisoned by Agrippina on Oct. 13, 54, though the details differ. The version of poisoning by mushrooms prevailed. L. Annaeus Seneca, who had been recalled from exile to educate Nero, derided the dead emperor and his apotheosis (duly decreed by the senate) in the satire *Apocolocyntosis Divi Claudii* ("The Pumpkinification of Claudius the God": the title and its exact meaning are both subject to discussion).

The picture of Claudius that appears in this work has much in common with that of later Roman historians who give details of the unpopular side of Claudius' administration. The *Apocolocyntosis* ridicules his uncouth physical appearance and attacks his habit of giving legal judgments without a hearing, and the executions of relatives, senators and knights. Tacitus, Suetonius and Dio Cassius attribute Claudius' mistakes to infirmity of character and the influence of his wives and freedmen. They echo the hostility of the upper classes of Rome against an emperor who, in spite of his own words, had been unfavourable to them. That this tradition is one-sided is shown by the surviving documents of the reign and the energy with which Claudius carried out the practical affairs of government.

See also references under "Claudius I" in the Index volume.

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CLAUDIUS II GOTHICUS (MARCUS AURELIUS CLAUDIUS) (214–270), Roman emperor 268–270, born in Dardania, part of Moesia Superior, in May 214, was an army officer under Gallienus (260–268) when barbarian raids devastated most of the Roman empire. By the end of the reign he was commander of Gallienus' newly formed cavalry, and on Gallienus' murder in 268, in the course of suppressing the rebellion of Aureolus, Claudius succeeded him. It is quite uncertain whether he had anything to do with the death of Gallienus or not. Claudius speedily suppressed Aureolus and drove from Italy the Alamanni (*q.v.*) summoned by the usurper.

Claudius' authority was recognized only in the central territories of the empire; he made an unsuccessful attempt to recapture the allegiance of the western provinces who obeyed the emperors of the Rhine, and in the middle of 269 the princes of Palmyra assumed the style of emperor. But in his own area he destroyed near Naissus (Nish) in Moesia a vast Gothic migration. Much of the credit went to his cavalry commander Aurelian who succeeded him. He died of the plague early in 270, preparing a campaign against the Vandals.

In the next century, Constantine I claimed that his grandmother was niece or daughter of Claudius; it is not clear whether historical tradition glorifies Claudius because he was claimed as Constantine's relative, or whether Constantine made the claim because Claudius' reputation was already glorious.

CLAUDIUS, MATTHIAS (1740–1815), German poet, the author of lyrics of direct simplicity, deep feeling and piety. "Der Mond ist aufgegangen," the best known of his poems, well deserves its place in the anthologies. Claudius was born on Aug. 15, 1740, at Reinfeld, Holstein. He studied at Jena but subsequently kept no fixed occupation for long until, in 1788, he acquired a sinecure post in the Schleswig-Holstein bank.

From 1771 to 1775 he edited a newspaper, the *Wandsbecker Bote*, in which, under the name "Asmus," he published many of his essays and poems. Claudius formed one of a group (including J. G. Herder and others) who fought against the rationalistic and classical spirit of the day and sought to preserve in literature a Christian and a natural—almost a folk—atmosphere. He died on Jan. 21, 1815, in Hamburg.

See U. Roedl, *Matthias Claudius*, 2nd ed. (1950). (M. KL.)

CLAUSEWITZ, KARL VON (1780–1831), Prussian general, military historian and foremost modern theorist on land warfare, was born at Burg, near Magdeburg, Ger., on June 1, 1780, of a poor middle-class family with professional background. Entering the Prussian army in 1792, Clausewitz was commissioned during the Rhine campaign of 1793–94 and spent the next years, while on garrison duty, in educating himself, an effort that enabled him to gain admission to the War college in Berlin in 1801.

During his formative years in Berlin, Clausewitz learned military science under the guidance of his teacher, Gerhard von Scharnhorst (*q.v.*), studied philosophy and literature, and developed his basic strategic concepts. Scharnhorst introduced him at court, where he met his future wife, the Countess Marie von Brühl, and obtained for him an appointment as aide to Prince August. He served in this capacity in the campaign of Jena (1806), was captured at Prenzlau and returned to Prussia when released in 1808. Clausewitz became one of the leaders of the Prussian army reform under Scharnhorst, but resigned his commission on the eve of Napoleon's invasion of Russia (1812) and, like other German patriots, entered Russian service.

In the campaign of 1812 Clausewitz distinguished himself as a Russian staff officer. He was partially responsible for the successful strategic retreat and for negotiating the convention of Tauroggen, which marked the beginning of Prussia's abandonment of the French cause. After having served in various capacities during the campaigns of 1813–14, Clausewitz returned to Prussian service and served as chief of staff of an army corps during the Waterloo campaign. In 1818 he became a general and was appointed administrative head of the War college.

During the next 12 years he used much of the leisure that this position provided in writing his historical studies and his major work on strategy, *On War* (*Vom Kriege*). Before completing this manuscript, he was transferred to Breslau and then assigned to Prussian forces deployed to observe the Polish revolution of 1830. He contracted cholera and died shortly after his return to Breslau on Nov. 16, 1831. His papers were edited and published by his devoted widow.

Clausewitz's personality reflected not only his relatively humble origins, but also the strong influence of contemporary German literature and philosophy. Shy and sensitive by nature, he often kept his ideas to himself. He never had a command of his own but served mostly in a staff capacity, distinguishing himself through his sound advice and bravery in combat. His background and career identified him more closely with the broader movements for national German revival than with the aristocratic Prussian military tradition.

Clausewitz's fame rests on his military studies. While his extensive histories of the various Napoleonic campaigns are only of technical interest, his work *On War* has made a profound impact on modern strategic concepts. Drawing on the experiences of Frederick the Great and Napoleon, Clausewitz tried to analyze the workings of military genius by isolating the factors that decide success in war. His conclusions have remained generally applicable, and since his work contains a minimum of technical discussion, it has retained a wide appeal. Clausewitz produced no system of strategy, thus breaking with the more rigid and mechanistic concepts of his predecessors. Instead, he emphasized the importance of psychological and accidental factors that elude exact calculation and the necessity of a critical approach to strategic problems. By a lengthy discussion of a variety of situations likely to confront the military leader Clausewitz tried to develop in his reader a theoretically founded military judgment, capable of weighing all pertinent factors in a given situation. He stated that strategy should aim at three main targets, the enemy's forces, his resources and his will to fight.

His most significant single contribution is the doctrine of political direction in military matters. In maintaining that "war is nothing but a continuation of political intercourse with the admixture of different means," be denied that war is an end in itself. His emphasis on defensive warfare was based on the argument that it is both the militarily and politically stronger position.

Clausewitz was studied closely by his countrymen and left his imprint on German military thought, but his influence on German over-all strategy has been overrated. The military specialists considered him outmoded, and the general staff rejected his doctrine of political direction of warfare. Beginning with the 1853 edition of *On War* the crucial passage calling for cabinet control of strategy was altered to prescribe the reverse. German military planning became increasingly devoid of political purpose, leading to the rigid and aggressive mobilization concepts of 1914 and to Ludendorff's virtual dictatorship in 1916. There was a considerable revival of interest in Clausewitz during the interwar period, and his political doctrines influenced the military officers who tried to assassinate Hitler on July 20, 1944.

Clausewitz was read extensively outside of Germany. Swedish, Dutch, Swiss and Austrian officers took an early interest in his doctrines and most of his works were translated into French. An English translation of *On War* appeared in 1873, and other editions exist in Russian, Italian, Hebrew, Hungarian, Serbian and Spanish. By 1900 his doctrines were known in the United States and Japan. The first American translations appeared during World War II. Marx and Engels discussed Clausewitz's work and Lenin studied his political doctrines during exile in Switzerland. Communist theory on the nature of war, including such concepts as that of the "imperialistic war," was largely derived from Clausewitz, whose authority has been recognized behind the "iron curtain." By the middle of the 20th century, when new long-range weapons systems appeared, the significance of Clausewitz's strategic concepts which are derived exclusively from land warfare has declined, although many of his basic ideas are as valid as ever. *See* also STRATEGY.

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CLAUSIUS, RUDOLF JULIUS EMANUEL (1822–1888), German physicist, made important contributions to molecular physics. He was born at Köslin, in Pomerania. In 1848 he took his degree at Halle, and in 1850 was appointed professor of physics in the royal artillery and engineering school at Berlin and *Privatdocent* in the university. In 1855 he became an ordinary professor at Zürich Polytechnic and professor in the University of Zürich. Clausius moved to Würzburg in 1867 as professor of physics, and two years later was appointed to the same chair at Bonn, a position which he held until his death.

The work of Clausius, who was a mathematical rather than an experimental physicist, was concerned with many of the most abstruse problems of molecular physics. By his restatement of Carnot's principle he put the theory of heat on a truer and sounder basis, and he deserves the credit of having made thermodynamics a science; he enunciated the second law, in a paper contributed to the Berlin Academy in 1850, in the well-known form, "Heat cannot of itself pass from a colder to a hotter body." He applied his results to an exhaustive development of the theory of the steam engine, laying stress in particular on the conception of entropy.

The kinetic theory of gases owes much to his researches. He raised it, on the basis of the dynamical theory of heat, to the level of a theory, and he carried out many numerical determinations in connection with it; *e.g.*, of the mean free path of a molecule. Clausius also made an important advance in the theory of electrolysis, suggesting that molecules in electrolytes are continually interchanging atoms, the electric force not causing but merely directing the interchange. This view found little favour until 1887, when it was taken up by S. A. Arrhenius, who made it the basis of the theory of electrolytic dissociation.

CLAUZEL, BERTRAND, COMTE (1772–1843), marshal of France, governor of Algeria from 1835 to 1837, was born on Dec. 12, 1772, at Mirepoix in Languedoc. He joined the national guard there on the outbreak of the Revolution in 1789 but resigned his commission in 1792 to volunteer for the army of the Pyrenees. After service in the eastern Pyrenees, northwestern France and Italy, he had risen to be general of division in 1802. In that year he accompanied the expedition to San Domingo, where he married a planter's daughter. After serving further in Dalmatia, he was present at the battle of Wagram (1809) and was then sent to Spain, where at Salamanca (1812) he saved the army when Marshal Marmont was wounded. He was general in chief of the northern army in 1813. Having crushed the Bordeaux royalists during the Hundred Days, he was made a peer of France by Napoleon (1815) but had to flee to America in 1816 to escape prosecution under the Restoration. Returning to France under the 1820 amnesty, he was elected deputy for Ariège in 1827. After the July revolution of 1830 he was sent for a short time to replace Marshal Bourmont in command in Algeria. On his recall he was elected deputy for Ardennes (Oct. 1830) and made marshal of France (Feb. 1831).

Thenceforth Clauzel devoted himself to propaganda for the colonization of Algeria, where he himself acquired large estates. Convinced of Algeria's possibilities, he proposed that settlers be brought there from all countries, that cotton be grown there and that the Mitidja be drained and protected by a network of block-houses. Presenting himself as the only man capable of establishing and extending the French colony there and undertaking to make enough profit by the end of seven years to cover the occupation costs, he secured appointment as governor in succession to J. B. Drouet d'Erlon in July 1835. The French cabinet, however, would not authorize his forward policy, and he was soon in conflict with it. He captured Mascara but then gave it up, launched the Tlemcen expedition despite the cabinet and then began preparing to attack Constantine. Alarmed at ministerial changes in Paris (Sept. 1836), he advanced hastily against Constantine with inadequate forces and suffered a reverse, which he minimized as being due to bad weather. Summoned to Paris to account for his conduct, he was amazed to learn, in Feb. 1837, that Gen. C. M. D. Damrémont had been appointed to succeed him. He then retired to the village of Secourrieux (Haute-Garonne), where he died on April 21, 1843.

His Algerian correspondence was edited by G. Esquer, as volume v of the series *Correspondance générale* in the *Collection de documents inédits sur l'histoire de l'Algérie* (1948). (L. G.)

CLAVECIN, the French for harpsichord (*q.v.*). The word is derived from the Latin *clavisimbalum*, a stringed instrument of the dulcimer type with an added keyboard mechanism. *See* CEMBALO.

CLAVICHORD, a stringed keyboard instrument in use at the beginning of the 15th century and obsolescent by about 1800. The 20th century saw a revival of interest in the clavichord, which in the early 1960s was being built in a number of small workshops.

By the 16th century the words clavichord, monochord, virginal and clavicymbalum were freely used to describe any of the forerunners of the pianoforte; but a more precise use of these words was adopted in the second half of the following century. In Germany, however, the word clavier became generic and was applied to any domestic keyboard instrument, including the pianoforte. This untidy nomenclature makes it difficult and often impossible to identify the particular instrument, clavichord or harpsichord, when reading the directions of early composers or historians.

The clavichord usually has a compass of from three and one-half to five octaves. The right-hand or treble part of the instrument, which is oblong in shape, contains the soundboard, the bridge and the wrest or tuning pins. The strings run horizontally from the tuning pins over the bridge and are secured to the hitch pins in the left-hand or bass part of the instrument, where strips of felt are woven through the strings to act as dampers. A small blade of brass, the tangent, stands on each key just below the string which that key controls. When the key is depressed the tangent rises and strikes the string, dividing it into two parts. The right-hand part, between the tangent and the bridge, vibrates and produces the appropriate note; the left-hand part between the tangent and the hitch pin is damped by the felt and is silent. The tangent has done two things: it has determined the vibrating length of the string, as does the finger of a string player; and it has caused the string to sound, as does a pianoforte's hammer. When the key is released the tangent falls away from the string, which is immediately silenced by the felt dampers. The clavichord is usually built with two strings for a note, but it does not always have an independent pair of strings for each key on the keyboard. Thus the tangents of two or three adjacent keys, involving notes that are unlikely to be required together, are sometimes made to share a single pair of strings, each tangent marking the proper speaking length for the note in question. Such clavichords are fretted or, in German, *gebunden*, while those with independent strings for each key are unfretted or *bundfrei*; the nomenclature is reminiscent of the fretted finger boards of lutes and viols.

The tone of a clavichord is very soft, and the instrument is essentially suited to domestic use. It possesses two musical qualities that are unique among the forerunners of the pianoforte: first, a capacity for dynamic variation including piano, forte, crescendo and diminuendo, all of which are obtained by touch alone; and second, the ability to vary a note that is sounding with a vibrato or *Bebung*, the rapid sequence of a normal and a slightly sharpened pitch obtained by a corresponding variation of finger pressure on the key and thus of the tension of the string—a technique familiar to all string players.

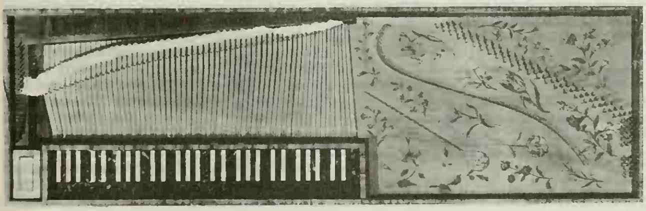
Music expressly written for the clavichord is not easily identified with certainty; the simultaneous presence of three or four types of domestic keyboard instruments resulted in the use of whichever instrument was at hand, a practice that is therefore sound today. Some idea of the type of music that will sound well on the clavichord can, however, be obtained by considering some of the works for which J. S. Bach particularly specified the harpsichord, and not the clavichord: his *Italian Concerto*, the *Partita in B minor*, *Goldberg Variations*, the *Chromatic Fantasy and Fugue* and the *Toccata in D major*.

Thus it can be seen that the clavichord is not the best medium for brilliant or virtuoso music, extended works or compositions calling for two manuals. The instrument is best suited to contrapuntal music in two or three parts, and to other works of the smaller and more intimate sort that are contained within a four-octave compass, such as the six sonatas (1753) of C. P. E. Bach. (R. A. Ru.)

CLAVIJO Y FAJARDO, JOSÉ (1730–1806), Spanish man of letters, remembered for his campaign against public performance of the Corpus Christi *autos sacramentales* which led to their being banned in 1765, and for his love affair with Beaumarchais's sister Louise, immortalized in Goethe's tragic drama *Clavigo*. Born in Lanzarote in the Canary Islands, he was educated in France, acquiring the respect for the French classical ideal which led him to criticize the peculiarly Spanish *auto sacramental* for its nonconformity to rule. Settling in Madrid, he edited a periodical influenced by Joseph Addison's *Spectator*, and translated plays by Racine and Voltaire and critical works by Buffon. He died in Madrid in 1806.

CLAY, CASSIUS MARCELLUS (1810–1903), U.S. antislavery leader, was born in Madison county, Ky., Oct. 19, 1810. He was the son of Green Clay (1757–1826), a Kentucky soldier in the War of 1812 and a relative of the noted congressman Henry Clay. Prior to graduation from Yale in 1832, he attended lectures by William Lloyd Garrison, then a reforming editor, and became a confirmed abolitionist. Clay was elected to the Kentucky legislature in 1835, 1837 and 1840, but was defeated in 1841 on the slavery issue. He established an antislavery publication, the *True American*, in Lexington, Ky., in 1845, turning his offices into a virtual arsenal to repel proslavery raiders. In spite of this, the newspaper was sacked during his absence and he was forced to move it to Cincinnati and then to Louisville.

Clay was one of the founders of the Republican party in 1854. He served as U.S. minister to Russia in 1862, and again between 1863 and 1869. He temporarily left Republican ranks to support Horace Greeley in the presidential election of 1872, but returned to the party and supported James G. Blaine in 1884. He lived his last days in Kentucky and was adjudged insane shortly before his death, July 22, 1903.



RAYMOND RUSSELL

GERMAN CLAVICHORD MADE BY JOHANH A. HASS, 1764

See Cassius M. Clay, *Life of Cassius Marcellus Clay* (1886); Horace Greeley (ed.), *Speeches and Writings of C. M. Clay* (1848).

(J. M. Wo.)

CLAY, HENRY (1777–1852), U.S. political leader, known as the "great compromiser" in the era preceding the American Civil War, was born in Hanover county, Va., on April 12, 1777. His parents, John and Elizabeth Clay, came of English stock and were moderately well-to-do. Henry was the seventh of a family of nine children. He had little formal schooling, but he early displayed great ambition. Given an opportunity to act as amanuensis for Chancellor George Wythe, one of Virginia's most distinguished lawyers, he turned easily to the law as a profession. He studied under Wythe and another famous Virginia lawyer, Robert Brooke, and in Nov. 1797 was admitted to the bar. Then, attracted to Kentucky, to which his mother had moved and which drew many lawyers because of innumerable suits over land claims, he left the strenuous competition of the Richmond bar for the opportunities of the frontier.

Clay went to Lexington, Ky., which was then the centre of frontier culture and refinement. There his star swiftly rose. Shrewd, facile in argument, naturally eloquent, he had no equal in the state as a criminal lawyer, and had numerous clients in civil as well as criminal cases. His position was further established by his marriage in 1799 to Lucretia Hart, daughter of Thomas Hart, a wealthy Lexington businessman. By 1800 Clay was one of Kentucky's outstanding lawyers.

Clay had begun political activities a few months after his arrival in Lexington. A Jeffersonian Republican, he urged liberalization of the state constitution. This, together with an eloquent speech against the alien and sedition laws of 1798, made him popular with Republican voters, and in 1803 he was elected to the Kentucky legislature. In 1806 he acted as counsel for Aaron Burr, who was under grand jury investigation in Kentucky because of his designs in the southwest. When Burr was freed, Kentucky Republicans believed that he had been the victim of a Federalist conspiracy. Clay's reputation did not suffer when his client's designs were later exposed.

Shortly after his defense of Burr, Clay, not yet 30 years of age, was appointed to fill an unexpired term in the U.S. senate, where he advocated a broad construction of the constitution that would permit use of federal funds for roads, canals and other internal improvements. Already he was a "fusionist," ready to accept Federalist doctrines where they promoted western and national economic development.

From 1807 to 1809 he served in the Kentucky legislature, where he defended President Jefferson's embargo and urged the development of home manufactures. In Jan. 1809 he fought a duel with Humphrey Marshall, a Federalist; both men were wounded. Later that year Kentucky again sent Clay to the U.S. senate. There he supported home manufactures and President Madison's seizure of West Florida. He also helped defeat the proposal to recharter the Bank of the United States, which he regarded as an unconstitutional and dangerous money power.

Clay thought of himself as a defender of the people's interests and as such gladly exchanged his seat in the senate for one in the house of representatives in the 12th congress. On Nov. 4, 1811, he was elected speaker of the house, an office he filled with distinction many times in subsequent years. An ardent expansionist, a champion of western economic interests that had been hard hit by the British and French treatment of neutrals, and a nationalist outraged by British contempt for American rights on the high seas, he headed the congressional group known as the "War Hawks" that steadily pushed Madison toward the War of 1812 (*q.v.*). He supported the war vigorously when it came. Then in 1814, as a member of the U.S. peace commission, he took an active part in negotiating the peace treaty. During the negotiations at Ghent he vigorously and successfully opposed giving Great Britain the right to navigate the Mississippi river.

By 1815 Clay was recognized as one of America's leading younger statesmen. He was the spokesman for Kentucky and now sought to consolidate his position as a national leader. In congress he urged limited measures of preparedness, internal improvements at national expense and the protective tariff of 1816. Reversing himself on the bank issue, he successfully championed with Calhoun the incorporation of the second Bank of the United States. Clay also urged that aid be given to the Latin-American patriots who were struggling for independence from Spain, an attitude that made him very popular in South America. He hoped to become secretary of state, as a step toward the presidency, but President Monroe gave the appointment to John Quincy Adams. This so embittered Clay that he became a needling critic of Monroe's administration. In 1819 he also attacked Andrew Jackson for his invasion of Florida, thus earning that doughty general's lasting enmity.

In 1820 Clay became prominent in a role for which he was to become famous: that of compromiser. The dispute over the admission of Missouri to the union as a slave state rocked the nation. Clay, a slaveholder, disliked slavery but saw no way, other than by colonization in Africa, to end the institution. He believed that the Missourians should be free to have slavery, and backed the compromise admitting Maine as a free and Missouri as a slave state, with the rest of the Louisiana purchase above latitude 36° 30′ N. to be forever free. He also pushed through a plan that enabled Missouri to gain admission with a state constitution that excluded free Negroes and mulattoes from admission to the state. His tactfulness in handling the disputes over Missouri won general acclaim, and his admirers called him "the great pacificator."

Clay left congress in 1821 and for the next two years devoted himself to his private affairs, but his political ambition was undiminished. He was easily elected to the 18th congress (1823–1825) and again became speaker of the house. He approved Monroe's famous message of 1823, but criticized the president for his opposition to internal improvements at national expense. He defended the protective tariff of 1824 in a brilliant speech that demanded an "American system" of tariff protection to build up national industry and wealth. In a broader sense, the "American system" that became identified with Clay's name also included the Bank of the United States as a guarantee of a stable currency, internal improvements and distribution to the state governments of revenue from the sale of public lands. It was essentially a nationalistic program.

Clay was a candidate for the presidency in 1824 but ran fourth and last in the election. This excluded him from consideration when the contest was decided in the house of representatives. There the leading contestants were Andrew Jackson and John Quincy Adams. The Kentucky legislature instructed Clay to vote for Jackson, but he refused to do so. He threw his support to Adams, who was elected. Adams then made Clay his secretary of state. Jackson was furious, and he and his followers raised the cry of "bargain and sale." Clay marshaled impressive evidence to show that he had decided to vote for Adams before coming to Washington. The charges of corruption would not down, however, and were periodically resurrected with damaging effect to Clay throughout the rest of his life.

As secretary of state, Clay was loyal to Adams, but he found the department of state dull. He concluded a number of minor commercial treaties but failed to reach an accord with Great Britain on West Indian trade, and British West Indian ports were closed to U.S. shipping. He sought close relations with the South American states, but his effort to send delegates to a Pan-American congress at Panamá was thwarted by his political opponents in congress. In 1826 Clay challenged John Randolph to a duel because of charges of corruption made by the eccentric Virginian, but neither man suffered harm. Political rivalry thereafter became increasingly bitter, the followers of Jackson, Calhoun and William H. Crawford of Georgia combining against the Adams administration and the National Republican party. Out of this conflict grew the Jacksonian Democratic party that defeated the National Republicans in 1828 and put Jackson in the White House.

After March 4, 1829, Clay retired to his estate, Ashland, at Lexington, but he kept in close touch with the national political situation. He attacked Jacksonian policies in regard to the Indians, the use of the veto power and political discrimination in appointments to federal offices. A National Republican convention in Dec. 1831 nominated him for the presidency. That same year he re-entered the senate, where he headed the opposition to the Jacksonian Democrats. He supported a protective tariff and the use of public land revenues for internal improvements. He also championed the recharter of the second Bank of the United States and went down to disastrous defeat before Jackson on that issue in the presidential campaign of 1832. In the following year, however, he successfully piloted the compromise tariff of 1833 through congress, in this way ending the nullification crisis with its menace to the union.

During the remainder of Jackson's second term, Clay continued to challenge Jackson and his cohorts. Now in alliance with Calhoun, Clay prevented confirmation of Martin Van Buren as U.S. minister to England, and pushed through the senate resolutions censuring the president for removing the government deposits from the Bank of the United States. He opposed Jackson's handling of the French debt question, and in so doing helped to restore good relations with France. But his course of action produced few positive results. The deposits were removed from the bank; the censure resolutions were expunged in 1837; Clay's policy of keeping up the price of public land and distributing the proceeds to the states failed to pass congress. His gloom increased as Jackson's term of office drew to its close. He declined to run for the Whig nomination in 1836, and it was only with a heavy heart that he accepted re-election to the senate in 1837.

Van Buren, Jackson's chief lieutenant and designated successor, was elected president in 1836. The charter of the Bank of the United States expired in that year and the new president came out for an independent federal treasury which would keep its money in its own vaults instead of depositing it in a national bank or in the so-called "pet" state banks. Clay fought this proposal, but the Independent Treasury bill became law in 1840. The struggle over this issue separated Clay and Calhoun, the latter now rejoining the Democratic party.

The panic of 1837 and the subsequent depression killed Van Buren's chance of re-election, and Clay confidently expected the Whig nomination in 1840. But Whig party leaders, especially Thurlow Weed of New York, judged it better to find a candidate not so closely associated with the bank issue and turned to Gen. William Henry Harrison, the victor in the battle of Tippecanoe against the Indians in 1811. John Tyler of Virginia, one of Clay's supporters, received the vice-presidential nomination as a sop to the Clay group.

Harrison and Tyler won handily in 1840 but Harrison died one month after his inauguration and Tyler became president. Clay had already proposed in the senate a party program which consisted of repeal of the Independent Treasury act, re-establishment of a Bank of the United States, distribution among the states of the proceeds of public land sales and a higher tariff. The Independent Treasury act was repealed, but Tyler vetoed two bank bills in the summer of 1841, and Clay's plans for the tariff and distribution were frustrated by opposition from both the legislative and executive branches. In 1842, he resigned from the senate.

Tyler could not qualify as leader of the Whigs. The party rallied around Clay and it speedily became evident that he would be the Whig choice for president in 1844. But a new issue now appeared, one fraught with great peril for the Kentucky statesman. This was the annexation of Texas. Clay and Van Buren (who seemed destined for the Democratic nomination) apparently agreed to oppose immediate annexation. Clay was nominated by the Whigs, but Van Buren lost the Democratic nomination to James K. Polk of Tennessee, an ardent expansionist. In the campaign Clay tried by his "Alabama letters" to convince southern voters that he favoured the annexation of Texas at the earliest possible moment. This helped him in the south, but cost him votes in the north. Thousands of New York abolitionists deserted him; he lost that state and with it the election. Bitterly disappointed, the "sage of Ashland" now devoted himself for a time to the pleasures of country life and the repair of his depleted fortunes, but his political ambition burned as brightly as ever. He opposed war with Mexico before it came, but supported the prosecution of the struggle once it began. He hoped for the Whig nomination in 1848 but he was then 71 years old; this, together with the fact that he was a thrice-defeated candidate, worked against him and his own state refused to support him. The Whigs turned to the victorious Mexican War general, Zachary Taylor, and once again Clay's hope for the presidency vanished in frustration.

There remained for the disappointed leader one last great act of national service. Strife was growing between the north and south over the extension of slavery, particularly in the territories gained by the Mexican War, and Clay came back to the senate in 1849 resolved to meet the growing threat of disunion. He proposed a series of resolutions in the senate: California was to be admitted as a free state; the rest of the territory acquired from Mexico would be organized without reference to slavery; there would be a more effective fugitive slave law. These and a number of other provisions were designed to quell the growing tumult. Clay fought hard for this Compromise of 1850 (*q.v.*) and its main proposals were finally enacted into law, largely through Democratic support. Tension between the sections eased and the Civil War was delayed for a decade. Had it come in 1850, the south might have won, for the disparity of strength between north and south was nowhere near as great then as it was ten years later.

Clay's health began to break in 1850 and was only temporarily improved by a vacation trip to Cuba in 1851. He spoke on every appropriate occasion on behalf of the union, but his day of leadership was over. He returned to Washington in the fall of 1851, but could take little part in the proceedings of the senate. Hungary, then oppressed by Austria, was pleading for U.S. intervention, but Clay told the Hungarian patriot Kossuth, in Jan. 1852, that the greatest service the United States could render his suffering land would be to continue setting an example of the results of liberty. During the ensuing months the Kentuckian's health gradually ebbed. He died of tuberculosis in the National hotel at Washington, June 29, 1852. He was buried in the cemetery at Lexington as the nation mourned.

Ardent, impulsive, fearless, Clay was one of the outstanding leaders of the middle period in American history. He sought to make the United States great and powerful by joining the industrial east and the agrarian west in a political alliance under the banner of his "American system." With equal ardour he sought the presidency. But the "American system" and Clay's presidential ambitions alike went down to defeat. Mistakes in judgment, such as accepting the post of secretary of state and campaigning on the bank issue, together with his fundamentally conservative position on tariff, monetary and public land policies, laid him open to damaging attacks by the Jacksonian Democrats. Loved and honoured though he was by many thousands of American citizens, the country would not follow his lead on the great economic questions of the day, nor would it put him in the White House. He was, nevertheless, a national patriot, devoted to public service. At times arrogant and overbearing in his leadership, he yet commanded the loyalty of his followers to an unusual degree. He loved Ashland, with its 600 ac., its stately mansion and its 50 slaves; he was fond of cards, horse racing and good liquor. He and his wife Lucretia had 11 children, 6 daughters and 5 sons. Of these, only four sons outlived him. His direct line ended with the death of his son John M. Clay in 1887.

See also references under "Clay, Henry" in the Index volume.

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CLAY, LUCIUS DUBIGNON (1897–), U.S. army officer of World War II, was born in Marietta, Ga., on April 23, 1897, of a prominent old Georgia family. He graduated from the U.S. Military academy at West Point, N.Y., in 1918, served in various army engineer assignments and during 1940–41 directed the first national civil airport program. Clay was assigned to Washington, D.C., in March 1942, and for the next two and one-half years was in charge of the army procurement program. After brief assignments as base section commander in Normandy and as deputy for war mobilization and reconversion, Clay went to Germany in the spring of 1945 as deputy military governor. In 1947 he became commander in chief, U.S. forces in Europe, and military governor of the U.S. zone of Germany. His administration was marked by the dramatically successful Allied air lift of food and supplies into Berlin during the Soviet land blockade of that city in 1948–49. Following his retirement from the army in May 1949, with the rank of general and numerous decorations, Clay entered private business. He was a prominent supporter and adviser of Dwight D. Eisenhower in the electoral campaign of 1952 and subsequently. Late in Aug. 1961, Pres. John F. Kennedy appointed Clay as his personal representative in Berlin, with the rank of ambassador, to help deal with the critical situation that had developed during the year as to the future status of that city. (R. M. Ln.)

CLAY AND CLAY MINERALS. The term clay has been used in several senses: (1) to designate particle size, about minus 0.004 mm.; (2) as a rock composed essentially of clay materials; and (3) as a name for a group of minerals—the clay minerals. As a rock name it comprises soils, ceramic clays, clay shales, mudstones, glacial clays—including great volumes of detrital and transported clays—and the oceanic clays, red clay, blue clay and blue mud. These are all characterized by one or more of the clay minerals together with varying amounts of organic and detrital materials, among which quartz is dominant.

Clay materials are plastic when wet, water retentive, and coherent when dry. Most clays are the result of weathering, but some are formed by hydrothermal processes. They are one of the major mineral products, being used in a wide variety of industries; and they provide the mechanical and chemical environment for almost all plant growth, and hence for nearly all the life on the earth's surface.

The Clay Minerals.—Clay minerals, which are hydrous aluminum silicates, are divided into three main groups, all being characterized by a sheetlike crystal structure:

Kaolinite group	kaolinite, dickite, nacrite halloysite;
Montmorillonite group	montmorillonite aluminian montmorillonite (beidellite) nontronite, saponite, hectorite sauconite;
Potash clay or hydrous mica group	hydromica, hydrous mica, illite, glimmerton (German) bravaisite.

Kaolinite Group.—Kaolinite, dickite, halloysite and nacrite have the same chemical composition ($Al_2O_3.2SiO_2.2H_2O$) and differ only in their crystal structure. The related mineral endellite contains twice as much water and loses half of it at 60° C., changing to halloysite. Allophane, a material without crystal structure (amorphous) and with variable chemical composition, occurs widely as a product of weathering that is not assignable to any mineral group.

Montmorillonite Group.—The montmorillonite group can be represented by means of ion substitutions in the chemical formula of the related mineral, pyrophyllite [$Al_2Si_4O_{10}(OH)_2$]. In typical montmorillonite about one-sixth of the aluminum is proxied by magnesium, and such exchangeable ions as calcium, sodium, potassium, hydrogen and some magnesium are held between the sheets of the crystal lattice (the so-called exchangeable bases). Variable amounts of loosely held water occupy a position between the crystal sheets. Various ions may proxy aluminum in the crystal structure. If this is iron, the mineral is nontronite; if magnesium, it is saponite or hectorite; and if zinc, it is sauconite. A limited proportion of aluminum may proxy silicon. In the crystal structure approximately three bivalent ions (magnesium, zinc) may proxy trivalent ions (aluminum, iron), which occupy only two of three potential octahedral positions in the crystal structure.

Potash Clay or Hydrous Mica Group.—The hydrous mica group has not been adequately studied. It seems to range in chemical composition from potash-bearing montmorillonite on the one hand to micas on the other. A material with about half the potassium oxide of mica (about 6%) occurs widely. Preliminary studies suggest that the group includes potash-bearing montmorillonite, mixed layers of more than one of the various sheet materials and materials closely related to muscovite mica.

Uses.—No other earth material has so wide an importance or such extended uses as do clays. Their properties as soils are dependent on their providing the physical environment for plant growth; that is, porosity, aeration and water retention. Clays are the storehouse of chemical fertility, base exchange being a fundamental property. Ion exchange in clays plays a major role in plant growth, being a reservoir of potassium oxide, calcium oxide and even nitrogen. It also is a factor in industry in water softeners and oil clarification, with or without acid treatment. Montmorillonites have a high ion exchange capacity (60 to 100 milliequivalents per 100 gram); potash clays have roughly half as much, but in the kaolinite group it is slight.

The purest available source of montmorillonite is bentonite (*q.v.*), a clay resulting from the alteration of volcanic ash. With calcium as the exchangeable ion it is treated with acid and used in petroleum refining. With sodium it is highly dispersable (colloidal) and has wide use as an absorbent.

The use of clay in pottery making antedates recorded human history, and pottery remains are a major record of past civilizations. In western Asia the hieroglyphics inscribed on tiles played a major role in ancient culture. As building materials, bricks (baked and as adobe) have been used in construction since earliest time. Brick, tile and the cruder types of pottery have used impure clays but even the early potters learned to add ground rock or previously baked clay (grout) and even volcanic ash. The finer grades of ceramic materials have made use of white clay or kaolin (*q.v.*), in which kaolinite is the characteristic clay mineral. To this are usually added ground quartz (or flint), ground feldspar and ball clay (a commercial grade containing more organic matter and ion compounds than kaolin) to increase plasticity. Refractory materials, including fire brick, chemical ware and melting pots for glass, make use of kaolin together with other materials which increase resistance to heat. Certain clays known as fuller's earth (*q.v.*) have long been used in wool scouring. A large use of clays (bentonite, halloysite and altapulgite) is in the refining of both organic and mineral oils, commonly after activation by means of acid treatment.

A major use of white clays is as paper coatings and fillers; they give the paper a gloss and increase opacity and printability.

In rubber compounding, the addition of clay increases resistance to wear and aids in the elimination of molding troubles.

The essential raw materials of portland cement are limestone and clays (commonly impure ones). These are ground together, sintered and then ground to a fine powder. On the addition of water, the calcium, aluminum and silicon combine into crystals of hydrous alumina silicates, and the material sets.

Clay materials have a wide variety of uses in engineering. Earth dams are made impermeable to water by adding suitable clay materials to porous soil materials; commonly this is an impermeable core. Water loss in canals may be reduced by adding clay materials. Clays, after acid treatment, have been used as water softeners. The base exchange property permits the clay to remove calcium from solution and substitutes sodium. A major use of bentonitic clay is as drilling muds. These prevent flocculation and their circulation removes the drill cuttings of the rotary drill. A heavy material (barite is commonly used) may be added to the mud, and the hydrostatic head thus developed prevents escape of gas.

See also references under "Clay and Clay Minerals" in the Index volume. (Cl. S. R.)

CLAYS, PAUL JEAN (1819–1900), Belgian marine painter, famous for his pictures of fishing boats in the estuaries and harbours of Holland and his native Belgium, was born at Bruges on Nov. 27, 1819. As a boy Clays ran away to sea, and kept his passion for the sea all his life. He studied in Paris under the French marine painter Théodore Gudin (1802–80) and on his return to Belgium worked mainly in Brussels where he died on Feb. 9, 1900. He began as a follower of C. J. Vernet and Gudin, but after about 1850, under the influence of Gustave Courbet, his paintings became naturalistic in feeling and approach, less composed, and bolder in colour and execution, often with heavy impasto. (A. Bs.)

CLAYTON, JOHN MIDDLETON (1796–1856), U.S. politician, best known for his part in negotiating the Clayton-Bulwer treaty (*q.v.*), was born in Dagsboro, Del., on July 24, 1796. He graduated from Yale in 1815, studied law and was admitted to the bar in 1819. He then entered politics, became a member of the Delaware house of representatives in 1824, and from 1826–28 was secretary of state for Delaware. In 1829 he was elected to the U.S. senate by anti-Jackson forces, was re-elected in 1835 as a Whig but resigned the next year. He was elected chief justice of Delaware in 1837 and in 1845 re-entered the U.S. senate, where he opposed the annexation of Texas and the war with Mexico. In March 1849 he became secretary of state under Pres. Zachary Taylor. His brief secretaryship, which ended on July 22, 1850, was notable for his negotiation of a treaty dealing with canal rights in Central America with Sir Henry Lytton Bulwer, the British minister in Washington, D.C. This treaty, although the crowning achievement of his political career, was probably the most persistently unpopular American treaty. In March 1853 Clayton again entered the senate and served until his death in Dover, Del., on Nov. 9, 1856. (A. De C.)

CLAYTON-BULWER TREATY, one of the most discussed and difficult treaties in the history of Anglo-American relations, was signed April 19, 1850, and later ratified by both the United States and Great Britain. To quote from its official title, the treaty was a "convention for facilitating and protecting the construction of a ship canal between the Atlantic and Pacific Oceans, and for other purposes." It was the joint product of Sir Henry Lytton Bulwer, British minister in Washington, D.C., and John M. Clayton, U.S. secretary of state.

The negotiators hoped that the treaty would relieve certain tensions that had developed between the two nations over Central America and would make it possible for private enterprise to construct and operate a canal. U.S. interest in such a project had been stimulated by the discovery of gold in California in 1848. The two governments agreed that Central America should be neutralized—*i.e.*, neither government would erect or maintain fortifications or occupy, colonize, assume or exercise any dominion over any part of Central America; make use of any protection or alliance that either had or might have with any state or people in Central America; take advantage of any intimacy, or use any alliance, connection or influence that either might possess with any state or government through whose territory the canal might pass.

These provisions were followed by seven articles. One guaranteed freedom of passage at all times, in war as well as in peace, to the ships of either nation. Another assured protection against local violence to any persons who undertook to build the canal. The signers pledged mutual co-operation in inducing states or governments through whose territory the canal would pass to give the project their support. They also engaged that, once the canal was completed, they would protect it and see that it was operated on the principle of fair and equal treatment of the commerce of both nations. They promised that other interested states would be invited to make similar agreements and that they (Great Britain and the United States) would on their part enter into treaty stipulations with the Central American states concerned so that the canal would be maintained "for the benefit of mankind, on equal terms to all." The signatories declared they would support and encourage such persons or company as should first offer to commence construction with the necessary capital. Finally, they agreed to extend their joint protection under the same conditions to any other system of trans-isthmian communication, whether by canal or railway, that might be built by way of Tehuantepec or Panamá.

During the years immediately following ratification of the treaty private capitalists, notably Cornelius Vanderbilt, considered, but decided against, investment in a canal. On the other hand, means of transit across the isthmus were provided to meet the flow of immigrants to the west coast. Vanderbilt opened a combined river and wagon road route across Nicaragua, the same that the proposed canal was expected to traverse; and a rival concern built the Panama railroad, opened for business in 1855. Neither of these enterprises could be said, however, to owe anything to the Clayton-Bulwer treaty, whose elaborate provisions respecting an international waterway remained inoperative.

The historical significance of the Clayton-Bulwer treaty rests, not so much on its safeguards respecting an isthmian canal that was never built under its auspices, as on the international tensions and power rivalries that the treaty was expected to alleviate. Far from accomplishing this object, the treaty entered a stormy period of 10 years, the United States arguing that it required renunciation on Britain's part of certain established interests, viz., a protectorate over the Mosquito Coast, a settlement in British Honduras, and a community of settlers, mostly Negro, living on the Bay Islands, who asked for and received from the colonial office recognition in 1852 as a colony. Britain's counter position on these matters was that the treaty recognized the *status quo*. This argument ended in certain adjustments being made in 1859–60; but in 1881 James G. Blaine, U.S. secretary of state, demanded that the treaty be abrogated, his argument being that the United States was now the paramount power in the Americas and could not permit its hands to be tied by the treaty. This argument, rejected by the Gladstone ministry at the time, gained acceptance in 1901 with the conclusion of the second Hay-Pauncefote treaty. This treaty abrogated the Clayton-Bulwer treaty and authorized the United States to construct and control the canal. *See* also Panama Canal.

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CLAZOMENAE, an ancient city of Ionia, about 20 mi. W. of Izmir (Smyrna) on the south side of the Gulf of İzmir in the Izmir *il* of Turkey. It was a member of the Ionian Dodecapolis (confederation of twelve cities). Its founders are said to have come from Cleonae and Phlius and to have settled at Clazomenae only after unsuccessful attempts elsewhere. The city stood originally on the mainland near the base of the Erythraean peninsula; but the inhabitants, alarmed by the encroachments of the Persians, moved to an island 400 yd. from the coast, and there established their city. This island was connected with the mainland by Alexander the Great by means of a pier, some traces of which are still visible. During the 5th century b.c. it was subject to Athens but in 412 b.c. it revolted and after a period of bitter party strife became subject to Persia in 387 b.c. Under the Romans Clazomenae was included in the province of Asia and enjoyed immunity from taxation. It was the birthplace of the philosopher Anaxagoras and of Pericles' siege engineer, Artemon. It is famous for its painted terra-cotta sarcophagi which are notable monuments of Ionian painting in the late 6th century b.c. (E. Gr.; Jo. M. Co.)

CLEANTHES (*c.* 301–232 or 252 b.c.), Stoic philosopher, was born at Assos in the Troad. He came to Athens, where he listened first to the lectures of Crates of Thebes and then to those of Zeno the Stoic, supporting himself meanwhile by working all night as water carrier to a gardener (hence his nickname, "one who draws from a well"). On the death of Zeno he became the leader of the school. Among his pupils were his successor, Chrysippus, and Antigonus II Gonatas, king of Macedonia.

Cleanthes produced little that was original, though he wrote about 50 works, of which fragments have survived. The principal is the large portion of the *Hymn to Zeus*, which was preserved in Stobaeus. He regarded the sun as the abode of God, the intelligent providence, or (in accordance with Stoic materialism) the vivifying fire or ether of the universe. Virtue, he taught, is life according to nature; but pleasure is not according to nature. The principal fragments of Cleanthes' works are contained in Diogenes Laërtius and Stobaeus; some may be found in Cicero and Seneca. *See* Stoics.

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muth, *Commentationes de Zenone Citiensi et Cleanthe Assio* (1874–75); R. Hirzel, *Untersuchungen zu Ciceros philosophischen Schriften,* ii (1882), containing a vindication of the originality of Cleanthes.

CLEARINGHOUSE. When business firms engaged in the same kind of activity have extensive dealings with each other, it is an obvious convenience and economy to establish an institution to enable them to offset one transaction with another, thus limiting payment settlements to net balances. Such mutual institutions are called clearinghouses and they may be established in many branches of industry.

Clearinghouses have been set up for the purpose of settling interbank check clearings in financial centres throughout the world; clearinghouses also play an important role in settling transactions related to railroads, stock and commodity exchanges and international payments.

Bank clearinghouses generally are voluntary associations of local banks set up for the purpose of simplifying and facilitating the exchange of such items as checks, drafts, bills and notes, and to facilitate the settlement of balances among the banks. (*See* BANKING.) In addition, bank clearinghouses may serve as the medium through which participating banks may discuss matters of mutual interest and perform such functions as fixing service charges, exchanging credit information, gathering credit data and regulating advertising. Before the formation of the federal reserve system, bank clearinghouses in the United States, on occasions, performed additional functions such as fixing interest rates on deposits and extending loans to the government and to member banks.

The first modern bank clearinghouse was established in London in 1773, although the clearinghouse idea had been applied to various forms of trade in such places as Tokyo, Japan, Florence, Italy, and Lyons, France, many centuries earlier. It was not until 1853 that the New York clearinghouse, the first bank clearinghouse in the United States, was established. By the early 1960s there were more than 300 bank clearinghouses in the United States; they varied greatly in volume of clearings and physical facilities. In smaller towns, for example, the clearinghouse might be only a single room within one of the member banks.

A large share of all bank clearings in the United States is effected through the New York clearinghouse. Settlements among the member banks are effected through the deposit account that each holds at the Federal Reserve bank of New York. Other banks in the New York metropolitan area and throughout the country indirectly effect many of their check clearings via the New York clearinghouse either through the Federal Reserve bank of New York or through correspondent relations with New York clearinghouse members. Daily check clearings at the New York clearinghouse frequently exceed $2,000,000,000, but over 80% of settlements generally are effected through exchange of clearing items.

See Walter E. Spahr, *The Clearing and Collection of Checks* (1926); American Institute of Banking, *Principles of Bank Operations* (1956); Federal Reserve Bank of New York, *The Money Side of the "Street,"* (1959). (S. C. S.)

CLEAVAGE, in geology, refers to parallel surfaces of secondary origin along which rocks tend to break into thin sheets one millimetre or so thick. Ordinary roofing slate (*q.v.*) is an excellent example of a rock possessing good cleavage. Cleavage is more restrictive in its meaning than foliation, which refers to any parallel surfaces, regardless of whether they are primary or secondary, along which the rock tends to break into thin sheets. The tendency of many sedimentary rocks to break into slabs parallel to the bedding is primary, that is, it is the result of properties inherent in the rock from the time of deposition. Schistosity is that variety of cleavage found in the more coarsely crystalline metamorphic rocks, notably schists (*q.v.*).

Cleavage, the result of deforming forces acting on the rock, is sometimes referred to as rock cleavage to distinguish it from mineral cleavage, which is due to the parallel arrangement of the layers of atoms of which the mineral is composed (*see* MICA: *Mineralogical Properties*).

See also FAULT; FOLD; METAMORPHISM.

CLEAVERS, commonly called goose grass, *Galium aparine* (family Rubiaceae), is a common plant in hedges and waste places. It has a long, weak, straggling, four-sided, green stem, bearing whorls of six to eight narrow leaves, one-half to two inches long and, like the angles of the stem, rough from the presence of short, stiff, downwardly pointing, hooked hairs.

The small, white, regular flowers are borne, a few together, in axillary clusters, and are followed by the small, bristly, two-celled fruit which, like the rest of the plant, readily clings to a rough surface, whence the common name. The plant has a wide distribution throughout the north temperate zone, and is also found in temperate South America.

CLEETHORPES, a municipal borough (1936) in the Louth parliamentary division of the Parts of Lindsey, Lincolnshire, Eng., adjoining Great Grimsby to the southeast, 36 mi. S.S.E. of Lincoln by road. Pop. (1961) 32,705. Its gently shelving shore of fine sand, affording safe bathing, is part of the Humber estuary. The sea wall and continuation embankment form the three-mile Kingsway promenade. The church of the Holy Trinity and St. Mary is principally Norman, but pre-Conquest work appears in the tower.

Cleethorpes, facing eastward to the North sea, is a health and seaside resort for the midlands, Lancashire and Yorkshire. There are parks, pleasure grounds and a pier.

CLEF: *see* MUSICAL NOTATION.

CLEFT PALATE, a congenital cleavage in the roof of the mouth, due to faulty embryologic development. *See* SPEECH DISORDERS.

CLEISTHENES, the name of two ancient Greek statesmen, one Sicyonian, the other Athenian.

CLEISTHENES OF SICYON, tyrant of Sicyon, from about 600 to 570 B.C., belonged to the non-Dorian family of Orthagoras, who had established the tyranny in Sicyon with the support of the Ionian section of the inhabitants. Cleisthenes emphasized the destruction of Dorian predominance by giving ridiculous epithets to their tribal units, which from Hylleis, Dymanes and Pamphyli become Hyatae ("Swine-men"), Choireatae ("Pig-men") and Oneatae ("Ass-men"). He also attacked Dorian Argos and suppressed the Homeric rhapsodists who sang the exploits of Dorian heroes. He championed the cause of the Delphic oracle against the town of Crisa in the Sacred War of *c.* 590 B.C. Crisa was destroyed, and Delphi became one of the meeting places of the Delphic amphictyony (*see* AMPHICTYONY). The Pythian games were re-established with new magnificence, and Cleisthenes won the first chariot race in 582. He founded Pythian games at Sicyon and built a new Sicyonian treasury at Delphi. His power was so great that when he offered his daughter Agariste in marriage, some of the most prominent Greeks sought the honour, which fell upon Megacles, the Alcmaeonid. The story of the rival suitors is told by Herodotus.

CLEISTHENES OF ATHENS (late 6th century B.C.), the Athenian statesman, was the son of Megacles, the Alcmaeonid, and Agariste, daughter of Cleisthenes of Sicyon. The Alcmaeonidae (*q.v.*) had been in exile during the last period of Pisistratus' tyranny, but Cleisthenes had been allowed to return by 525, when he was archon (Pisistratus' son Hippias, after his father's death, may perhaps have been trying to reconcile the opposition). He was, however, soon in exile again. Then, after an unsuccessful attempt to return by force, he used his influence at Delphi to secure the intervention of Sparta. Cleomenes I, the Spartan king, at the Delphic oracle's bidding (and because he was concerned at Pisistratid friendship with Argos) expelled the Pisistratidae from Athens in 510. Returning to Athens, Cleisthenes realized that the Athenians would not tolerate a new tyranny, and the other nobles were unwilling to accept him as leader of an oligarchy. Defeated in the struggle of aristocratic factions, he "took the people into partnership," in Herodotus' words. The crisis came in 508 when his main rival, Isagoras, was archon. Cleisthenes' democratic program was accepted by the assembly, but Isagoras appealed to Sparta. Cleisthenes and his supporters went into exile when the Spartans revived the old question of the Alcmaeonid bloodguilt, but when Cleomenes tried to set up an oligarchy in Athens the democrats rose and, after securing the withdrawal of Cleomenes and Isagoras, recalled Cleisthenes and his supporters from exile. Cleisthenes' reforms could now be carried through.

Cleisthenes saw that the existing system of tribes, with their constituent units of phratries (brotherhoods) and clans, militated against the effective working of democracy. This was so because the divisions of phratry and clan, having not only racial and religious associations but also associations of property (since they were more or less parallel with geographical divisions), caused local and family interests to predominate in the four tribes and enabled noble families to exert undue influence in politics. He accordingly abolished the four tribes and created ten new ones on an entirely different basis. He divided Attica into three districts, urban (including suburban), inland and maritime, each of which was subdivided into ten *trittyes* (a purely artificial geographical unit). He created a tribe by taking one *trittys* from each of the three districts, so that each of the ten new tribes so constituted included people from all parts of Attica. Each *trittys* comprised one or more demes or townships, and the deme now became the political subdivision of the tribe and the basic electoral unit. Electoral divisions thus ceased to be identical with those of clan and property. This new organization was for political purposes only. For religious purposes the clans and phratries retained their old signification.

The names of the new tribes were taken from legendary heroes and therefore contributed to the idea of a national unity. Each tribe had its shrine and its particular hero cult, which, however, was free from local association and the dominance of particular families. This national idea Cleisthenes further emphasized by setting up in the market place at Athens a statue of each tribal hero.

The number of members of a deme varied greatly, though, at first, the division was local (*i.e.*, a deme consisted of its residents); the qualification became hereditary, a man belonging to his father's deme wherever he lived. Hence there arose a distinction between resident demesmen and residents belonging to another deme. The main purpose of the reform was to do away with the religious qualification of connection with clan or phratry and so facilitate the enfranchisement of new citizens. The demes were not invented by Cleisthenes. They were primitive divisions of Attica which were now given definition as political divisions. But the formation of demes in the city itself was new; there were six, in five different tribes, and the other five tribes were represented in the suburbs and the Piraeus. In the Cleisthenean system there was one great source of danger, namely that the residents in and about Athens must always have had more weight in elections than those in distant demes. Moreover, a special class, the new commercial element in the citizenship devised by Solon and fostered by Cleisthenes, soon came to have a preponderating influence in the city and suburbs.

Cleisthenes also carried out a franchise reform. According to Aristotle he created new citizens by enrolling in the tribes "many resident aliens and emancipated slaves." Metics (resident aliens) had been encouraged to settle in Athens by Solon and the grant of citizenship had been made to many skilled in trades and handicrafts. The Pisistratidae had favoured this commercial class as a support against the aristocrats, but after their expulsion a revision of the citizen roll had removed many or all of these as "not of pure descent." Cleisthenes restored these and opened the way to citizenship to all satisfactory resident aliens, so strengthening the position of the democracy.

The *boule* (*q.v.*) was reorganized to suit the new tribal arrangement and was known henceforward as the Council of the Five Hundred, with 50 members from each tribe, each 50 acting as an executive committee (*prytaneis*) for one month. Later, in the fully developed democracy, the president of the *boule* and *ecclesia* was chosen by lot each day from the tribe which was providing the *prytaneis* that month, but in the time of Cleisthenes it is more probable that the archon continued to preside. The new tribal system was also applied to the boards of magistrates, which henceforward had each ten members, and the *apodektai* (receivers) may have been introduced to assist the *kolakretai* (treasurers), since state finance was becoming more complex. A further change which followed from the new tribal system was the reconstitution of the army under ten tribal commanders; this, however, probably took place about 501 B.C. and cannot be attributed directly to Cleisthenes. For most purposes the deme replaced the *naucraria* as a local administrative unit, but the *naucrariae* still supplied the fleet, and were increased from 48 to 50.

Cleisthenes is also said to have introduced ostracism (*q.v.*) to enable the democracy to remove potential tyrants without violence. The device was not used until 487, some time after the battle of Marathon, and it has been thought that it must have been instituted immediately before its first use; but this inference is not necessary and is against the best evidence.

We hear nothing of Cleisthenes after his reforms except for a late story, probably false, that he was himself ostracized. He may have been discredited as a result of Athens' approaches to Persia when the new democracy was threatened by Sparta, Boeotia and Chalcis (506). There are indeed indications that some of the Alcmaeonidae may have favoured Persia in the period 507–490, but the evidence is not decisive.

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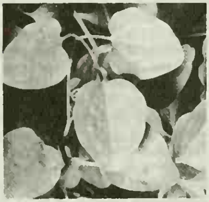
CLEITHRAL, an architectural term applied to a Greek temple whose roof completely covered it; in contradistinction to hypaethral, applied to one partly or wholly open to the sky. *See* GREEK ARCHITECTURE; TEMPLE ARCHITECTURE.

CLEITOMACHUS (CLITOMACHUS, originally named HASDRUBAL) (187/186–110/109 B.C.), from Carthage, head of the Academy in Athens from 127/126 B.C. (*see* ACADEMY, GREEK), was the pupil and the main literary exponent of Carneades. His works, all of which are lost, filled 400 volumes and included *On the Withholding of Assent;* two popular introductions to the Academic philosophy; and a consolatory letter to his compatriots on the fall of Carthage. How much can, in addition to quotations, be traced to him in Cicero, in Sextus Empiricus and in other writers is controversial. Contradicting some philosophers, he maintained that Carneades never disclosed preference for any philosophical doctrine. True to antidogmatism, he expected the ideal wise man never to assent to anything (to practice *epochē*), but permitted him to admit or to deny verisimilitude, according to circumstances. (PP. M.)

CLEMATIS, a genus of vines and herbs of the crowfoot family (Ranunculaceae; *q.v.*), containing approximately 200 species and widely distributed but most abundant in temperate regions. The plants are semiwoody climbers with generally compound, opposite leaves, the stalk of which is sensitive to contact like a tendril, becoming twisted round suitable objects and thereby giving support to the plant. The flowers are arranged in axillary or terminal clusters; they have no petals, but white or coloured, often large sepals, and an indefinite number of stamens and carpels. They contain no honey, but are visited by insects for the pollen which is plentiful. The fruit is a head of achenes, each bearing the long-bearded, persistent style, suggesting the popular name of old-man's-beard. This feathery style is an important agent in the distribution of the seed by means of the wind. Inclusive of the sections *Viorna* and *Atragene*, which some botanists regard as separate genera, there are about 27 species of *Clematis* native to North America. Of these, the following representatives are more or less cultivated: the virgin's-bower (*C. virginiana*), found from Nova Scotia to Manitoba and southward to Georgia and Louisiana; the western *C. ligusticifolia*, growing from North Dakota and



JOHN H. GERARD

FIG. 1.—LEAVES OF OLD-MAN'S-BEARD, OR TRAVELER'S-JOY (C. VITALBA)

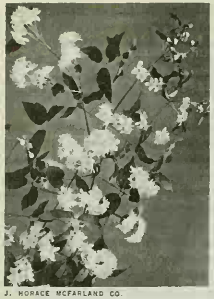


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FIG. 2.—VIRGIN'S-BOWER (CLEMATIS VIRGINIANA)

Missouri westward to British Columbia and California; the purple virgin's-bower (*C. verticillaris*), found from Hudson bay to Minnesota and southeastward to Connecticut and Virginia; the scarlet virgin's-bower (*C. texensis*), native to Texas; and the pipestem virgin's-bower (*C. lasiantha*) of California and Oregon.

Clematis is represented in England by *Clematis vitalba*, old-man's-beard or traveler's joy, a common plant on chalky or light soil.

Several of the species, especially the large-flowered ones, are favourite garden plants, well adapted for covering trellises or walls or trailing over the ground. Of these over 30 are grown in U.S. gardens, and about 40 in England. They grow best in a rich, loamy soil with a fair supply of well-rotted manure thoroughly distributed in it.

Far finer than the species are the garden hybrids, mostly derived from crosses between *C. jackmanii* (itself a hybrid) and several other species. Some of these have flowers four to six inches wide and are extremely handsome vines. A selection from over 60 of these hybrids might include: Gipsy Queen (purple), Ramona (blue), Lady Caroline Neville (mauve, with dark bars), Sir Garnet Wolseley (bronzy blue), William Kennett (lavender), Lord Neville (dark plum), Henryi (white), Belle of Woking (azure blue), Crimson King (red) and Duchess of Albany (scarlet).

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CLEMENCEAU, GEORGES (1841–1929), French statesman whose determination and perseverance urged his country on to victory in World War I, was born at Mouilleron-en-Pareds, Vendée, on Sept. 28, 1841. He took up his father's profession of medicine and studied at Nantes and Paris. Attracted by inclination and family tradition to the republican opposition to Napoleon III, he began to take an interest in British and U.S. affairs. At the end of 1865 he embarked for the United States, taking with him Mill's *Auguste Comte and Positivism* to translate into French. He remained in New England for three years, writing descriptions of American post-Civil War conditions to the Paris *Temps* and teaching French in a girls' school at Stamford, Conn. He married one of his pupils, Mary Plummer, but they separated after seven years.

In 1869 Clemenceau returned to Paris. After the revolution of 1870 he was nominated mayor of the 18th *arrondissement* of Paris (Montmartre). On Feb. 8, 1871, he was elected as a Radical to represent the Seine *département* in the national assembly at Bordeaux, where he voted against the preliminaries of the peace with Germany. In Paris, the execution of Generals C. M. Lecomte and Clément Thomas by their mutinous soldiers on March 18, which he tried to prevent, brought him into collision with the central committee of the National Guard, then the illegal government of Paris. It ordered his arrest, but he escaped; he was accused, however, by various witnesses, at the subsequent trial of the murderers (Nov. 29), of not having intervened when he might have, and though he was cleared of this charge it led to a duel, for his share in which he was prosecuted and sentenced to a fine and a fortnight's imprisonment.

Meanwhile, on March 20, 1871, Clemenceau had introduced in the national assembly at Versailles, on behalf of his Radical colleagues, the bill establishing a Paris municipal council of 80 members, but he was not himself elected to it. He tried with the other Paris mayors to mediate between Versailles and the central committee, but failed. He accordingly resigned his mayoralty and his seat in the assembly and temporarily gave up politics; but he was elected to the Paris municipal council on July 23, 1871, for the Clignancourt *quartier* and retained his seat till 1876, passing through the offices of secretary and vice-president and becoming president in 1875. In 1876 he stood again for the chamber of deputies and was elected for the 18th *arrondissement*. He joined the extreme left, and his energy and mordant eloquence speedily made him the leader of the Radical section.

In 1877, after the *Seize mai* (*see* FRANCE: *History*), Clemenceau took a leading part in resisting the anti-republican policy of which the *Seize mai* incident was a symptom, and in 1879 he demanded the indictment of the duc de Broglie's ministry. In 1880 he started his newspaper, *La Justice*, which became the principal organ of the Radicals in Paris; and from this time onward throughout Jules Grévy's presidency he rapidly built up his reputation as a political critic and as a destroyer of ministries who yet would not take office himself. He led the extreme left in the chamber. He was an active opponent of Jules Ferry's colonial policy and of the Opportunist party, and in 1885 his use of the Tongking disaster principally determined the fall of the Ferry cabinet. At the elections of 1885 he was returned both for his old seat in Paris and for the Var, selecting the latter. Refusing to form a ministry because he could not command a majority in the senate to replace the one that he had overthrown, he supported the right in keeping Charles de Freycinet in power in 1886 and was responsible for the inclusion of Gen. Georges Boulanger (*q.v.*) in the Freycinet cabinet as war minister. When Boulanger showed his real colours, Clemenceau became a vigorous opponent of the Boulangist movement and helped to found the League of the Rights of Man to press for radical reforms.

By his share in the exposure of Daniel Wilson, President Grévy's son-in-law, for trafficking in honours, Clemenceau caused the resignation of the prime minister Maurice Rouvier (*q.v.*). Having refused Grévy's request to form a ministry, he also contributed to Grévy's resignation (Nov. 1887) and was primarily responsible, by advising his followers to support neither Charles Floquet, Ferry nor Freycinet, for the election of an "outsider" as president in Sadi Carnot. Clemenceau's relationship with Cornelius Hertz inevitably threw suspicion upon him when the Panamá scandal was exposed (1892) and the Boulangists took revenge upon him for repudiating the general. Although their attack failed it involved him in a duel with Paul Déroulède and cost him his seat in the elections of 1893.

For the next nine years Clemenceau confined his political activities to journalism, his career being further clouded by the Dreyfus case (*see* DREYFUS, ALFRED). In this he was an active supporter of Zola (whose exposé of the affair appeared in *L'Aurore*, founded by Clemenceau in 1897) and an opponent of the anti-Semitic and nationalist campaign. In 1900 he withdrew from *La Justice* to found a weekly review, *Le Bloc*, which lasted until March 1902. On April 6, 1902, he was elected senator for the Var, although he had previously demanded the suppression of the senate. He sat with the Radicals and vigorously supported the ministry of Émile Combes. In June 1903 he undertook the direction of *L'Aurore*. In it he led the campaign for the revision of the verdict on Dreyfus, and for the separation of church and state.

In March 1906 the fall of the Rouvier ministry, because of riots provoked by the inventories of church property, at last brought Clemenceau to power as minister of the interior in Ferdinand Sarrien's cabinet. When a strike of miners in the Pas-de-Calais after a disaster at Courrières led to the threat of disorder on May 1, 1906, he resolved to employ the military; and his attitude in the matter alienated the Socialist party, from which he definitely broke in his notable reply in the chamber to Jean Jaurès in June 1906. This speech marked him out as the "strong man" of the day in French politics; and when the Sarrien ministry resigned in October he became premier. During 1907 and 1908 the new entente with England was cemented, and France played a great part in European politics, in spite of difficulties with Germany and attacks by the Socialist party in connection with Morocco. On July 20, 1909, Clemenceau was defeated in a discussion in the chamber on the state of the navy. He was succeeded as premier by

Aristide Briand, with a reconstructed cabinet.

Two years later Clemenceau entered the senate again and became a member of its commissions for foreign affairs and the army. He could have had no better position for surveying European fluctuations and German activities or for inquiring into the real condition of French armaments, about which he was most concerned. Convinced that Germany meant war, he was haunted by the fear that again France might be caught unprepared. In order to make better known his views on armaments, he founded in May 1913, a new daily paper, *L'Homme Libre*, with himself as editor. He could thus wage daily battle for security against the German menace.

In the spring of 1913 the question of restoring the three years' term of conscript service suddenly arose. Clemenceau took an impassioned part in the debates on armaments. In Aug. 1914 World War I started. *L'Homme Libre* suffered at the hands of the censor for Clemenceau's plain speaking. He wanted the whole youth of France to be mobilized; he denounced the shirkers, demanded technical efficiency and attacked red tape, inadequate munition factories and badly run hospitals. He made war upon all who failed to realize that this was a conflict of supplies and organization, and upon every kind of apathy and feebleness. In Sept. 1914 *L'Homme Libre* was suppressed. Two days later, however, it reappeared as *L'Homme Enchaîné*, but wore its fetters lightly. For three months there was a daily struggle with the censor. For some time not a week passed without articles' being mutilated, but Clemenceau won and excisions became rare. Meanwhile, in the senate, Clemenceau agitated for more and more guns, munitions and soldiers, for judicious use of the available manpower and for a better-equipped and better-organized medical service.

Above all, Clemenceau strove to create an indomitable "will to victory." As the war dragged on, weariness, slackness and pacifism began to appear. Clemenceau was the first to draw public attention to that growing peril, and it was at a public debate in the senate on July 22, 1917, that he made his famous attack on Louis Malvy, who had been minister of the interior since 1914. Clemenceau declared that Malvy had not treated revolutionaries with a firm enough hand. Malvy's justification was that he desired to "gain the confidence of the working-man"; but Clemenceau retorted that there was no comparison between those workingmen who were loyally doing their duty to their country and a number of abject "defeatists."

In Nov. 1917 the president of the republic, Raymond Poincaré, asked Clemenceau to form a government. Clemenceau knew that his task meant victory or death: morale at the front was bad, and at home even worse; resources were nearly at an end, and no solution whatever could be discerned. Though he was 76 years of age, he formed his cabinet on Nov. 16, 1917, with himself as minister of war as well as premier. Thenceforward till Nov. 11, 1918, he concentrated on war only. He made it clear that France was bent on absolute victory and would accept no half-measures. Those who spoke of wavering or yielding were immediately silenced; anyone who obstructed the path to victory was ruthlessly removed. By these means Clemenceau restored the nation's self-confidence. When the Germans launched their great assault on the Anglo-French line in March 1918, Clemenceau joined in organizing the unity of command with Ferdinand Foch at the head. In May came the disaster of the Chemin-des-Dames, and the French troops were driven back on the Marne. The commander in chief was severely criticized, but three months later Clemenceau made him marshal of France. During 1918 Clemenceau's resolution remained unshaken, and on Nov. 11 the Germans signed the Armistice.

From Nov. 11, 1918 to June 28, 1919, Clemenceau devoted himself to the international settlement. The peace of Versailles was in preparation, and this necessitated strenuous days of work and delicate negotiations. Clemenceau made it his task as president of the conference of Paris to reconcile the interests of France with those of Great Britain and the United States. He defended the French cause with enthusiasm and conviction, forcing his view alternately on David Lloyd George and Woodrow Wilson. Meanwhile he took care to see that Germany disarmed. Yet the French parliament began to grow restless, for it saw itself put to one side in the peace negotiations. It no longer regarded Clemenceau as indispensable. The great patriot, anxious to finish the work that he had begun, did his best to smooth matters over. Demobilization had to be faced, a general election was looming ahead, and the questions of Alsace-Lorraine and the liquidation of war stocks had to be settled. Clemenceau decided to deal simultaneously with these questions as of equal importance.

Peace was signed on June 28, 1919, and on Nov. 11 the new chamber was elected. Clemenceau counted on its support, for he believed that its members, many of them ex-soldiers, would have profited by the lesson of the war. Yet though Clemenceau had saved his country, the parliamentarians could not forgive the fact that he had excluded them from the final work for victory. During the war he had undoubtedly worked alone, as he felt that large assemblies were not made for action, but he might have admitted the commissions to the deliberations on the treaty of Versailles if diplomatic obstacles had not precluded it. He had also to face the hostility, not only of the clerical party of the right who suspected him of indifference to the Vatican, but also that of the extreme left, who were alienated by what they considered to be his militarism. He thus met the fate which overtook other war ministers, and on Jan. 20, 1920, his cabinet fell, Alexandre Millerand being summoned to office. Clemenceau had earned the gratitude of his country and could now have sought repose; instead he sailed for India.

When it appeared that the United States was seeking to dissociate itself from European affairs, Clemenceau, 81 years old, sailed at once for the United States at the end of 1922. From town to town he carried the message of France to the citizens of the U.S. He had no official mission, for he had neither asked anything nor received anything from the French government. His progress was nonetheless triumphant. Once more he returned to Paris, but not to rest. By the end of 1925 he was already writing two books: one on philosophy, *Au soir de la pensée*, two volumes (1927; Eng. trans., *In the Evening of My Thought*, two volumes, 1929), and the other on Demosthenes, *Demosthène* (1926; Eng. trans. by C. M. Thompson, 1926). He was at work upon his memoirs, *Grandeurs et misères d'une victoire* (1930), when he died in Paris on Nov. 24, 1929.

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CLEMENS (non Papa), **JACOBUS** (*c.* 1510–*c.* 1558), Flemish composer famous for his sacred music. Born in Ypres, about 1510, from 1546 he called himself "Clemens non Papa" to avoid confusion with a priest and poet of the same name there. In 1544 he was in Bruges as probationary choirmaster of St. Donatien, leaving before 1545, and in 1550 he was a singer and composer at 's Hertogenbosch. His outstanding *Souter Liedekens* (1556), an almost complete series of Flemish metrical psalms, were probably interrupted by illness or death; an elegy of 1558 suggests that he died violently. His works include 15 Masses (10 published 1557–59); many motets (6 published 1546; 11, 1556; 92, 1559); and 90 chansons. He composed in all the current styles, using simple, impressive themes, melodious lines and dextrous imitation foreshadowing Lassus.

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CLEMENS, SAMUEL LANGHORNE: *see* Twain, Mark.

CLEMENT, the name of 14 popes and 3 antipopes.

St. Clement I (St. Clement of Rome), pope from 88 to 97 or from 92 to 101, according to Tertullian was consecrated by St. Peter. Irenaeus lists him as third successor of Peter, contemporary of the apostles and witness of their preaching. Eusebius' *Ecclesiastical History* dates his pontificate from the 12th year of Domitian to the third year of Trajan (A.D. 92 to 101). Origen, Epiphanius, Eusebius and Jerome identify him with the Clement of Philippians iv, 3. Though the important Epistle to the Church of Corinth, called I Clement, does not bear Clement's name, the tradition which ascribes it to him is early and universal. References to the persecution by Domitian and the testimony of Hegesippus (quoted by Eusebius in his *Ecclesiastical History*) indicate that it was written around A.D. 96. The unmistakably authoritative tone of the letter addressed to a church in Greece makes the author more than merely a peacemaker. Clement regards the ejection of several presbyters as a highhanded and unjustifiable procedure on the grounds that the hierarchical principle of the Christian ministry, the apostolic succession, precludes such action by the Corinthians. The long invocation toward the end of the letter is probably the contemporary Roman liturgical prayer in the Eucharist. Extensive use of the Greek version of the Old Testament (Septuagint) points to a Judaeo-Hellenistic background. Christian antiquity, especially in Syria and Egypt, read the letter avidly, almost equating it with the New Testament. Numerous so-called Clementine writings (*see* CLEMENTINE LITERATURE) witness the high regard for Clement in the early church. His feast day is Nov. 23. (J. M. F. M.)

CLEMENT II (Suidger), pope from 1046 to 1047, a worthy man of noble Saxon birth and formerly bishop of Bamberg, was elevated Dec. 24, 1046, by Henry III. His short pontificate saw the beginning of a period of reform, and in 1047 he convoked the council of Rome which passed decrees against simony. Clement died Oct. 9, 1047. (C. P. L.)

CLEMENT III (Guibert, or Wibert, of Parma), antipope from 1080 to 1100, the talented son of an imperialist family, served at the German court, becoming imperial chancellor for Italy (1058–63). Confirmed as archbishop of Ravenna by Alexander II (1073), he fell out with Gregory VII and became Italian leader of the imperialist faction. Already excommunicated, he was elected on June 25, 1080, by a synod convoked by Henry IV at Brixen, which declared Gregory deposed. He was enthroned when Henry finally took Rome (March 24, 1084), and kept power there until the 1090s. He died Sept. 8, 1100. (J. J. RY.)

CLEMENT III (Paolo Scolari), pope from 1187 to 1191, a Roman and cardinal bishop of Palestrina, was elected pope on Dec. 19, 1187. In October Jerusalem had fallen to Saladin, and Clement urged the princes of the west to undertake the third crusade. Apart from the capture of Acre the results were disappointing. In Italy the marriage of King Henry of the Romans with Constance of Sicily threatened to unite south Italy to the German crown. This Clement tried to avert by enfeoffing Count Tancred of Lecce with Sicily, but he died before the results of his policy became apparent. One of his permanent acts was the removal of the Scottish church from the jurisdiction of York (1188) and it became dependent directly on Rome. Clement III died March 20, 1191. (C. H. LE.)

CLEMENT IV (Guido Fulcodi or Faucoi), pope from 1265 to 1268, was born at St. Gilles, near Nîmes. An eminent jurist serving Louis IX, he had become priest when widowed, then bishop of Le Puy (1257), archbishop of Narbonne (1259) and cardinal bishop of Sabina (1261). He was elected pope on Feb. 5, 1265. Executing Urban IV's plan, Clement invested Charles of Anjou with the Sicilian kingdom (1266) and financed the costly invasion. But the Hohenstaufen defeat brought peace neither to Rome nor to Italy; the Angevins were a new threat to the papacy's independence and a heavy drain on its material and moral resources. Clement died Nov. 29, 1268, at Viterbo. (J. J. RY.)

CLEMENT V (Bertrand de Got) (1264–1314), pope from 1305 to 1314, the first of the Avignon popes. He created a majority of French cardinals and assured a line of French popes. Blackmailed by King Philip IV of France, the chronically sick pope acquiesced to Philip's demands for the suppression of the Knights Templars. A scholar himself, he founded chairs of oriental languages at Paris, Bologna, Oxford and Salamanca and made important additions to canon law. He died April 20, 1314.

CLEMENT VI (Pierre Roger) (1291–1352), pope from 1342 to 1352, was a French Benedictine abbot, archbishop and cardinal before his election. He purchased Avignon, enlarged the papal palace there and patronized artists and scholars. During the Black Death he welcomed Jews to Avignon when they were accused of starting the plague. He died at Avignon on Dec. 6, 1352.

CLEMENT VII (Robert of Geneva), antipope from 1378 to 1394, was one of the leaders of the cardinals who declared the election of Urban VI invalid. He settled at Avignon, thus precipitating the schism which lasted until 1417.

CLEMENT VII (Giulio de' Medici) (1478–1534), pope from 1523 to 1534, was born at Florence on May 26, 1478. A weak, vacillating pope in the political rivalries of Francis I of France and the emperor Charles V he supported first one and then the other under the pressure of events. In 1527 he had to ransom himself after the sack of Rome by Charles V and promise to call a general council to deal with Lutheranism. Clement delayed in handling the plea of Henry VIII of England for the annulment of his marriage with Catherine of Aragon until, losing patience, the king led the English church into heresy. Clement died Sept. 25, 1534. (J. A. CT.)

CLEMENT VIII (Gil Sánchez Muñoz), antipope from 1423 to 1429, was the creature of Afonso V of Aragon. After his abdication he became bishop of Majorca and died in 1446.

CLEMENT VIII (Ippolito Aldobrandini) (1536–1605), pope from 1592 to 1605, was born at Fano on Feb. 24, 1536. Cardinal in 1585, he was elected pope on Jan. 30, 1592. Clement, who was concerned principally with his spiritual functions, encouraged the labour of St. Francis de Sales and relied on St. Philip Neri. His absolution of Henri IV of France has been praised for freeing the papacy from Spanish domination and criticized as the replacement of one master by another. The dispute between the Dominicans and the Jesuits on grace and free will was given an airing in Rome from 1594 on. Clement died on March 5, 1605.

CLEMENT IX (Giulio Rospigliosi) (1600–1669), pope from 1667 to 1669, was born at Pistoia on Jan. 28, 1600. Cardinal and secretary of state under Alexander VII, he was elected pope on June 20, 1667. The Gallican principles of Louis XIV troubled his pontificate. Clement's policy of appeasement of the Jansenists brought peace for a time. He died on Dec. 9, 1669.

CLEMENT X (Emilio Altieri) (1590–1676), pope from 1670 to 1676, was born in Rome on July 12, 1590. Cardinal in 1669, he was elected pope on April 29, 1670. In spite of his advanced age, Clement showed himself surprisingly firm in the face of French arrogance. He died on July 22, 1676.

CLEMENT XI (Giovanni Francesco Albani) (1649–1721), pope from 1700 to 1721, was born at Urbino on July 23, 1649. He was made cardinal in 1690 and elected pope on Nov. 23, 1700. He espoused the losing cause in the War of the Spanish Succession and was ignored in the peace of Utrecht (1713). Jansenism again convulsed France, and Clement's measures proved unacceptable to some Catholics. He condemned the Chinese rites in 1704 and made the feast of the Immaculate Conception of the Virgin Mary a holy day of obligation in 1708. He died on March 19, 1721.

CLEMENT XII (Lorenzo Corsini) (1652–1740), pope from 1730 to 1740, was born in Florence on April 7, 1652. Cardinal in 1706, he was elected pope on July 12, 1730. Clement tried, despite ill health, to halt the decline in the influence of the papacy. He defended the rights of the church threatened by the encroachments of the Catholic powers. He died on Feb. 6, 1740, having been totally blind since 1732.

CLEMENT XIII (Carlo della Torre Rezzonico) (1693–1769), pope from 1758 to 1769, was born at Venice on March 7, 1693. Made cardinal in 1737, he was elected pope on July 6, 1758. The question of the suppression of the Jesuits dominated his pontificate as it did that of his successor, Clement XIV. Clement XIII could not prevent their brutal suppression in Portugal, France, Spain, Naples and Parma. He died on Feb. 2, 1769.

CLEMENT XIV (Giovanni Vincenzo Antonio Ganganelli) (1705–1774), pope from 1769 to 1774, was born near Rimini on Oct. 31, 1705. He joined the Order of Friars Minor Conventuals in 1723, taking the name of Lorenzo. Becoming cardinal in 1759, he was elected pope on May 18, 1769. Clement endeavoured to conciliate the Catholic powers by decreeing the suppression of the Jesuits (Aug. 16, 1773). He died on Sept. 22, 1774. (E. A. R.)

See also PAPACY.

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(J. M. F. M.; J. J. Ry.; E. A. R.)

CLEMENT OF ALEXANDRIA (TITUS FLAVIUS CLEMENS) (*c.* 150–*c.* 215), Christian presbyter, whose writings mark an epoch in early Christian intellectual development, was born of pagan parents probably at Athens. He became an independent Christian teacher in Alexandria and died probably before 215, possibly in Asia Minor.

The pagan intelligentsia of the 2nd century, including such a person as Celsus, dismissed the Christians as vulgar upstarts who violently rejected the hallowed religious traditions of Greek and Roman society and wanted to set aside the noble literary heritage of the past in favour of the seemingly unimpressive and obscure Jewish writings which they called the Scriptures. Though Celsus admits that not all Christians of his time are so foolish, he consoles himself with the reflection that the educated minority are knaves who can reconcile their faith and their philosophy only by sophistry and forced exegesis of the Scriptures. Against this background Clement appears not as a Christian whose relation to education and culture is that of a disappointed lover but as one who is an accepted member of cultivated society and who surveys the world from within the Christian society as one who has found there the best that life has to offer.

The most important of his writings is a trilogy: "Exhortation to the Greeks" (*Protrepticus*), the "Tutor" (*Paedagogus*) and the "Miscellanies" (*Stromateis*). These are extant virtually complete; the first page of the *Stromateis* is lost, and Clement does not seem to have continued after the 7th book; the 8th, which may have been appended posthumously from his papers, consists of desultory notes. He also wrote an almost complete tract on the right use of wealth (*Quis dives salvetur?*); a short moral exhortation "To the Newly Baptized"; a collection of summary notes on the doctrines of the Valentinian Gnostic Theodotus (*Excerpta ex Theodoto*); some disconnected notes, partly exegetical, entitled "Prophetic Selections" (*Eclogae propheticae*); "Outlines" (*Adumbrationes* or *Hypotyposes*) briefly explaining Genesis, Exodus, Psalms, Ecclesiastes, the Pauline and Catholic Epistles (of the last, except for fragments, only an epitome of the section on the Catholic Epistles, purged of some risky opinions, is extant in a Latin version by Cassiodorus); fragments of works on the Easter season, against the Judaizers (dedicated to Alexander, bishop of Jerusalem) and on providence; and letters. Treatises on fasting, on malicious gossip and on the prophet Amos have been lost.

After passing through the lecture rooms of a number of Christian teachers, Clement found his ideal in Pantaenus of Alexandria, a philosophically minded Christian whom he praises above all for his fidelity to the apostolic tradition. This insistence on orthodoxy is significant. In 2nd-century Alexandria there were many adherents of Gnosticism, and the dividing line between orthodoxy and heresy was still in process of being drawn. Clement's writings are a contribution to the drawing of that line. He believes that his faith could be reconciled with reason and philosophy, and that he must refuse the choice between an obscurantist adherence to orthodoxy on the one hand and an intelligent but heretical reinterpretation of the faith on the other. As a Christian thinker he must steer a middle course between, on the one hand, Gnosticism, which freely interpreted the apostolic tradition in a syncretistic hotchpotch of theosophical ideas, and, on the other, an anti-intellectual faith that regarded philosophy as the mother of all heresy. Clement is therefore both an apologist and a defender of the faith against heretical adulteration. He sets a high value upon the Hellenic literary and philosophical tradition; it is relative truth pointing forward to the revelation of God in Christ. Philosophy is to the Greeks what the Old Testament is to the Jews—a tutor to bring them to Christ. Hebrew history is therefore profoundly significant in the story of God's self-disclosure, but not unique or exclusive. Providence is at work everywhere, educating all men to the right worship of God. Pagan cults, with their immoral myths and phallic crudities, Clement condemns as diabolical, making only the concession that God may have allowed the heathen to worship sun and moon to raise their eyes from earthly materialism. Sharply negative toward heathen religion, Clement is generously positive toward philosophy, especially toward Plato and the Stoics. Platonic metaphysics and Stoic ethics play a large part in his thought. All wisdom is one, all truth is of God. This positive evaluation of Greek philosophy derives either from the conventional argument of Hellenistic Judaism (Clement owed much to Philo and the Jewish Wisdom literature) that the Greek philosophers had plagiarized Moses or from the theological affirmation of an identity between the divine Logos and human reason.

Clement is especially sensitive to the accusation that Christianity is a revolutionary innovation, an abandonment of ancestral customs of immemorial antiquity. He therefore insists on the timeless character of the divine wisdom discerned alike by Hebrew sages and Greek philosophers. That truth is found everywhere is a consequence of God's implanting his image in all men at the Creation. The very miracle of the incarnation is a focus and climax of the divine immanence in all the world. Thus Christ is God and ideal Man, the divine Son is God in his immanent relation to the world, while the Father is transcendent and ineffable. The Son became flesh to help man to be free of sin and to give a pattern of moral and spiritual perfection. The ground of redemption is creation; nevertheless, the image of God does not eliminate the discontinuity between God and man which results from finitude and sinfulness. Salvation is therefore dependent on the divine initiative and grace. With this grace man must cooperate in reciprocal love. The ideal is "likeness to God as far as possible," and the summit is adoption into sonship, "deification" or sanctification, especially through the sacramental life of the church and the indwelling power of the Word himself in the sanctuary of the soul. The saint who attains this is "the true Gnostic." Clement's description of the true Gnostic (*Stromateis*, bk. vii) deeply influenced later ascetical theology; and although he attacks Gnostic hostility to marriage and wine and holds that Christ condemned not wealth but the wrong use of wealth, his final recommendations for Christian practice are stern and rigid. He must be reckoned one of the fathers of monastic spirituality.

Some of his most original thinking concerns the nature of faith, discussed at length in *Stromateis*, bk. ii. The problem was imposed on him from more than one quarter. The pagan critic ridiculed faith as unreasoning prejudice. Gnostics disparaged the mere faith of ordinary church folk in comparison with that higher esoteric insight and innate mystical knowledge which they offered their adherents. Anti-intellectual Christians asserted the all-sufficiency of the act of faith and rejected all claims to provide a reasoned understanding of it. Clement vindicates faith partly as a deliberately chosen hypothesis which is subsequently verified by experience, justified on the principle that a preliminary directing of the will is a precondition of all knowledge, and partly as obedient assent to Authority which, inasmuch as it is divine, is fully reasonable.

Though an independent teacher, he accepted the authority of the orthodox church tradition, and was eventually ordained presbyter. In the eyes of posterity, however, his will to be orthodox was not equaled by deed. His writings were criticized as tainted with the heresies associated with Origen. Some of his speculative passages and his belief in the purely remedial character of divine punishment explain the charge. Photius is particularly severe on the *Hypotyposes*. Clement does not seem to have been widely read in medieval times. Except for the *Adumbrationes* nothing was translated into Latin. The survival of the *Protrepticus* and *Paedagogus* is solely due to the interest of the Byzantine humanist

Arethas, archbishop of Caesarea in Cappadocia, whose beautiful copy, written by his scribe Baanes in 914, is now at Paris. Likewise the *Stromateis* depend on a single manuscript of the 11th century at Florence. In the west, however, he was long reckoned among the saints and commemorated on Dec. 4. On the advice of C. Baronius his name was deleted from the Roman martyrology issued in 1586 by Pope Sixtus V; the omission provoked protests but was defended by Benedict XIV in *Litterae apostolicae de nova martyrologii Romani editione* (1748) chiefly on the ground of Clement's uncertain orthodoxy.

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CLEMENTI, MUZIO (1752–1832), Italian pianist and composer whose studies and sonatas developed the techniques of the early pianoforte. Born in Rome on Jan. 24, 1752, he was a youthful prodigy; he was appointed an organist at 9, and at 12 had composed an oratorio. In 1766 Peter Beckford, cousin of William Beckford, the author of *Vathek*, prevailed upon Clementi's father to allow him to take the boy to England, where he lived quietly in Wiltshire pursuing a rigid course of studies until 1773, when he went to London and met with immediate and lasting success as both composer and pianist. The pianoforte had become more popular in England than anywhere else, and Clementi, in studying its special features, made brilliant use of the new instrument and its capabilities. From 1777 to 1780 he was employed as harpsichordist at the Italian Opera in London. In 1780 he went on tour to Paris, Strasbourg, Munich and Vienna and in the last city became engaged in a friendly musical duel with Mozart at the instigation of the emperor, Joseph II.

In May 1782 Clementi returned to London, where for the next 20 years he continued his lucrative occupations of fashionable teacher, composer and performer. He took shares in the music publishing firm of Longman and Broderip and lost a good deal of money when they went bankrupt, but he was a shrewd businessman and in 1799 in partnership with Longman founded a firm for both music publishing and the manufacture of pianos that was very successful. Among his numerous pupils were J. B. Cramer, G. Meyerbeer and John Field. Clementi visited the continent again in 1820 and 1821. In his later years he devoted himself to composition, and to this period belonged several symphonies, the scores of which were either lost or incomplete. Two of them were reconstructed from sketches by Alfredo Casella (*q.v.*). During the later part of his life he had a country residence at Evesham in Worcestershire, where he died on March 10, 1832. He was buried in Westminster abbey.

Clementi's chief claims to fame are his long series of pianoforte sonatas, many of which are remarkably fine and unduly neglected, and his celebrated studies for piano, the *Gradus ad Parnassum* (1817). His own contributions to the development of pianoforte technique coincided with the period of the new instrument's first popularity and did much to establish the lines on which piano playing was to develop.

See G. C. Paribeni, *M. Clementi nella vita e nell'arte* (1922); G. de Saint-Foix, "Muzio Clementi" in *The Musical Quarterly* (1923). (Cs. Ch.)

CLEMENTIA, the Roman personification of mercy and clemency. Her worship begins with her deification as the celebrated virtue of Julius Caesar. The senate in 44 B.C. decreed a temple to Caesar and Clementia in which the cult statue represented them clasping hands. The location of this temple, however, is unknown. Tiberius was honoured with an altar to his *clementia,* the clemency of Caligula received yearly sacrifices, and the Arval brothers record a sacrifice in Nero's time. On coins she is typically a standing goddess with patera (a dish used in sacrifices) in one hand and sceptre in the other.

See G. Wissowa, *Religion und Kultus* (1912). (R. B. Ld.)

CLEMENTINE LITERATURE, a title that covers a diversified group of writings that at various times were added to the one genuine epistle (for which, *see* Clement) remaining from Clement, bishop of Rome toward the end of the 1st century. These include (1) the so-called Second Epistle, a homily probably written at Rome about 140; (2) two "epistles" *On Virginity*, perhaps the work of Athanasius in the 4th century; (3) the *Homilies* and *Recognitions*, along with an introductory letter supposed to have been written by Clement to James; (4) the Apostolic Constitutions, also from the 4th century; and (5) five letters that are part of the forged Decretals (for the last two, *see* Constitutions, Apostolic; Decretals, False).

Second Epistle of Clement.—II Clement is not an epistle but a sermon; it lays emphasis on a high Christology and the importance of preserving the seal of baptism by maintaining the purity of the flesh for the resurrection. Its use of uncanonical writings and the silence of earlier writers caused it to be questioned by Eusebius (*c.* 315), the first writer who mentions it, as well as by Photius (*c.* 854), who criticizes it but regards it as genuine. In the interval it was occasionally cited by both Monophysite and orthodox authors, but it was never popular, even though in the Codex Alexandrinus of the Bible (5th century) and in the later Syrian church it was regarded as canonical.

On Virginity.—The two "epistles" (actually treatises) *On Virginity* are preserved in a Syriac manuscript of the year 1470 and one of them in Coptic fragments, though they were originally written in Greek; extracts from the original are preserved in the homilies of the Palestinian monk Antiochus (*c.* 620). They are first mentioned by Epiphanius (*c.* 375) and were used in Egypt in the 4th and 5th centuries. Their basic purpose is to denounce the abuses of "spiritual marriage" and of the "kiss of peace," and violations of asceticism in general. The Coptic version ascribes them to Athanasius, and the time, if not the person, is surely correct.

Homilies and Recognitions.—The *Homilies* (preserved in the Greek original) and the *Recognitions* (translated into Latin by Rufinus and into Syriac by an anonymous translator, both about 400) contain a great deal of common material, though Rufinus evidently tried to remove unorthodox ideas from the *Recognitions*. The *Homilies* clearly reproduce more accurately peculiar Jewish-Christian notions about the perpetuity of the Mosaic Law, about the importance of daily baptisms and of abstinence from meat, and about Jesus as "the true prophet" (*cf.* Deut. xviii, 15) who showed his disciples how to detect interpolations in the Old Testament. There are also many Gnostic notes in the book, which has a framework based on Clement's travels with Peter and finally his recognition of his long-lost father, mother and brothers. Both *Homilies* and *Recognitions*, composed in the last quarter of the 4th century in an attempt to exalt the position of the oriental churches in relation to Rome, are based on an earlier work, the *Circuits of Peter,* attested by Epiphanius and probably mentioned by Eusebius and by Origen (early 3rd century). It is even possible that this source, or another prior to it and known as the *Preachings of Peter*, goes back into the 2nd century, for (1) Irenaeus (*c.* 180) mentions contendings of the apostles with Simon Magus, and they are reflected in our documents; and (2) the Gospel quotations in the *Homilies* and *Recognitions* sometimes seem to represent a stage in the transmission of the Gospels before the text reached its present, relatively fixed state. Some of the ideas set forth, especially in the *Homilies*, may well represent the thought of various kinds of Jewish Christianity as early as the 2nd century, though it is extremely doubtful that they reflect 1st-century conceptions, at least in what was to be the main stream of Christianity.

Influence.—In later times these Clementine documents were remarkably influential. The medieval story of Faust is based on the portrait of Simon Magus in the *Recognitions,* while the letter of Clement to James served as the starting point for the Pseudo-Isidorian *Decretals*. Another forged Clementine letter was used by Anabaptists to justify the community of women. And in the 19th century the Tübingen school of New Testament critics claimed that the *Homilies* and *Recognitions* represented the

Petrine thesis as against the Pauline antithesis; out of thesis and antithesis came the (Hegelian) Catholic synthesis. Unfortunately for this theory, it is based not on chronology but on philosophy. The importance of the Clementines lies in the light the *Homilies* cast on Jewish-Christian heresy in the early centuries of the church, while the *Recognitions* show how, in an expurgated form, such literature could provide entertainment along with edification. It may be that these documents will still yield information about early stages of the New Testament text (the Gnostic Gospel of Thomas seems to be related to them), but it is unlikely that they reflect a truly primitive form of Christianity.

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CLEOBIS AND BITON were two brothers of the city of Argos, noted for their strength. During an Argive festival honouring Hera, they took up the yoke of a wagon and themselves drew their mother to the temple. She begged the goddess to grant them, as a reward for their piety, whatever was best for men, whereupon they fell asleep and died (Herodotus).

The story was famous in antiquity and apparently had some historical foundation. Pausanias saw a relief of the brothers at Argos; Herodotus says that the Argives dedicated statues of the two at Delphi, where in fact they were found by French excavators in 1893. The statues date from the early 6th century B.C. (T. V. B.)

CLEOBULUS (? 6th century B.C.), Rhodian statesman, is listed by Plato as the fifth of the Seven Wise Men of ancient Greece. According to the "life" by Diogenes Laërtius (i, 89–93), he was the son of a certain Evagoras and became tyrant of Lindus in Rhodes, where he invited Solon (*q.v.*) to take refuge from Pisistratus. He is also said to have been strong and handsome and to have written 3,000 lines of verse, many of them riddles. Cleobuline, his daughter, also composed riddles in hexameters. Among the sayings attributed to him is: "Neither quarrel with your wife nor indulge her in the presence of others."

For lists of the sayings *see* F. W. Mullach (ed.), *Fragmenta philosophorum Graecorum*, vol. i, book 2 (1860); and Diels-Kranz, *Fragmente der Vorsokratiker*, vol. ii, 7th ed. (1954).

CLEOMENES, the name of three Spartan kings of the Agiad house.

CLEOMENES I (king after 520–*c.* 490 B.C.), son of Anaxandridas, succeeded him not long after 520 B.C., in preference to his half-brother Dorieus, who then led a colony abroad and was killed in Sicily in 510. Early in his reign Cleomenes advised the expulsion from Sparta of Maeandrius of Samos, who wanted help against Persia. About 513 a Scythian proposal to attack Darius I, king of Persia, was also rejected. In 510 he led an army to Athens to expel the tyrant Hippias. In 507 he came again with a small force to support Isagoras against Cleisthenes, but he had to withdraw. He next collected a large Peloponnesian army against Athens, but at Eleusis the Corinthians mutinied and the other king, Demaratus, supported them. Later the Spartans proposed to their allies to reinstate Hippias at Athens, but the Corinthians defeated the project.

Herodotus' account suggests that Cleomenes' influence in the Peloponnese was very great from at least 507, and when Aristagoras of Miletus in 499 appealed for help for the Ionian revolt from Persia, the king's personal refusal was treated as decisive. Cleomenes' failure to dominate Athens may have damaged Spartan prestige, but this was restored in 494 when he inflicted a heavy defeat on Argos at Sepeia near Tiryns. In 491 he intervened at the request of the Athenians at Aegina, which had given tokens of submission to Darius, but Demaratus thwarted him. He got the latter deposed by bribing the Delphic oracle, but the bribery was discovered and he had to flee to Thessaly. Returning to Arcadia he recruited an army there, and the Spartans reinstated him, but soon afterward he went mad and committed suicide.

A powerful ruler, he consolidated Sparta's leadership in Greece, later the kernel of resistance to Persia. His refusal to commit Spartan forces overseas may have been military calculation rather than indifference to the Persian danger. Because of his interference at Athens, Herodotus' informants were generally less than fair to him.

CLEOMENES II (king 370–309 B.C.), son of Cleombrotus, succeeded his brother Agesipolis II in 370. His long reign was an eventful period, but no action of his is recorded.

CLEOMENES III (king 235–222 B.C.), son of Leonidas II, who married him young to Agiatis, widow of Agis IV. From 229 onward he was at war with the Achaean league (*q.v.*) under Aratus of Sicyon. Aratus declined battle at Pallantion in 228, but was defeated in 227 at Lycaeum, though he contrived to seize Mantinea. Cleomenes now recalled from exile Agis' brother Archidamus V, but he was murdered soon after, possibly with Cleomenes' connivance. Later in the year he defeated the Achaeans at Ladoceia near Megalopolis, and conducted further operations in Arcadia.

Late in 227 he left the citizen troops in camp and hurried back to Sparta to enforce reform on the lines attempted earlier by Agis IV (*q.v.*). Four of the five ephors were executed and 80 citizens were exiled. Debts were canceled, land redivided to provide 4,000 new citizen holdings and the old Spartan training was restored. His brother Euclidas became king in Archidamus' place, the ephorate was abolished, the powers of the council were probably curtailed and he is said to have instituted the board of six elders called *patronomoi* which existed later. The army was trained in the use of a longer pike. (*See* SPARTA.)

In 226 he retook Mantinea and heavily defeated the Achaeans at Hecatombaeum near Dyme. The league began to disintegrate and Cleomenes hoped to become its leader, but negotiations broke down in 225. He took Pellene, Phlius, Argos and other cities, and was invited to Corinth. Aratus now called in the Macedonian king Antigonus Doson. He failed to pierce Cleomenes' lines near Corinth in 224, but trouble broke out at Argos from disappointment that Cleomenes had not carried out social revolution. He had to retire, and in spite of bold strokes like his surprise capture of Megalopolis, Antigonus finally defeated him in 222 at Sellasia north of Sparta. Sparta fell into Antigonus' hands, and Cleomenes fled to Ptolemy Euergetes in Egypt. Imprisoned by his successor Ptolemy Philopator, he broke out in 219 and, having failed to raise a revolt in Alexandria, took his own life.

Cleomenes' Spartan reform was designed to re-create a society of aristocrats, and neglected *perioeci* and helots; the hope of social revolution which it aroused elsewhere could not be fulfilled, and gained him only momentary support. But Sparta alone had not the resources to back his military ambition, for all his ability and force of character.

BIBLIOGRAPHY.—For Cleomenes I, *see* Herodotus, *History*, especially bks. v–vi. For Cleomenes III, *see* Plutarch, *Life of Cleomenes;* Polybius, especially bk. ii, 37–70 and v, 35–39, with F. W. Walbank's *Commentary on Polybius* (1957). (A. As.)

CLEON (d. 422 B.C.), the first prominent representative of the commercial class in Athenian politics, was the son of Cleaenetus, from whom he inherited a tannery. He came to notice first as an opponent of Pericles (*q.v.*) during the Peloponnesian War, and as such found himself acting in concert with the aristocrats, who equally hated and feared Pericles. In 430, when Athens was devastated by the plague, Cleon headed the opposition to the Periclean regime. Pericles was accused of maladministration of public money and was actually found guilty though he was reelected *strategos* in 429. The death of Pericles (429) left the field clear for Cleon. Hitherto he had only been a vigorous opposition speaker, a critic and accuser of state officials. He now came forward as the champion and leader of the democracy and was for some years undoubtedly the foremost man in Athens. He was gifted with natural eloquence and a powerful voice, and knew how to work upon the feelings of the people. He became the leader of the war party in opposition to Nicias and the moderates, who favoured a cautious strategy and an early peace. He probably advocated a vigorous offensive in the war and may have been responsible for the introduction of a capital levy (*eisphora*) in 428, when the Athenian reserves were running low.

When Mytilene, which had revolted against Athens, fell in 427, Cleon proposed that all its citizens should be put to death, and the women and children enslaved. His policy was to hold down the empire, which, according to Thucydides, he regarded as a "tyranny," by naked force. His decree was passed, but rescinded next day, in time to save Mytilene.

In 425 when the Spartans were blockaded in Sphacteria, an island off the peninsula of Pylos, Cleon caused the Athenians to reject the terms offered by Sparta, in the hope of securing a peace which would restore Athens' land empire. He then reached the summit of his fame by capturing the Spartans on the island. Much of the credit for this success, the most notable which the Athenians won during the Archidamian War, was due to the military skill of his colleague Demosthenes; but it was due to Cleon's determination that the *ecclesia* (assembly) sent out the additional force that was needed. About this time Cleon doubled the tribute payable by the allies and raised the pay of the Athenian jurors from two to three obols. He attempted, unsuccessfully, to bring over Argos to the Athenian side and was elected *strategos* in 424. The Athenian failures in Megara and Boeotia were not Cleon's fault, but they strengthened the peace party and in 423 a year's armistice was agreed. In 422, after the close of the armistice, Cleon, who was eager to continue the war, went to recover Thrace from Brasidas, but, after capturing several cities, was taken by surprise at Amphipolis, defeated and killed. With his death, the peace party at Athens gained power, and the peace of Nicias was concluded. (*See* PELOPONNESIAN WAR.)

Cleon is represented by Aristophanes and Thucydides in an extremely unfavourable light, but neither can be considered an unprejudiced witness. Aristophanes was opposed to Cleon's political program and also bore him a personal grudge, having been prosecuted by him after the production of his *Babylonians*. Thucydides had been exiled after the loss of Amphipolis and Cleon may have been responsible.

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CLEOPATRA, the name of the sister of Alexander the Great of Macedonia; of a daughter of the Seleucid king Antiochus III who was married to Ptolemy V, king of Egypt, in 193 B.C.; and, after that time, the name of several queens and princesses of the Ptolemaic dynasty (*see* PTOLEMIES).

CLEOPATRA VII (69–30 B.C.), by far the most famous bearer of the name, was the daughter of Ptolemy XII Auletes and became queen on his death (51 B.C.), ruling successively with her two brothers Ptolemy XIII (51–47) and Ptolemy XIV (47–44) and her son Ptolemy XV Caesar (44–30), until her death in 30 B.C. During this period she participated in the struggles that attended the replacement of republican by autocratic government at Rome, not so much by reason of the resources of her kingdom, though these were considerable, as through her personal attachment to, and influence over, two of the chief Roman statesmen of the time —Julius Caesar and Mark Antony (*see* CAESAR, GAIUS JULIUS; ANTONIUS).

Born in 69, Cleopatra was of Greek and Macedonian stock in roughly equal proportions, with a very small admixture of Iranian blood. Although not beautiful, she had in full measure the gift of exciting men's senses. She was highly educated, with a knowledge of several languages (including Egyptian, which none of her ancestors had studied). To the native Egyptians she showed herself sympathetic, and, whether from policy or conviction, she identified herself with many of their religious beliefs and rituals. She was without scruples, yet in those whom she chose as friends she inspired devotion. Possessing great energy, courage, charm and intelligence, she gave first place in her life to the realization of two ambitions: to consolidate her dynastic heritage in Egypt and to share in the central power at Rome. The second of these ambitions was impossibly daring in a foreign woman; but it is a convincing proof of her greatness that her Roman enemies came eventually to fear as well as hate her.

Three years after succeeding her father Cleopatra became involved in a conflict with her brother consort and his guardians. At that point Julius Caesar, who was then engaged upon securing the eastern Roman provinces in his war against the followers of Gnaeus Pompeius, arrived in Alexandria. With good judgment Cleopatra threw in her lot with him, becoming his mistress. In the so-called Alexandrine War (winter 48–47) he crushed her enemies and eliminated her brother the king. Early in 47 he departed. From the autumn of 46 Cleopatra resided at Rome in a villa set aside for her by Caesar. The full significance of her presence at Rome cannot be determined. Either in 47 or 44 she bore a son whom she claimed to be Caesar's child and who was given the name Ptolemy Caesar (Caesarion or "little Caesar" was his Alexandrian nickname); but the available evidence is insufficient to confirm the truth of this claim, however probable it may appear in some ways. Caesar continued to show Cleopatra much favour, and, according to one view of his ultimate aims, it is conceivable that marriage to her and adoption of his child by her was envisaged by Caesar as part of a design of becoming a divine ruler of the Hellenistic type, and that Cleopatra encouraged him in these thoughts.

Upon the murder of Caesar (March 44) Cleopatra returned to Egypt. In 41 the triumvir Mark Antony summoned her to Tarsus in Cilicia to give an account of her actions in the recent war between the Caesarians and the forces of Brutus and Cassius. By a lavish display of wealth she ensnared Antony and made him her lover. They spent the winter of that year in Alexandria in the pursuit of pleasure. At that time no important political advantage accrued to Cleopatra from the liaison. After Antony's departure she gave birth to twins, Alexander Helios and Cleopatra Selene. Not until 37 was she reunited with Antony (at Antioch in Syria) and thereby given a fresh opportunity of intervening in world affairs. Their reunion was a spontaneous act on his part, and, although in character and resolution she was the stronger partner, she remained entirely dependent upon his good will. It is true that she disposed of a substantial asset in the royal treasure which she had inherited, but this meant nothing apart from her personal hold over Antony. The lovers now married (and were recognized in the east as legal partners in spite of Antony's Roman marriage to Octavia), and Antony acknowledged as his the twins born in 40, giving them the symbolic names mentioned above. Moreover, he bestowed upon Cleopatra large gifts of territory in Judaea, Arabia, Phoenicia, Cilicia and Crete, besides restoring to Egypt Cyrene (bequeathed to Rome 96 B.C.) and Cyprus (annexed in 58). Later, in 34, at a ceremony in Alexandria he proclaimed the setting up of an eastern empire in which Cleopatra's children should be the rulers of various territories, with the queen herself supreme above them all as "queen of kings" (the so-called donations of Alexandria).

When in 33 Antony, at her prompting, at last began to prepare for the inevitable war with Octavian (*see* AUGUSTUS), Cleopatra accompanied him at his successive headquarters. Her material contributions to the campaign were important, but her presence in camp increased the effectiveness among Antony's followers of the enemy propaganda which had made her its chief target. Together she and Antony escaped in Sept. 31 from the lost battle of Actium (*q.v.*). When Octavian finally occupied Alexandria in August of the next year, they committed suicide, Antony first, Cleopatra a few days later. Shortly before her death she had met Octavian privately, probably with the object of securing the safety of her children rather than in any hope of being permitted to continue as a client-queen. She deliberately chose death by snake-bite for the sake of the significance which such a death would have in the eyes of her Egyptian subjects because of the ancient belief that the snake was the minister of Amon-Ra, the sun-god of the country's religion.

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CLEOPATRA'S NEEDLES, the name popularly given to the two Egyptian obelisks presented to the British and American people respectively, and now standing on the Thames Embankment in London and in Central Park in New York city. Originally set up by Thutmose III at Heliopolis about 1500 B.C., they were removed by Caesar Augustus to adorn the Caesareum at Alexandria about 14 B.C. and there remained until removed (in each case by private munificence) to their present positions in 1878 and 1880. Both are of rose-red Syene granite, covered with hieroglyphical inscriptions, and are estimated to weigh some 200 tons. *See* OBELISK.

CLEOPHON (d. 404 B.C.), Athenian statesman, an opponent of the oligarchs and of the peace party in the later phases of the Peloponnesian War, was the son of Cleippides (recorded as *strategos* in 428 B.C.). He inherited the radical policies and the following of Cleon (*q.v.*) and Hyperbolus. His power, like Cleon's, rested on his control of the *ecclesia* (assembly) and on his activity in the courts. He was violent in his style of oratory, but probably patriotic and honest. Like Hyperbolus, he was a bitter enemy of Alcibiades (*q.v.*), and in Thucydides' view the feud between the radical leaders and Alcibiades was the main cause of Athens' defeat in the Peloponnesian War. Cleophon came to power on the collapse of the oligarchic reaction in 410 and was one of the dominant figures in Athenian politics until the end of the war. He led the people to reject Spartan peace offers after the Athenian victory at Cyzicus (410) and again after Arginusae (406), as Cleon had rejected similar peace offers in 425. He encouraged the prosecution of members of the oligarchy of 411 and, by the distribution of poor relief, helped to sustain morale among the common people at a time when the Spartan control of most of Attica caused serious destitution in the city. Even after the decisive defeat of the Athenians at Aegospotami, when the Spartans were blockading Athens, Cleophon continued to urge resistance, but as the situation became desperate the oligarchs gained control of the *boule*, and Cleophon was arrested and condemned to death in 404. (R. ME.)

CLEPSYDRA, a chronometer that measures time by the gradual flow of water. Simple water clocks were used in Egypt and examples from *c.* 1400 B.C. survive. These were bucket-shaped vessels from which water was allowed to escape by a small hole at the base. Uniform scales of time, one for each month to allow for the different seasonal lengths of Egyptian hours, were marked on the inside. By the end of the first hour water filled to the brim would have fallen to the first mark of the scale of the month in question. The difficulty of regulating the pressure of outflow of these clocks, only partly achieved by the sloping sides of the vessel, and the differential viscosity of water according to temperature, rendered them inaccurate.

From Egypt, water clocks were introduced into the classical world and called *clepsydrae* (Gr. *kleptein,* "to steal," *hydor,* "water"). By adjusting the outflow Greeks and Romans were able to make such clocks record regular temporal hours. The Roman clepsydra took the form of a cylinder into which water dripped from a reservoir. Readings were taken against a scale with a float in the cylinder. With a full reservoir irregularity of flow was minimized. Vitruvius describes a water clock with a wheel and ratchet mechanism. A shaft attached to the float had teeth that engaged a cog wheel fixed to a pointer moving over a dial. Such dial clocks were perfected by the Chinese and Arabs and used in Europe until the 16th century.

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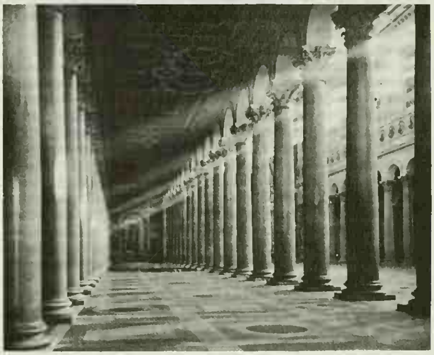
CLÉRAMBAULT, LOUIS NICHOLAS (1676–1749), French composer and organist whose secular cantatas, his most important works, show both grace and feeling, was born in Paris, Dec. 19, 1676. He was organist at several Paris churches, and at St. Cyr; he also held the post of *surintendant de la musique* to Mme de Maintenon, and, perhaps through her and his position at St. Cyr, wrote the music for the wedding of the Dauphin with the Infanta of Spain in 1745.

His church music includes a large *Te Deum,* and he also composed a book of organ music and one of pieces for the harpsichord. His cantatas were published in five volumes (1710 ff.). The recitatives are in French style but the arias are fluent and strong, in the prevailing Italian tradition. In *Orphée, Héro et Léandre* and *Pigmalion,* which are characterized by refinement of workmanship, the instrumental introductions or *simphonies* show a mastery of the concerto style. One of his best works is *Le soleil vainqueur des nuages,* a thanksgiving for Louis XV's recovery from illness (1721). Clérambault died in Paris, Oct. 26, 1749. (B. P.)

CLERESTORY (CLERESTOREY or CLEARSTORY), in architecture, any wall of a room carried higher than the surrounding roofs so that windows can be pierced in it to light the room. In a large building, where interior walls are far from the outside of the building, some such method of lighting the central part becomes necessary, and the use of the clerestory appeared as early, at least, as the 19th dynasty in Egypt, under which the great hypostyle hall of the temple at Karnak was built. This had a central range of columns, higher than those on either side, to allow clerestories to be built of pierced stone slabs. In Roman architecture many great halls were thus lighted, usually groined vaults over the central hall allowed large semicircular windows to be built above the side roofs; *e.g.,* Sta. Maria degli Angeli (the tepidarium of the Baths of Diocletian) and the basilica of Constantine, both at Rome. Similarly the walls under the side arches of Hagia Sophia at Istanbul are clerestory walls. It was however in the Romanesque and Gothic churches of the middle ages that the clerestory idea received its most adequate expression. *See* GOTHIC ARCHITECTURE.


G. E. KIDDER SMITH

CLERESTORIES LIGHTING THE INTERIOR OF ST. PAUL'S OUTSIDE THE WALLS, ROME; REBUILT IN 1823

CLERFAYT (CLAIRFAIT), **CHARLES JOSEPH DE CROIX,** GRAF VON (1733–1798), Austrian field marshal, was born at Bruille in Hainaut on Oct. 14, 1733. He entered the Austrian army in 1753, distinguished himself during the Seven Years' War (1756–63) and also took part in the Turkish War of 1787. In 1792 he was given command of the Austrian contingent in the duke of Brunswick's army. His corps was conspicuously successful at Croix-sous-Bois and inflicted a heavy defeat on the French.

In the Netherlands in 1793 he had initial successes at Aldenhoven and at the siege of Maestricht and a decisive victory at Neerwinden (March 18, 1793). After that his fortunes changed: he was defeated at Wattignies, and his campaign in West Flanders in the following year was also unsuccessful. Clerfayt succeeded the duke of Saxe-Coburg as commander in chief, but his troops were outclassed by the French and withdrew east of the Rhine.

By 1795 he had become a field marshal and was commanding on the middle Rhine against Jourdan, whom he defeated at Höchst (Oct. 11, 1795) and Mainz. The armistice terms which he concluded were badly received in Vienna and he resigned: thereupon he became a member of the Aulic council. He died in Vienna on July 19, 1798. (C. N. B.)

CLERGY, a term used to describe clerks (Lat. *clerici*) in holy orders. In the Roman Catholic Church the term "clergy" includes all orders from the episcopate down to the minor orders; more freely, it includes also members of religious orders. In the Church of England "clergy" strictly speaking includes all orders but modern definition tends to separate by distinguishing offices; *i.e.*, bishop, dean, archdeacon (*qq.v.*). This usage, which is anomalous, has probably arisen from the increasing disuse of the term "inferior clergy" for all orders below the dignity of bishop. By 20th-century usage the term "clergy" is used to describe ordained ministers of all Christian churches.

The 2nd century of the Christian church witnessed the emergence of a distinction between clergy and laity (Gr. *laos*, "people"). This distinction received form and recognition by the privileges and immunities granted to the clergy by Constantine I, which were later extended and codified in the 16th book of the Theodosian code. In certain circumstances the clergy were exempted from the jurisdiction of civil courts. In the first regularly constituted English parliament in 1295 the clergy formed a part together with the baronage and commonalty. The arrogation of power by the clergy from the 13th century down to the Reformation was based upon the claim of Pope Innocent III that the clergy as rulers over spiritual things were as much superior to temporal rulers as the soul over the body. Progressive legislation has removed the privileges and immunities of the clergy, but vestiges of these may still be seen, as in England in their exemption from jury service and from candidature for election to the house of commons. *See* HOLY ORDERS; MINISTRY, CHRISTIAN; *see* also references under "Clergy" in the Index volume. (J. W. L.)

CLERGY, BENEFIT OF, often called "clergy," was once a useful device for substituting a lesser punishment than death in English and American criminal law. In England, in the late 12th century, the church succeeded in compelling King Henry II and the royal courts to grant to every *clericus* accused of a capital offense immunity from trial or punishment in those courts. On producing letters of ordination the accused *clericus* was turned over to the local bishop for trial in the bishop's court, which never inflicted the death penalty and frequently acquitted the *clericus*. In the 14th century the royal judges gradually turned this clerical immunity into a discretionary device for mitigating the harsh criminal law by holding that a layman, convicted of a capital offense, might be deemed a *clericus* and obtain clerical immunity if he passed a reading test. For this purpose verse 1 of Psalm li came to be frequently used and was known as the "neck verse." Later it was held that a layman could claim his "clergy" only once, and in 1490 parliament enacted a law that all such laymen should be branded on the thumb for identification.

The practice of handing convicted clerics or laymen over to the bishop was abolished in 1576 and imprisonment for one year substituted instead. In 1692 the layman's "clergy" was extended to women and in 1707 to all persons whether they could read or not. From the 16th century on, however, a long series of statutes made certain crimes punishable by death "without benefit of clergy." Its importance was further diminished by the 18th-century practice of transporting persons convicted of capital crimes to the colonies, whether they were entitled to "clergy" or not, and in 1827 it was abolished. Benefit of clergy was adopted in most of the American colonies by judicial practice. Though generally abolished soon after the American Revolution, it persisted in the Carolinas until the mid-19th century.

See F. Pollock and F. W. Maitland, *History of English Law*, 2nd ed., vol. i, pp. 424–440 (1898); G. W. Dalzell, *Benefit of Clergy in America* (1955). (Mo. H.)

CLERGY RESERVES. By the act of 1791, establishing the provinces of Upper and Lower Canada, the British government set apart one-eighth of all the crown lands in Canada for the support of "a Protestant clergy." These reservations, after being for many years a stumbling block to the economic development of the province and the cause of much bitter political and ecclesiastical controversy, were secularized by the Canadian parliament in 1854 and the proceeds applied to other purposes, chiefly educational. Because of the wording of the imperial act, the amount set apart is often stated as one-seventh, and was sometimes claimed as such by the clergy.

CLERIHEW, a form of brief biography invented by Edmund Clerihew Bentley (1875–1956) and introduced in his *Biography for Beginners* (1905). It is written as a four-line verse of two rhyming couplets, the first line almost invariably ending with the name of the subject, as in the following from Bentley's first collection:

> After dinner, Erasmus
> Told Colet not to be "blas'mous"
> Which Colet, with some heat
> Requested him to repeat.

The number of accents in the line is irregular, and one line is usually extended to tease the ear, as in the last of these anonymous lines on two famous Victorian murderers:

> It is unfair
> To be too hard on Hare.
> Early anatomical work
> Owes much to men like him and Burke.

Another requisite of the successful clerihew is an awkward rhyme, as in Bentley's "Aeschylus":

> "Steady the Greeks!" shouted Aeschylus.
> "We won't let such dogs as these kill us!"
> Nothing, he thought, could be bizarrer than
> The Persians winning at Marathon.

Some of the best clerihews were written during the 1920s by Sir Francis Meynell, Edmond Kapp and the ever-active Anon. (Jo. M. C.)

CLERK, SIR DUGALD (1854–1932), Scottish engineer, pioneer in the development of internal-combustion engines whose researches on the explosive pressure and specific heat of gases advanced the science of thermodynamics and brought him international fame, was born in Glasgow on March 31, 1854, and studied science at Andersonian college, Glasgow, and Yorkshire college, Leeds. Having built his first gas engine in 1876, he concentrated for 12 years on research on gas engines. In 1881 he patented and exhibited his two-stroke gas engine working with compression on the Clerk cycle, with an explosion once in every two strokes of the piston in contrast to the Otto four-stroke cycle. In 1888 Clerk and Sir G. C. (later Lord) Marks became life partners as consulting engineers and patent agents.

Clerk, a director of the National Gas Engine company, was appointed director of engineering research at the admiralty in 1916 and knighted in 1917. He was elected a fellow of the Royal society in 1908. His researches were published in his scientific papers and in his book *The Gas, Petrol, and Oil Engine* (new ed., vol. i, 1909; vol. ii, 1913). He was elected president of the Institution of Civil Engineers in 1932, but died at Ewhurst, Surrey, on Nov. 12 of that year. (AR. S.)

CLERKENWELL, the western part of the metropolitan borough of Finsbury (*q.v.*), London, Eng., consisted formerly of the parishes of St. James and St. John, which grew up about the ancient nunnery of St. Mary and the priory of St. John of Jerusalem, both founded in the 12th century by Jordan de Briset. The name Clerkenwell is derived from the "clerks' well" which adjoined the nunnery, and there the parish clerks of London used to meet to perform miracle plays. The well was lost for many years until rediscovered in Farringdon road in 1924. The church of St. James, Clerkenwell Green, built in 1792, replaced the old nunnery church. The priory was the headquarters in England of the Knights of the Order of the Hospital of St. John of Jerusalem from the 1140s until 1559. Prior Docwra's gatehouse (1504), after being put to many uses, has since 1874 been associated with this order. The 18th-century parish church of St. John was conveyed to the order in 1930. It was bombed in 1941, only the 12th-century crypt remaining, but it was rebuilt and in 1958 it was rededicated. Clerkenwell has been famous for clock- and watchmaking from the 18th century, and although the actual manufacture has almost disappeared, it is the centre of the repairing trade. It is also known as a quarter for jewelers and opticians. (M. McD.)

CLERKS REGULAR, in the Roman Catholic Church, are bodies of men who live in community under religious vows but engage actively in pastoral work. Best known of the clerks regular are the members of the Society of Jesus (*q.v.*); others are the Theatines, Barnabites, Caracciolines, Piarists, Somaschi, Clerks Regular of the Mother of God and Ministers of the Sick. *See* also ORDERS AND CONGREGATIONS, RELIGIOUS.

CLERMONT (CLERMONT-EN-BEAUVAISIS), a small town of northern France on the Brèche river, in the *département* of Oise. Pop. (1954) 4,585.

Probably founded as a military post during the Norman invasions, Clermont became the seat of a countship, the lords of which were already powerful in the 11th century. Raoul de Clermont, who rose to be constable of France, died at Acre in Palestine in 1191. His daughter Catherine brought Clermont to her husband, Louis I, count of Blois and Chartres, but their son Thibaut VI of Blois died childless in 1218. Philip II Augustus of France then obtained Clermont from Thibaut's collateral heirs and gave it to his son Philip Hurepel, from whom it passed to his daughter Jeanne (d. 1251). Louis IX of France recovered it for the crown in 1258, then gave it in 1269 to his son Robert, ancestor of the royal house of Bourbon (*q.v.*). Thus the eldest son and heir of the ducs de Bourbon was styled comte de Clermont until the end of the senior male line. During the Hundred Years' War the town was several times taken and retaken by the English and the French before the French finally recovered it in 1451.

After the treason of the constable Charles, duc de Bourbon, in 1523, Francis I of France confiscated the countship. Granted to the queen mother Louise of Savoy in 1527, to Charles, duc d'Orléans, in 1540 and to Catherine de Médicis in 1562, it was pledged in 1569 to Eric, duke of Brunswick-Calenberg, in payment for supplying mercenaries. His widow transferred it in 1599 to her brother, Charles III of Lorraine, whose third son, François, comte de Vaudémont, sold it in 1610 to Henry II de Bourbon, prince de Condé. Condé ceded the domain in 1615 to his aunt Anne de Montafié, comtesse de Soissons, whose grandson Emmanuel Philibert Amédée, prince de Carignan, sold it in 1702 to Françoise de Brancas, princesse d'Harcourt (d. 1715). The title, however, was meanwhile still used occasionally to designate younger sons of the house of Condé, and the duc de Bourbon, Louis Henri de Condé, bought the domain back in 1719. The property was confiscated from the house of Condé in 1792. Under the Restoration, the countship passed with the rest of the Condé inheritance to Henri d'Orléans, duc d'Aumale, son of Louis Philippe. Henri d'Orléans, eldest son of Henri, comte de Paris, was given the title comte de Clermont on his marriage in 1957.

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CLERMONT-FERRAND, an industrial city of south central France, capital of the *département* of Puy-de-Dôme (*q.v.*), was formed in 1731 by the union of Clermont and Montferrand. It is situated on the small Tiretaine river, 181 km. (112 mi.) W. of Lyons. Pop. (1954) 133,391. Hills surround it to the north, west and south, and beyond are mountains, with the Puy de Dôme dominating. Boulevards encircle the old part of Clermont, where the buildings are commonly of dark volcanic rock from nearby quarries. The 13th-century Gothic cathedral, built of the same dark stone, stands on the summit of a small hill on the site of an earlier church. The church of Notre Dame du Port (12th century) is a fine example of Auvergnat Romanesque, with its four radiating chapels and its transept surmounted by an octagonal tower. There are many houses from the 16th, 17th and 18th centuries. The Amboise fountain dates from the Renaissance, and the nearby Lecoq garden, laid out in the 19th century, is one of the finest in France. The buildings of the university (faculties of letters, medicine, pharmacy and law) adjoin the garden. The city also has colleges of music and drama and of fine arts, a library, and three museums (natural history, arts and local history and regional ethnography). Montferrand has Gothic and Renaissance houses, in excellent state of preservation. Royat, 5 km. (3 mi.) W. of the city centre, is famous as a spa. Clermont-Ferrand is on the main railway line from Paris and Nevers to Nîmes and the south coast of France. From the nearby Aulnat airport air service is available to Algiers, Paris and Nîmes. The chief industries of Clermont-Ferrand are the manufacture of rubber tires and other heavy rubber equipment. Metalwork, chemical and pharmaceutical goods and clothing also are made; preserved fruit, apples and cheese are marketed. The town also is the centre of the Auvergne tourist trade.

Clermont, the Augustonemetum of the Romans, replaced Gergovia as the centre of the Auvergne after the Roman conquest of Gaul. It was evangelized about the 3rd or 4th century by St. Austremonius (Stremoine), the "apostle of Auvergne" and first bishop of Clermont. The town was devastated in turn by the Visigoths and Normans. Its bishopric and two large monasteries gave it great ecclesiastical importance during the middle ages, and several councils took place there. At one of them, in 1095, the first crusade was inaugurated. Struggles with Riom and Montferrand to obtain the supremacy of the province were the chief events in Clermont's history in the 12th and 13th centuries; the Hundred Years' War and religious wars did not affect the city. It became capital of the duchy of Auvergne in the 16th century, and was the birthplace of Blaise Pascal (1623). Clermont was developed in the 18th century when the boulevards and squares were built. In 1731 Clermont was united with Montferrand, taking its present name. The Revolution hardly touched the town, and it was not until the 19th century that it grew into a large manufacturing centre. In World War II it was occupied by the Germans from Nov. 1942 to Aug. 1944. *See* also AUVERGNE. (A. Mo.)

CLERMONT-GANNEAU, CHARLES (1846–1923), French archaeologist with unusual knowledge of the languages of ancient western Asia and close firsthand acquaintance with the middle east, who contributed much to biblical studies. He was born at Paris on Feb. 19, 1846, and after studying oriental languages entered the diplomatic service. While holding various posts in the near east he carried on archaeological research. As early as 1869 he recovered at Dibon (modern Dhiban, Jordan) the celebrated Moabite stele of King Mesha (9th century B.C.), bearing directly on the Old Testament; and in 1873–74 he identified the site of the ancient town of Gezer, Judaea, a great event in biblical research. From 1880 he directed expeditions to Syria (1881), to the Red sea (1886), to Cyrenaica and Crete (1895) and to the island of Elephantine (Aswan Jazirat), Egypt (1906–08).

In 1889 Clermont-Ganneau became a member of the Académie des Inscriptions et Belles Lettres and in 1890 professor of archaeology and oriental epigraphy at the Collège de France. He improved the translations of important Phoenician, Aramaic, Nabataean, Neo-Punic and Palmyrene texts. He also exposed various archaeological forgeries, among them the collection of "Moabite" pottery in the Berlin museums (1874), the "biblical manuscript" acquired by the British museum (1883) and the golden "tiara of King Saïtapharnès" in the Louvre, Paris (1903). Clermont-Ganneau died at Paris on Feb. 15, 1923.

His chief publications were *Études d'archéologie orientale,* two volumes (1880–97), *Recueil d'archéologie orientale,* eight volumes (1885–1924), *Les Fraudes archéologiques en Palestine* (1885).

For a more complete bibliography, *see* R. Dussaud, "Les Travaux et les découvertes archéol. de C. C.-G.," *Syria,* vol. iv, pp. 140–173 (1923). (J. P.)

CLERUCHY, the name given in the ancient Greek world to a body of citizens holding allotments of land in a dependent country. The earliest example of a cleruchy was in Salamis where Megara and Athens in turn planted their citizens on Salaminian land in the 6th century B.C. A fragmentary inscription gives the conditions under which the Athenian citizens held such allotments: the cleruch was forbidden to lease the allotment which he owned in perpetuity; provision was made for him to act as a soldier, and disputes with the native Salaminians were regulated by a resident Athenian official. A cleruchy of 4,000 Athenian citizens was planted on the best land of Chalcis in Euboea about 505 B.C.

When the Confederacy of Delos and the Second Athenian Confederacy were established in the 5th and 4th centuries B.C., the cleruchy became a regular weapon of Athenian imperialism. The cleruchs retained full Athenian citizenship—voting, paying taxes and serving in the forces—and governed their internal affairs with magistrates and assembly on the Athenian model. They were thus extensions of the Athenian state, separate in prestige and privilege from the native peoples among whom they were placed.

The object of each cleruchy was to cripple the dependent state, which lost its best territory, and to garrison it for the future. The network of cleruchies which the Athenians planted had an important strategic value, for they were placed on main lines of communication, for instance on the islands of Andros, Naxos and Samos and at Sestos on the Hellespont and they provided permanent bases for the Athenian fleets which policed the empire. At the same time the financial advantage of being a cleruch encouraged thousands of Athenian citizens to settle overseas; the pressure of population in Athens was thereby relieved, and the financial and military strength of the state increased. The dependent "allies" of Athens detested the system of cleruchies which ended all hope of co-operation in an equal alliance, and the vested interest of Athenian democrats in the cleruchies made the Athenians cling desperately to their imperial possessions.

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CLETHRA, a genus of shrubs or small trees, commonly known as white alder, belonging to the Clethraceae or pepper-bush family and found largely in the tropics and subtropics of the eastern hemisphere with some occurring in Asia and Madeira. They have alternate, simple, toothed, persistent or deciduous leaves and fragrant white or pinkish flowers in terminal racemes or panicles in summer. They are allied to the heath family and grow best in lime-free soils.

C. alnifolia, the sweet pepper bush, is found from Maine to Florida, *C. acuminata* from Virginia to Alabama and *C. tomentosa* from North Carolina to Florida. (J. M. BL.)

CLETUS, SAINT: *see* ANACLETUS, SAINT.

CLEVE (CLEEF), **JOOS VAN** (JOOS VAN DER BEKE) (*c.* 1480–1540), Flemish religious and portrait painter, is now commonly accepted as the painter of the pictures formerly grouped under the name of the "Master of the Death of the Virgin," and it is suggested that he was the pupil of Jan Joest van Calcar. The earliest work ascribed to Joos, the two wings with Adam and Eve, dated 1507, in the Louvre, shows marked affinities with Calcar's style. Joos is first mentioned in 1511, when he entered the Antwerp guild as a master painter. He soon received commissions from Cologne. The date 1515 is on one of the two well-known triptychs which he painted for the Hackeney family of Cologne, representing the "Death of the Virgin" on the central panel and the portraits of the male and female members of the family grouped on the wings. The larger picture is in the Munich Pinakothek, and the smaller is in the Cologne museum. These two pictures, which gave the artist the provisional name of "the Master of the Death of the Virgin," brought the Flemish tradition to Cologne, and exercised a far-reaching influence on the local school. Another picture painted for Cologne is the "Pietà" at Frankfurt (1524), for the church of St. Maria in Lyskirchen.

In 1520 Joos was appointed dean of his guild in Antwerp. In that year Albrecht Dürer visited the city, and Joos must have admired his work for he copied the German master's "St. Jerome." It seems to have been his custom to copy other masters. The "Madonna and Child" (New York) recalls Jan Van Eyck; "The Deposition" (Philadelphia) is founded on Rogier van der Weyden; the Saviour in the Louvre on Quentin Massys; the "Two Children Embracing," of which there are many replicas, on Leonardo da Vinci. He must have felt drawn to the great Italian by his delight in delicate modeling, and he may have seen some of Leonardo's work in France; it is known on the authority of Francesco Guicciardini that when Francis I of France sent to Flanders for a good portrait painter, Joos van Cleve was chosen among others; he was rightly described as a good colourist. The originals of the portraits which he painted of the king and of his wife, Eleanor of Austria, are apparently no longer extant, but it is thought that the portraits of the king at Hampton court and at Philadelphia, and of the queen at the Vienna museum, are replicas of his work, if not the originals. An attractive portrait by his hand, of Henry VIII when young, at Hampton court, suggests that the artist visited England. He also painted the emperor Maximilian (Paris). In the Louvre is a large altarpiece with a "Pietà" in the central panel, a "St. Francis" in the lunette and a "Last Supper" on the predella, which came from a church in Genoa. The "Last Supper" is founded on the famous fresco of Leonardo da Vinci at Milan. Three more altarpieces were painted by Joos for Genoa; one of these is still in the church of San Donato; another is the triptych of the "Crucifixion" in the Metropolitan museum, New York; the third is the larger of two versions of the "Adoration of the Magi," by the master, at Dresden. Thus he probably visited Italy some time after 1530. He died at Antwerp in 1540.

The following may also be noted: "The Crucifixion" (Boston); "The Crucifixion" in the Naples museum; "The Holy Family" (Chicago); and "The Annunciation" (New York). At his best when painting the Virgin and Child, Joos's fame rests on "The Madonna" at Ince hall and on "The Madonna" at the Vienna museum. The heads are delicately modeled, with pretty complexions and sweet expressions. Characteristic of his work are the accessories he introduced in the foreground, such as a bowl of fruit, a knife, a lily in a glass, an open manuscript carefully finished—as in "The Madonna" (Cambridge) and one in Paris, and as in the "Virgin and Child and St. Anne" at Modena. The landscape backgrounds often recall the style of Joachim Patinir, who settled at Antwerp in 1515. The landscape in "St. John at Patmos" (New York) seems certainly to be by Patinir. Joos van Cleve is sometimes called "the Elder" to distinguish him from his son, Cornelis van Cleve (1520–67), a distinguished portrait painter commonly known as Sotte Cleve because he lost his reason.

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CLEVELAND, BARBARA VILLIERS, DUCHESS OF (1641–1709), mistress of the English king Charles II, was born at Westminster in the autumn of 1641, the daughter of William Villiers, 2nd Viscount Grandison (d. 1643). Her intimacy with Charles II began soon after her marriage, in 1659, to Roger Palmer, who was created earl of Castlemaine two years later. The king was probably the father of her first child, Anne, born in Feb. 1661, although the paternity was also attributed to one of her earliest lovers, the earl of Chesterfield. There is a legend that the restored king spent his first night at his palace at Whitehall with her. Certainly she dominated the early years after the Restoration, and her house became the rendezvous for opponents of Lord Chancellor Clarendon. Her delight at his fall in 1667 was conspicuous. But although her favour had become an avenue to political advancement, her most famous protégé being Henry Bennet, earl of Arlington, her influence was essentially negative and her hold on the king was precarious. He had forced the queen to accept her as one of the ladies of the bedchamber in 1662, and she retained her status for several years. She had become a Roman Catholic in 1663 and for a while the French ambassador was instructed to seek her favour. But the king paid less attention to her demands after 1670, and by 1674 she was entirely supplanted by Louise de Keroualle, duchess of Portsmouth.

Barbara Villiers had become countess of Southampton and duchess of Cleveland in 1670, with remainder to her first and third sons, Charles and George, the king at this time not admitting the paternity of her second son, Henry. She consoled herself with other lovers, among them John Churchill, afterward duke of Marlborough, and William Wycherley. In 1677 she settled in Paris, where she formed an intrigue with the English ambassador, Ralph Montagu, who lost his position through some revelations which she made to the king. His revenge, the exposure of secret Anglo-French intrigues, had serious repercussions.

She returned to England just before Charles died in Feb. 1685. In July 1705 her husband, the earl of Castlemaine, whom she had left in 1662, died, and in the same year the duchess was married to Robert (Beau) Feilding (d. 1712), a union which was declared void in 1707. She died at Chiswick on Oct. 9, 1709.

Her eldest son, CHARLES FITZROY (1662–1730), was created in 1675 earl of Chichester and duke of Southampton, and became duke of Cleveland and earl of Southampton on his mother's death. Her other sons, HENRY and GEORGE, were also given dukedoms (*see* GRAFTON, DUKES OF; NORTHUMBERLAND, EARLS AND DUKES OF). (H. G. Ro.)

CLEVELAND, (STEPHEN) GROVER (1837–1908), president of the United States from 1885 to 1889 and again from 1893 to 1897, was born, the fifth of nine children, in Caldwell, Essex county, N.J., on March 18, 1837. His father, Richard Falley Cleveland, a Presbyterian clergyman and a graduate of Yale college and of the theological seminary at Princeton, was a descendant of Moses Cleveland, who came to Massachusetts from England in 1635. His mother, Ann Neal, of Baltimore, Md., met and married Richard Cleveland in 1829 while he was employed as a tutor in that city. In 1841 the family moved to Fayetteville, N.Y., and in 1850 went to Clinton, N.Y., where Grover attended the town academy. He intended to enter Hamilton college, but at the death of his father in 1853 he abandoned his college plans to aid in supporting his mother and her five dependent children. He had worked in a general store in Fayetteville and now took a teaching position at the New York Institution for the Blind at New York city.

In 1855 Grover Cleveland became a clerk in the Buffalo law office of Rogers, Bowen and Rogers and in 1859 was admitted to the bar. He joined the Democratic party along with his law associates and quickly assumed an active role in the local organization. When the American Civil War began, Grover, who had no urge to become a soldier, did not enlist, as did two of his brothers. When drafted in 1863 he took advantage of the commutation provision of the law and hired a substitute. He continued, meanwhile, to support his mother and to assist two teen-age sisters.

His practice of law grew as did his reputation in the party. In 1862 he won his first elective office as ward supervisor. The following year the district attorney of Erie county appointed Cleveland his assistant and two years later (1865) the Democrats chose him as their candidate for district attorney. Defeated in the contest, Cleveland returned more actively to his law practice in the ensuing years and devoted his great energy and unflagging industry to a growing number of cases that came to his office. In 1870 he was elected sheriff of Erie county, and discharged the duties of the office with honesty and vigour. He devoted the years immediately succeeding his retirement from the office of sheriff to his law practice and came to be recognized as one of the leaders of the bar in western New York.

During these years of early manhood, Cleveland revealed a personality of contrasting characteristics. An indefatigable worker, he appeared as a stern, stolid and dignified citizen before the public. He sought relaxation, on the other hand, with a small circle of friends drinking, singing, roistering and indulging in carefree banter in the cafés, saloons and beer gardens of Buffalo. This dual aspect of his character persisted throughout his life.

Mayor of Buffalo.—The Democrats nominated the 44-year-old bachelor lawyer for mayor of Buffalo in 1881. The city government had been marred by extravagance and maladministration, and the voters, revolting against the Republican incumbent, elected Cleveland. Chosen to reform the city administration, he thoroughly reorganized the various departments of the government and introduced businesslike methods in the conduct of the public's affairs. He attracted widespread attention by his independence and his generous use of the veto and by 1882 state party leaders groomed him for a larger field. The Republicans in New York, weakened by scandals and intraparty strife, nominated Charles J. Folger (1818–1884), then U.S. secretary of the treasury, for governor. The Democrats chose Cleveland, who was little known outside of Erie county and was dissociated from the inner ring of state politicians. Supported by many thousands of disaffected Republican voters, Cleveland received an unprecedented plurality of 192,854 votes; he became governor of New York on Jan. 3, 1883.

Governor of New York.—As governor, Cleveland displayed the same stern and independent qualities that had marked his other public positions. He refused to play the game of partisan politics with its dreary round of patronage, spoils and party regularity. He subordinated the demands of party leaders to the general interest, thereby earning the plaudits of the public and the ill will of the political bosses. He backed a strong civil service law, vetoed a popular bill that would have lowered the fares on New York city's elevated lines in violation of a contract with the companies, worked for municipal reform legislation for New York city and fought Tammany Hall over appointments and legislation. The governor laboriously scrutinized all bills passed by the legislature and wielded the veto power without fear or favour.

President of the United States, 1885–89.—In 1884 the Democratic party had been out of power in national affairs for 23 years. The Republican party, in control at Washington since 1861, was now split into two factions—the Halfbreeds and the Stalwarts—which weakened its organization and sapped its effectiveness. The situation afforded the Democrats an unusual opportunity. The Democratic national convention adopted a platform calling for liberal reforms in the administrative departments, the civil service and the national finances and, despite the opposition of Tammany Hall, nominated Cleveland for president. The Republicans, after a contest involving violent personal animosities, nominated James G. Blaine (*q.v.*) of Maine, a brilliant man whose sense of honesty had been dulled by protracted associations with speculative promoters.

The ensuing campaign, one of the bitterest in U.S. history, was noted chiefly for its mudslinging. Partisans accused Cleveland of pro-Southern sentiments because he had avoided war service during the Civil War and exposed an unsavoury incident from his private life involving an illegitimate child. On the other side, campaigners unraveled a sordid story of Blaine's part in a series of political and financial scandals. Despite the closeness of the popular vote (4,874,986 to 4,851,981) Cleveland won the election by an electoral college vote of 219 to 182 (*see* also UNITED STATES [OF AMERICA]: *History*).

Cleveland's first term, while uneventful, was characterized by firmness, justice and a steady adherence to the principles which he deemed best for the nation. He staunchly backed the "Pendleton bill" (1883), designed to develop a nonpartisan civil service by making entrance and promotion dependent upon competitive examinations. Cleveland added 11,757 jobs to the classified service during his first term. Continuing an earlier practice, Cleveland made extensive use of the veto power, vetoing or pocket vetoing 413 bills (over two-thirds of which were private pension bills) passed by the congress. The president, in a politically explosive move, vetoed the Dependent Pension bill, a bold raid upon the federal treasury calculated to increase political support for its backers. Cleveland further alienated the bigwigs of his party by moving against the tariff.

In 1887 there was a large and growing surplus in the treasury which, because of the prevailing fiscal legislation of the country, acted to restrict the amount of currency available for business. About two-thirds of the public revenue came from tariff duties levied on imports from foreign countries. The Republican party, during its period of ascendancy at Washington, had fostered high tariffs to protect native American industry. Cleveland vigorously attacked the tariff legislation of the country, devoting his entire annual message of 1887 to the problem. He did not propose free trade, but he condemned the tariff laws as "vicious, inequitable and illogical." The administration tariff measure, the Mills bill, passed the Democratic house but was withdrawn owing to amendments in the Republican senate.

The presidential campaign of 1888 opened while the debate on the Mills bill raged. Although disgruntled party bosses fretted, the Democrats renominated Cleveland. The Republicans passed over the onetime loser, Blaine, and nominated Benjamin Harrison (*q.v.*) of Indiana. The politicians could raise little enthusiasm for the colourless Harrison and the stolid Cleveland as they devoted their major attention to the tariff issue. Although Cleveland received a popular vote of 5,540,309 to Harrison's 5,439,853, the electoral college gave Harrison the presidency by a vote of 233 to 168. Cleveland, weary of the White House, happily returned to private life and the practice of law in New York city after Harrison's inauguration in 1889.

President of the United States, 1893–97.—The Democrats, in 1892, despite the bitter protests of Tammany Hall, nominated Cleveland for president a third time. The Republicans renominated Harrison. The campaign was a quiet one despite the underlying tension abroad in the nation. The People's party, essentially agrarian in nature, had emerged after 1890 to offer a liberal challenge to the two conservative parties. The Populists, under the leadership of James B. Weaver of Iowa, boldly championed "free coinage of silver" as well as other reforms while Cleveland and Harrison emphasized the tariff in their appeals for votes. Cleveland won the election with a popular vote of 5,556,918 to Harrison's 5,176,108 and Weaver's 1,027,000. Although Cleveland gained less than a majority of the total popular vote, he received 277 electoral votes to Harrison's 145 and Weaver's 22.

Cleveland's second administration proved to be a stormy one. Shortly after his inauguration a financial panic struck the country leaving in its wake one of the most serious depressions suffered by the United States. The uncritical public, its temper on edge, blamed Cleveland and the Democrats for the disaster. To compound his difficulties the president found his party drifting away from his leadership.

His first major fight involved the repeal of the Sherman Silver Purchase act of 1890. The government had kept $346,000,000 "greenbacks" (inherited from Civil War days) as legal tender in circulation and had issued, under the terms of silver purchase acts, nearly $600,000,000 in silver coin and certificates. The treasury had accumulated over the years a gold reserve of more than $100,000,000 to protect its currency, but in April 1893 drains on the treasury reduced the reserve below the $100,000,000 mark. The president, alarmed at the threat of inflation, called the congress into a special session to repeal the Sherman act. The house promptly passed the repealing act but the senate proved obdurate. Although the Democrats controlled the senate, the prosilver Democrats refused to budge. During this period Cleveland underwent an operation for cancer but news of his illness was kept from the public.

Post-Civil War deflation had worked a severe hardship upon many agrarian sections of the country, a hardship intensified by the depression. Farmers clamoured not for less silver in the currency but more as a means of raising badly depressed prices for their crops. The president whipped his party into line and with the help of the Republican minority forced the passage of the repealing bill (Oct. 30).

Repeal of the silver act failed to cure the depression. The federal deficit bequeathed by the Republican administration made it necessary to dip into the gold reserve to meet current expenses. Holders of legal tender notes, fearing depreciation, presented them for redemption in gold. To replenish the gold supply Cleveland authorized the purchase of 3,500,000 oz. of gold from J. P. Morgan and August Belmont at an estimated profit to the financiers of $7,000,000 on a $62,000,000 loan. The business world, despite these efforts to bolster it, remained in a state of constant agitation. Bankruptcies were rife, trade was sluggish, wages were reduced and unemployment mounted. A bitter labour war broke out at the Pullman Palace Car works near Chicago from whence spread a railroad strike that tied up every midwestern railroad and caused riots and bloodshed at many centres. Gov. John P. Altgeld (*q.v.*) of Illinois, lacking sympathy for the railroads, refused to intervene in the strike. Cleveland, acting upon the appeal of the railroad association and over the protest of Governor Altgeld, dispatched federal troops on July 6, 1894, to safeguard the mails, clear the way for interstate commerce and restore peace. The troops dispersed the workers and broke the strike within one week. The president, while he received the plaudits of the business community, earned the suspicious distrust of organized labour.

Cleveland further weakened his party in dealing with the tariff issue. He believed that he held a mandate from the electorate to effect a downward revision of the tariff. With this in mind, William Lyne Wilson of West Virginia introduced a reform tariff bill in the house. The senate, under the leadership of Sen. Arthur Pue Gorman of Maryland and a group of high-tariff antiadministration Democrats, so amended the bill upward that it became a mockery of tariff reform. Unwilling to veto the measure and risk losing badly needed revenues, the president signified his dissatisfaction with its high rates by allowing it to become law without his signature.

In foreign affairs Cleveland began his administration by withdrawing a treaty for Hawaiian annexation negotiated by Harrison's administration. The American colony at Honolulu had engineered a revolution against the reactionary policies of Queen Liliuokalani, established a republic and sought admission to the United States. Cleveland, who opposed expansion and thought that the queen had been wronged, refused to support annexation and urged the revolutionaries to restore the dethroned queen. The president of the new republic politely informed Cleveland that Hawaii would brook no interference with its internal affairs. Cleveland also faced problems growing out of a new revolutionary outbreak in Cuba (1895) caused partly by the Wilson tariff, which had raised the duties on Cuban sugar and demoralized the industry. Cleveland stoutly refused to encourage the expansionists within the nation by interfering in Cuba.

On the other hand, the president did not hesitate to speak out boldly when he sensed an impending violation of the Monroe Doctrine (*q.v.*). Great Britain and Venezuela had for long disputed a boundary line between British Guiana and Venezuela. The Venezuelans had insisted on arbitration and London had resisted. Following a well-planned Venezuelan-inspired publicity campaign in this country, sentiment favouring Venezuelan claims developed rapidly and congress in 1895 adopted a resolution urging arbitration. Cleveland, unable to ignore the domestic political implications of the situation, on July 20, 1895, sent an intemperate note prepared by his secretary of state, Richard Olney, pointing out that England was violating the Monroe Doctrine and asking that her majesty's government arbitrate the boundary. After several months' delay Britain returned a reply which made Cleveland "mad clear through." On Dec. 17, 1895, the president sent a ringing message to congress calling attention to Britain's action and recommending an appropriation to finance an investigating commission to report on the disputed boundary. The United States, he insisted, "must resist by every means" an extension of British jurisdiction over what "we have determined of right belongs to Venezuela." The president implied that the United States should define the boundary and be prepared to fight, if necessary, to compel acceptance. The congress unanimously appropriated the necessary funds without delay.

Fortunately, after the jingoes on both sides of the Atlantic had had their field day, more sober counsels prevailed and tempers cooled. Britain agreed to arbitrate, as did Venezuela, and the commission awarded what Britain had on several occasions offered to Venezuela. Cleveland and the United States emerged from the dispute with enhanced prestige and England henceforth sought to eliminate sources of friction and bring the United States into closer relations with Great Britain.

Despite widespread support in the Venezuela affair, Cleveland, by the end of his second administration, had lost touch with the dominant forces of his party and unintentionally antagonized several important groups of voters. When the Democrats met in convention at Chicago in 1896 the antiadministration wing gained control and refused the customary endorsement of the administration. The inflationists proceeded to adopt a platform promising the free and unlimited coinage of silver as well as sweeping economic and political reforms. The convention, after listening to the impassioned "Cross of Gold" speech of William Jennings Bryan of Nebraska, nominated him for president. The gold Democrats thereupon bolted the convention and nominated their own candidates under the banner of the National Democratic party. Cleveland supported the "sound money" nominees.

Retirement.—When Cleveland's second term ended on March 4, 1897, he retired to a home in the quiet university town of Princeton, N.J., where he maintained his residence until his death. Partisan animosities gradually lost their intensity and Cleveland regained his reputation as a sincere, independent, disinterested defender of honest government. Princeton university made him a trustee and Stafford Little lecturer on public affairs. Democrats in 1904 talked of renominating Cleveland for a third term, which he doubtless would have declined. In 1905 Cleveland accepted an invitation to serve on a board of three trustees of the Equitable Life Assurance society to reorganize the company. Subsequently he acted as rebate referee for the Equitable, the Mutual of New York and the New York Life insurance companies. In the meantime he published several magazine articles on political and other subjects and found time to bring out *Presidential Problems* (1904) and *Fishing and Hunting Sketches* (1906).

Cleveland in 1886 at the White House had married Frances Folsom (1864–1947). The Clevelands enjoyed a happy family life despite the disparity in their ages. Four of their five children survived him. While Cleveland was not a rich man, he had carefully husbanded and invested his resources and was able to live comfortably and leave money for the generous support of his family. After several months of illness Cleveland died at his home on June 24, 1908.

There was an outpouring of expressions of esteem on the occasion of his death. The American people saw in Cleveland a staunch defender of many of their ideals and time-honoured virtues. He was a typical 19th century liberal whose views had altered little while all about him had changed. Cleveland had stood for honesty and probity in the public service, had fought against special privilege, had advocated as large a measure of freedom in economic life as was consistent with public order, had sought to lower tariff walls in the interest of the consuming public and had reasserted the nation's role in foreign affairs without embarking upon expansionist programs which might prove embarrassing to support.

See also references under "Cleveland, (Stephen) Grover" in the Index volume.

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CLEVELAND, JOHN (1613–1658), English royalist poet, originator of a native type of political satire, was born in June 1613 at Loughborough, Leicestershire, and educated at Christ's college, Cambridge. In 1634 he was made fellow of St. John's. Soon after June 1642, at the outbreak of the Civil War, he left Cambridge for Oxford and began to employ his pen in the service of the king. He was judge advocate in the garrison at Newark from May 1645 until its surrender in May 1646. After this nothing is certainly known about him until his arrest at Norwich in Nov. 1655, although it is possible that he was in London in 1647–49, and probable that he was at the house of Stephen Anderson in Manby, Lincolnshire, in 1651.

His arrest led to a three-month imprisonment in Yarmouth jail, from which he was released as a result of his "Petition to the Protector." He found his way to Gray's Inn, London, where he died on April 29, 1658.

Cleveland was the most popular poet of his age. Over 30 editions of his poems appeared between 1647 and 1700, whereas the same period saw only two editions of Milton's *Poems* (1645). His verse carries "metaphysical" obscurity and conceit to their limits, and many of his occasional poems are merely brilliant intellectual gymnastics ("Fuscara," "The Antiplatonick" and "The Senses Festival"). But his real achievement is in his political poems, and he is very nearly a great political satirist. His control of the heroic couplet in "Rupertismus," "The Rebel Scot" and "The King's Disguise" foreshadowed the method of Dryden and inaugurated the sophisticated form of satire. His metrical experiments in "Mark Anthony," "The Author's Mock Song to Mark Anthony" and "Square-Cap"—fine poems in their own right—provide further evidence of his technical inventiveness. Cleveland attracted a host of imitators, and his later editions contain many spurious poems. As a satirist he deserves more lasting fame than he has found.

BIBLIOGRAPHY.—The best text is in G. Saintsbury, *Minor Poets of the Caroline Period*, vol. iii (3 vol., 1905–21). For Cleveland's life see *The Poems*, ed. by J. M. Berdan (1911); S. V. Gapp, "Notes on John Cleveland," *Publications of the Modern Language Association of America*, xlvi, 4 (1931); G. Thorn-Drury, *A Little Ark* (1921). The bibliographical problems are considerable, and both Saintsbury and Berdan contain many inaccuracies. (B. R. M.)

CLEVELAND, a city of Ohio, U.S., and seat of Cuyahoga county, is the chief St. Lawrence seaway port on Lake Erie and port of entry for Ohio. Centrally located on Ohio's lake shore at the mouth of the Cuyahoga river, the city is 481 mi. W. of New York and 340 mi. E. of Chicago by highway. To the southwest are Columbus (141 mi.) and Cincinnati (239 mi.). Pop. (1960), city 876,050; standard metropolitan statistical area, which includes both Cuyahoga and Lake counties, 1,796,595. Largest of the bordering suburbs are Lakewood, Parma, Garfield Heights, Shaker Heights, Cleveland Heights, East Cleveland and Euclid (*qq.v.*). (For comparative population figures for Cleveland and its suburbs *see* table in OHIO: *Population*.)

History.—Cleveland is the product of enterprising men who made use of every advantage of its site and hinterland. Located at the mouth of the second largest river in the Erie watershed and at the western end of the only lowland corridor between the Atlantic at New York city and the central plains, the site is a natural transshipment centre. The first to recognize its value were the ancient mound builders who built fortifications within the present city limits. Indian and French trading posts were established in the lower Cuyahoga before the coming of the English. About 60 Indian families were residing on the west side of the river when Cleveland was founded and three important Indian trails became the chief highways of the settlers. The Lake trail between Buffalo and Detroit became the principal thoroughfare in Cleveland utilizing a glacial lake beach. The Muskingum trail led southward along the Cuyahoga over Portage path in Akron into the Muskingum valley of the Ohio watershed. The Mahoning trail was the most important one used by settlers between Pittsburgh and Cleveland.

When the Ohio country was opened to settlement after the American Revolution, Connecticut, in ceding its western lands to the federal union in 1786, reserved a 3,500,000-ac. tract (known as the Western Reserve) in northeastern Ohio. To expedite the sale of land, the Connecticut Land company sent Moses Cleaveland to lead the first surveying party of 46 into "New Connecticut"; they arrived at the mouth of the Cuyahoga on July 22, 1796. Surveying of the Western Reserve began immediately and two months later the plan for the town of Cleaveland was completed. The 4-ac. public square was surrounded by 220 lots of 2 ac. each to the east of the Cuyahoga gorge and due south of the lake, with 99-ft. streets, with the exception of Superior avenue (132 ft.). The downtown portion of Cleveland conforms in large measure to the original plan, including the pattern of thoroughfares radiating from the square. (The "a" in Cleaveland was dropped in 1832 to shorten a newspaper's masthead.)

From the nucleus of the original settlement the city spread first eastward on the 2–4 mi. wide lake plain between the lake and the glaciated portion of the Appalachian plateau, whose 200-ft. escarpment divides the narrow lowland from the rolling "heights." As the narrow plain was developed for commercial, residential and industrial land use, the Cuyahoga valley "flats" became the site where bulky raw materials could be shipped by water and rail for heavy industries. The heights remained a partially cleared farming area throughout the 19th century. The most notable farming community was that of the Shakers, a communal religious sect, supplying the city with high-quality farm produce.

Manufacturing had an early start in the usual pioneer industries, including flour milling with local sandstone for the grindstones. The convergence of river, lake and Indian trails did not, however, immediately bring prominence to Cleveland. As late as 1820 the population was only 606. Phenomenal growth and prosperity of the community began with the era of canal building. The completion of New York's Erie canal provided an all-water route between Lake Erie and the Atlantic. In 1825 Ohio began construction of its first canal, to connect Lake Erie and the Ohio river. The Cleveland-Akron portion was opened in 1827; five years later the canal was completed.

A decade later railroads increased the commercial and industrial activity of the city. When the Soo canal was opened in 1855, Cleveland became Lake Erie's transshipment centre for lumber, copper and iron ore and for rail shipments of coal and farm produce from the hinterland. Soon thereafter the American Civil War supplied the impetus for the initial growth in iron and steel processing, the fabrication of metals, oil refining and chemical manufacturing.

At the close of the 19th century a new means of transportation enhanced the position of Cleveland and initiated rapid suburban growth. A mushrooming development of electric interurban trains carried not only rural and intercity passengers but also large tonnages of perishable farm products, mail, express and packaged freight at more frequent intervals than the railroads. They offered Cleveland an efficient network of interstate services. In the 20th century, auto, bus and truck transportation became increasingly important.

Early in the 20th century Cleveland began a program of urban renewal to eliminate slums and revitalize the downtown area. The "group plan" committee in 1902 executed the plan for the construction of public buildings surrounding a mall near the public square and consisting of the courthouse, city hall, federal building, public library, public auditorium, board of education building and the stadium. Privately financed buildings were also erected after the state legislature in 1915 granted authority for steam and electric railroads to build a union station at the southwest corner of the public square. In addition to the Union Terminal building, other large multistory buildings included a hotel, a department store, large office buildings and the main post office. By the mid-1930s Cleveland had the appearance of a modern metropolis in a New England colonial setting of the public square.

Since 1950 urban renewal has prompted the removal of blighted buildings for modern office buildings, newspaper publishing, banks and civic centres. Along Euclid avenue between East 22nd and 40th streets, once the site of palatial homes of Cleveland's millionaires, are regional offices of national companies.

Government.—Cleveland is divided into wards, each represented by a councilman elected for two years. The mayor's cabinet and the council budget the city expenditures for safety and welfare, utilities and salaries, health and sanitation, properties and parks, port control, aviation and traffic, housing, urban renewal and planning. Civil and criminal cases are handled by the municipal court. The responsibilities for supporting several institutions offering county-wide benefits are assumed by the county commissioners. The Cleveland metropolitan services commission is designed to reduce many of the duplications of services in the more than 60 cities, villages and townships of the county.

Commerce and Transportation.—No natural factor of location was more impelling in the growth of Cleveland than its advantages for transportation. In the development of Cleveland lies the glacial history of the region, notably in the lower half of the Cuyahoga course. Its source is only 15 mi. S. of Lake Erie and 35 mi. E. of Cleveland. After flowing southwestward, at Cuyahoga falls on the northern limit of Akron, the river drops into a large and deep preglacial valley and, flowing northward, reaches the lake plain about 6 mi. from its mouth. There it is entrenched as a meandering stream in a gorge 60–125 ft. deep and near the lake is less than ¾ mi. wide. The Indian name, Cuyahoga, meaning "crooked," reaches the full sense of the word for it has 855° of curvature in the last 2 mi. of its course. The sharpest meanders have been widened so that lake freighters can reach the head of navigation about 5 mi. from the mouth. To straighten the river valuable river frontage would have been sacrificed. The original mouth lay more than 1 mi. west of the present outlet. To overcome constant silting at the last meander, the new river outlet was cut directly to the lake and the old mouth closed. The land between the old and new mouths, known as Whisky Island, is the city's most important bulk storage portion of the inner harbour.

Along the entire northern border of metropolitan Cleveland lies 40 mi. of lake shore, but the commercial and industrial dock activities are confined within the 5-mi. breakwater extending both east and west of the river mouth and along the Cuyahoga. General cargo facilities in the outer harbour include private piers able to accommodate ocean and lake vessels of 500-ft. length, including a 500-ft. pier specializing in Canadian newsprint. Also located in the outer harbour is the U.S. coast guard station. Reclamation along the lake front has added considerable acreage for warehouse facilities, railroad sidings, the municipal stadium, Burke Lakefront airport, pleasure craft moorings, parks, municipal parking lots and the highway east of the river.

In the inner harbour of the flats are found heavy industry, railroad yards, bulk storage space and 13½ mi. of navigable river frontage for privately owned bulk cargo docks handling iron ore, limestone, coal and chemicals.

As for land transportation, the terminals of five major trunk railways radiate from the right bank of the lower Cuyahoga. Three local railroads serve principally the steel industry.

Federal and state highways radiate from the public square. Seven bridges in the flats and four high-level structures cross the gorge to link the east, west and south sides of the city. Limited access multilane highways from the commercial core of the city expedite commuter traffic and in turn connect with several limited access federal highways constructed through metropolitan Cleveland.

To improve the public services for handling daily commuters, the municipally owned Cleveland Transit system operates a modern high-speed electric railway along the Nickel Plate and New York Central rights-of-way, 7.7 mi. due east and 7.2 mi. to the southwest of the Union terminal. Shaker Rapid Transit is a 10-mi. electric railway between the Cleveland terminal and the city limits of Shaker Heights in the southeast.

Ten miles southwest of the public square is the municipally owned Cleveland-Hopkins airport. Located in the terminal is one of the nation's major weather stations. Nearby is the federally owned Flight Propulsion laboratory and the National Administration for Space Aeronautics.

Industry.—The basic prosperity of metropolitan Cleveland rests upon heavy industry. Of the total industrial labour force, about three-fourths finds employment in the manufacturing of primary steel, the fabrication of steel and aluminum products, hardware and enamelware, machine tools, appliances, tractor and motor vehicles, airplane parts, electrical machinery, electronic equipment and hundreds of other metal products. In addition, the making of wool clothing is an important industry.

Much of Ohio's oil refining, basic chemicals, paint manufacturing and plastics industries are concentrated in the lower Cuyahoga valley and along the lake shore to the northeast. Long a centre for aeronautical, electrical and other industrial research, metropolitan Cleveland has about 400 research laboratories. During and after World War II manufacturing expanded into the sparsely populated suburban communities of Euclid, Parma, Brooklyn and Garfield Heights, where much level land was available for industrial sites.

Throughout the history of Cleveland, glacial deposits in the Cuyahoga valley fostered the building trades. The manufacture of brick and other clay products has declined, partially due to the change in land use, and most of the extensive glacial gravels and sands are exhausted. The chief sandstone formation, Berea Grit, outcropping southwest of Cleveland, supplied the world with high-quality grindstones and sandstone for Cleveland's older public buildings and palatial homes. In no other metropolitan area is there a greater mileage of sandstone sidewalks. In 1890 vast salt beds about 1,800–2,000 ft. below the surface of Cleveland's lake plain were discovered, and salt provides a valuable raw material for the chemical industry.

In Cuyahoga valley about 5 mi. south of the square is located a highly specialized vegetable greenhouse industry. Unlike most farming communities located near large cities where the growth of suburbs has forced a retreat of agriculture, the vegetable greenhouse acreage has increased. Three-fourths of the vegetables produced annually are shipped outside the Greater Cleveland market from the Atlantic to the Mississippi and as far south as Baltimore, Md., St. Louis, Mo., and Louisville, Ky.

Cleveland has an unlimited supply of medium soft water from Lake Erie. The first public waterworks system was put into use in 1856 by pumping water from the lake; the city has since multiplied and modernized its water facilities for distribution to most of the county. Abundant and dependable electricity is supplied by both public and private steam-generating plants.

The development and growth of manufacturing in Cleveland was made possible in large measure by immigration of skilled and unskilled labour from the British Isles, Germany and Scandinavian countries, and later from eastern and southern Europe. During and after World War II the southern labour force made possible continuing industrial growth.

Education and Cultural Institutions.—The largest of Cleveland's notable educational institutions is Western Reserve university, a private university founded in 1826; it consists of Adelbert college for men, Flora Stone Mather college for women, Cleveland college for continuing adult education, a graduate school and schools of law, medicine, dentistry, library science, nursing, business and applied social sciences. In 1958 a 20-year master plan was organized under the University Circle Development foundation to preserve and enlarge the facilities of the 28 cultural and religious institutions in close proximity to Western Reserve university.

Other educational institutions are Case Institute of Technology, a private technical college founded in 1880; John Carroll university, a Roman Catholic university for men, founded in 1886; Baldwin-Wallace college, Methodist, founded in 1845; Cleveland Institute of Art, private, 1882; Cleveland Institute of Music, private, 1920; Cleveland-Marshall Law school, private, 1897; Fenn college, private, 1923; Ursuline, founded in 1871, and Notre Dame, founded in 1923, both Roman Catholic colleges for women. Private schools include Laurel and Hathaway Brown, for girls, University and Hawken, for boys, and, in nearby Hudson, Western Reserve academy for boys. Within the Roman Catholic diocese are many high schools. There are two Lutheran high schools.

The Museum of Art, Western Reserve Historical society, Museum of Natural History, Health museum, Allen Memorial Medical library, Garden centre, Fine Arts gardens and the Cleveland Symphony orchestra housed in Severance hall are all located within ½ mi. of Western Reserve university and Case Institute of Technology. The Cleveland public library is one of the nation's great research libraries and the first to establish the open-shelf system.

In the field of drama, the needs of both professional and amateur players are met by year-round playhouses, the most famous being Karamu house.

Parks.—The natural beauty of several gorges is preserved in the metropolitan park system, notably in Chagrin, Rocky, Bedford and Euclid reservations. Big Creek is the site of the Cleveland zoological gardens and Doan Brook contains the formal cultural gardens established by various groups to commemorate international heroes and creators of art, music and literature. More than 500 neighbourhood playgrounds provide recreation for young and adult Clevelanders.

Health and Welfare.—Well-known for work in social welfare, Cleveland sponsors many settlement houses and civic centres for preserving old-world cultures and for the Americanization of foreigners. The community chest, which originated in Cleveland in 1913, finances many agencies within the metropolitan area. The highly endowed Cleveland foundation contributes annually large funds to charitable and cultural institutions.

Metropolitan Cleveland has about 60 hospitals. Those with graduate training programs are Cleveland clinic, Metropolitan General, Deaconess, Doctor's, Euclid-Glenville, Fairview Park, Huron Road, Lakewood, Lutheran, Marymount, Mt. Sinai, St. Alexis, St. John's, St. Luke's, St. Vincent's and University. There are also two veterans' hospitals, three state hospitals for the mentally ill and two county hospitals for the physically handicapped and tubercular. Cleveland and Cuyahoga county support six corrective institutions for juvenile offenders and three for adults.

See also references under "Cleveland" in the Index volume.

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CLEVELAND HEIGHTS, a residential suburb 8 mi. E. of Cleveland (*q.v.*) in Cuyahoga county, Ohio, U.S., and a part of the Cleveland metropolitan area, lies on the northern portion of the Appalachian plateau about 440 ft. above Lake Erie. It has no railroads or industry and is noted primarily for its many imposing homes. It was incorporated as a village in 1903. The region remained largely a wooded tract until it was incorporated as a city in 1921. The council-manager plan of city government went into effect at that time. The city has an excellent public school system and libraries. Its municipal park system includes Cain park, nationally known as an outdoor summer theatre in a natural amphitheatre setting. Cleveland Heights shares with Shaker Heights the scenic Shaker lakes in the valley of Doan Brook. In 1938 it received 70 ac. of Forest Hills, the summer residence of John D. Rockefeller, from which was created Forest Hills park, offering both winter and summer recreation facilities. The population in 1960 was 61,813. For comparative population figures *see* table in OHIO: *Population.* (M. M. WA.)

CLEVES (German KLEVE; Dutch KLEEF or CLEVE), a town on the western edge of Germany, which after partition of the nation following World War II was included in the *Land* (state) of North Rhine-Westphalia in the German Federal Republic. It is situated on three hills rising from a flat countryside, 65 km. (40 mi.) N. of Krefeld by road and 15 km. (9 mi.) S. of the Dutch frontier. Pop. (1959 est.) 21,342. Cleves is on the main railway from Cologne to Amsterdam. The Spoy Canal connects it with the Rhine.

The town is built on two levels. The Schwanenburg or "swan's castle," associated with the legend of Lohengrin, is used as a law court. Its two towers, the Spiegelturm and Schwanenturm, date from 1429 and 1440 respectively. The Collegiate church (1341–1402) and the Minorite church (1427) are also interesting. There are two parks, the Forstgarten, redesigned by the landscape architect Maximillian Weyhe, and Prinz Moritz park, the grounds of the former residence of the electors. The town's mineral wells and its proximity to large areas of heath and woodland attract a large tourist trade. Agriculture is the basis of the district's economic life; shoes, margarine, biscuits, cocoa, tobacco, leather goods and chemicals are manufactured.

The town was the seat of the counts of Cleves as early as the 11th century, but it did not receive municipal rights until 1242. The county, which lay on both banks of the Rhine, passed in 1368 to the counts of La Marck and was made a duchy in 1417. It was united to the neighbouring duchies of Jülich and Berg (*qq.v.*) in 1521. Anne of Cleves (*q.v.*), daughter of Duke John, was the fourth wife of Henry VIII of England. By the treaty of Xanten in 1614, Cleves passed to the elector of Brandenburg. It was ceded to France during the Revolutionary and Napoleonic Wars, restored to Prussia in 1815 except for some small portions given to the Netherlands, and became part of the German empire in 1871. Cleves was severely damaged in World War II before its capture by the Allies on Feb. 11, 1945.

CLICHY (CLICHY-LA-GARENNE), a northern suburb of Paris, is a commune and canton of Seine *département*. Pop. (1954) 55,578. The main features are the church, dedicated to St. Vincent de Paul, who was the village priest at Clichy (1612–25), and

Beaujon hospital. The station, shared with the neighbouring commune of Levallois-Perret, is on the main line from Paris to Rouen and Le Havre. The chief industry is the manufacture of automobiles; electrical equipment, machinery, plastics, chemicals, foodstuffs and pencils are also produced, and printing is done. Clichy (Lat. *Clippiacum*) was a residence of the Merovingian kings. On March 30, 1814, at the gate of Clichy, the Russians attacked the French in the battle of Paris. In World War II the town was occupied by the Germans from June 1940 to Aug. 1944. (A. Dl.)

CLICKS, in linguistics, are peculiar sounds of unknown origin found in many languages. The German term *Schnalze* and the Afrikaans *klukken* are both attempts to give a descriptive name, but the English word "click" is as onomatopoeic as any. The outstanding examples of click speech are the Hottentot languages (Nama, !Kora, Griqua, etc.) with four or five different clicks and those of the Bushmen of South Africa (*e.g.*, !Kung, Kham, !Ai) with as many as nine different clicks.

From contiguity with the Hottentots and Bushmen several Bantu stocks have acquired clicks, which are alien to Bantu speech systems. Such stocks are the Zulus and Kaffirs, while the Damaras (originally Bantu) have dropped their language entirely and speak only Hottentot. In the interior, even Afrikaans (Cape Dutch) has acquired clicks.

It seems fairly well established that clicks are not confined to South African tongues. There are cases of their presence in the Melanesian languages of the eastern Pacific, the Q recorded by R. H. Codrington and Bishop J. C. Patteson representing a click sound. Clicks never appear very far north of the equator and historically, at least, a definite "click zone" can be found girdling the earth at, and south of, the equator. A study of the Quichua language of the Incas of Peru showed the existence of click sounds, later changed to simple gutturals, in the ancient tongue. The Aztec or Nahuatl tongue also had clicks and in the surviving Aztec spoken by Mexicans in the hills of the interior, the *tl*, final and initial, sounds exactly like a Hottentot dental click.

In the Nama speech (standard Hottentot), there are four clicks, represented thus:

	Tindall	German system	International Phonetic Association
Dental	c	/	ʇ
Cerebral	q	!	ʗ
Palatal	v	≠	X
Lateral	x	//	ʖ

In the Bushman languages other clicks exist having such signs as:

Guttural ⌐ Semi-labial ▯ Labial ʘ

The sounds must be heard: no description can do more than convey a general idea of their nature. The dental click, for example, is pronounced by pressing the flattened tip of the tongue against the front teeth at the gums and quickly withdrawing it. Early attempts to define and describe these sounds will be found in the works mentioned below.

See also Bushman Languages; Hottentot; Sandawe; African Languages.

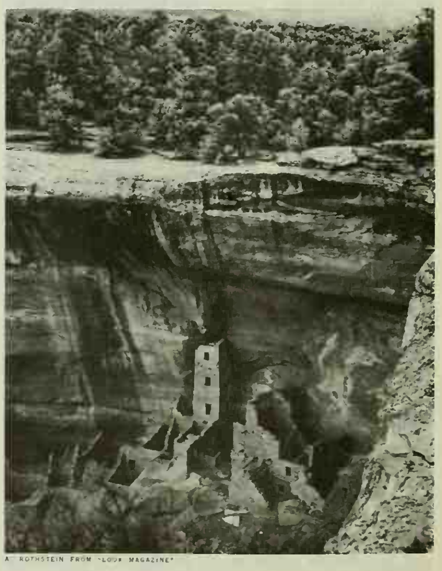
See H. Tindall, *A Grammar of the Namaqua-Hottentot Language;* J. L. Döhne, *Zulu-Kafir Dictionary* (1857); Meinhof, *Lehrbuch der Namasprache* (1909); Leonhard, *Aus Namaland und Kalahari* (1905); N. Whymant, *The Zone of Clicks* (1923). (A. N. J. W.; L. G. J.)

CLIFF DWELLERS is the popular name for the prehistoric American Indians belonging to the Anasazi (*q.v.*) culture in what is now the southwestern United States; their 20th-century descendents are the Pueblo Indians. About A.D. 1050 to 1300 the Anasazi characteristically built their homes and granaries on cliff ledges, probably as a protection against invaders. The most impressive site from that period is at Mesa Verde, Colorado (*see* Cliff Dwellings). *See* also North America: *Prehistory and Archaeology: Southwestern Village Farmers;* Indian, North American: *Culture Provinces: The Southwest.*

CLIFF DWELLINGS is the term usually applied to houses and villages built in natural caves and sheltered recesses in the faces of cliffs by the prehistoric Indians of the southwestern United States and northwestern Mexico. Except for such modifications made necessary by construction within the limited confines of a cave, they differed little from other masonry or adobe houses and villages (or pueblos) built by the same groups on the mesa tops or in the valley bottoms. Cliff dwellings should be distinguished from cave dwellings and rock shelters which with little or no modification have been used since earliest times in many parts of the world. Many of the southwestern caves which contain cliff dwellings were first utilized for burial, storage or habitation by the Basket Makers and similar people who were ancestors of the cliff dwellers (*q.v.*) and the modern Pueblo Indians (*q.v.*).

When cliff dwellings first came to attention many early visitors mistakenly attributed them to a "lost race" of pygmies. Beginning with the first scientific excavations by Gustav Nordenskiöld in 1891, however, it soon became apparent that the cliff houses were made by the same Indians who built houses in the open.

Like contemporaneous surface houses the cliff pueblos were communal dwellings. Although most were small, containing from 1 to 10 or 15 domestic rooms and 1 or 2 ceremonial rooms or kivas, a few were very large with more than 100 rooms and numerous kivas. Many dwellings consisted of two, three, or even four stories, often built in stepped-back fashion so that the roofs of the lower rooms served as porches for the rooms above. Some houses abutted the cave wall while others were free-standing. The lower, inner chambers were used primarily for the storage of maize (Indian corn), beans, squash and various wild foods such as pinyon and yucca seeds, and of basketry, pottery, agricultural implements and other objects. The upper rooms served for corn grinding, sleeping and living and were reached by ladders or, rarely, by stairways. Small doors helped to conserve heat in the houses. Cooking and most other domestic chores were carried on outside the houses, on the roofs or in the plaza areas between blocks of rooms. Towers, which often commanded the approaches to the caves, were presumably for defensive purposes but may have had ritual functions as well. Kivas were usually constructed as underground



A. ROTHSTEIN FROM "LOOK MAGAZINE"

SECTION OF SQUARE TOWER HOUSE, MESA VERDE NATIONAL PARK, COLORADO chambers in the plaza areas and served both for ceremonies and as clubhouses for the men of the villages. Houses were built of stone masonry with mud mortar or of adobe mud and frequently were plastered. Rooms and kivas often were whitewashed and occasionally had painted decorations.

Most of the cliff dwellings in the high, arid mesa and canyon country of the adjacent portions of Colorado, Utah, Arizona and New Mexico drained by the San Juan river have been dated by dendrochronology from the 11th to the 13th centuries, but some may date as early as the 9th century. Farther south, most of the cliff dwellings of central Arizona and southern New Mexico appear to have been built in the 14th century. Recent evidence suggests that some cliff dwellings in northwestern Mexico may date near A.D. 1000.

While defense may often have been a major reason for the selection of caves as village sites, protection from the elements and the warmth of the south-facing caves during winter were other considerations in the choice.

The best-preserved cliff dwellings are those in Mesa Verde National park (*q.v.*) in Colorado and in various national monuments in Arizona. Cliff palace in Mesa Verde, which occupies the entire floor of a cave approximately 300 ft. long, contains about 200 secular rooms and towers and 23 kivas. Spruce Tree house, Balcony house, Long house, Mug house, Square Tower house and Step house are other important cliff dwellings in Mesa Verde National park. White house and Mummy cave in Canyon de Chelly National monument and Keet Seel and Betatakin in Navajo National monument are also notable. Good examples of the smaller, later, southern type may be seen at Montezuma Castle and Tonto National monuments in central Arizona.

Cavate lodges are sometimes considered as cliff dwellings. These consist of groups of rooms excavated in relatively soft stone cliff faces. In front of these, flat-roofed pueblos were constructed, often as a series of terraces following the slope of the talus. Cavate lodges were built in the valleys of the Verde river in Arizona, the San Juan river in Colorado and especially in the upper Rio Grande valley in New Mexico. This type of village may be seen at Puyé and in Bandelier National monument (Rito de los Frijoles) near Santa Fe, N. M.

See also INDIAN, NORTH AMERICA: *Culture Provinces: The Southwest.*

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(J. B. W.)

CLIFFORD, the name of a famous English family and barony, taken from the village of Clifford in Herefordshire.

ROGER DE CLIFFORD (d. *c.* 1285) played an important part in the Barons' War in the reign of Henry III. He supported Simon de Montfort in 1263, but fought for the king at the battles of Lewes (1264) and Evesham (1265), and was granted estates in Westmorland. His grandson ROBERT (1274–1314), the 1st baron, served in the Scottish wars of Edward I and Edward II. He was one of the lords ordainers (1310) and an opponent of Piers Gaveston. He was killed at the battle of Bannockburn on June 24, 1314. His son ROGER (1300–22) joined in the rebellion of Thomas, earl of Lancaster, was captured at the battle of Boroughbridge and hanged at York on March 23, 1322. JOHN (1435–61), the 9th baron, earned the nickname of the "butcher" in the Wars of the Roses, in which he fought for Henry VI. He was killed by a chance arrow at Ferrybridge, Yorkshire, on March 28, 1461, and was attainted later that year. For this reason his son HENRY CLIFFORD (*c.* 1454–1523) was brought up in obscurity and is sometimes called "the shepherd lord." But after the accession of Henry VII the attainder was reversed (1485). Henry fought at the battle of Flodden (1513) and died on April 23, 1523. His son HENRY (1493–1542) was created earl of Cumberland (*q.v.*) in 1525, and the main line of the Cliffords was associated with this earldom until the title became extinct in 1643.

On the death of GEORGE (1558–1605), 3rd earl of Cumberland, the barony of Clifford, separated from the earldom, was claimed by his daughter ANNE (1590–1676), later countess of Dorset, Pembroke and Montgomery. After Anne's death the claim passed to her daughter MARGARET (d. 1676), wife of John Tufton, 2nd earl of Thanet, and to her descendants. The barony was later held with intervening abeyances by the Southwells and the Russells, to which latter family the present Lord de Clifford belongs.

In 1628 a new barony of Clifford was created in favour of HENRY (1592–1643), afterward 5th and last earl of Cumberland, passing on his death to his daughter ELIZABETH (1613–91), wife of Richard Boyle, 2nd earl of Cork. From the Boyles it passed to the Cavendishes, falling into abeyance in 1858.

The barony of Clifford of Lanesborough was held by the Boyles from 1644 to 1753. The Devonshire branch of the family is descended from ROGER (1333–89), 5th Lord Clifford. Its most famous member, THOMAS CLIFFORD (*q.v.*), a member of the cabal ministry under Charles II, was created 1st Baron Clifford of Chudleigh in 1672. The family of Clifford of Flaxbourne, N. Z., is descended from HUGH (1700–32), 3rd Lord Clifford of Chudleigh. CHARLES (1813–93), his great-grandson, speaker of the house of representatives in New Zealand from 1853 to 1860, was created a baronet in 1887.

CLIFFORD, JOHN (1836–1923), British Nonconformist minister and social reformer, was born on Oct. 16, 1836, at Sawley, Derbyshire. His father had Chartist sympathies. At the age of ten Clifford began work in a lace factory, but on his deciding to become a Baptist preacher he was sent in 1855 to the General Baptist academy in Leicester. In 1859 he became minister of Praed street chapel, Paddington, and continued his studies at London university, where he took degrees in arts, science and law.

A new chapel at Westbourne Park was opened in 1877 for his growing congregation. Clifford became president of the Baptist union in 1888 and was prominently involved in the "downgrade" controversy resulting from charges of heresy brought against the union by one of its most influential preachers, C. H. Spurgeon (*q.v.*). The uniting of the General Baptists of the New Connexion with the Baptist union in 1891 owed much to Clifford's leadership. In 1898 he became president of the National Free Church council.

His keen social sympathies led to his close association with the radical wing of the Liberal party and with a number of early Labour leaders, including James Keir Hardie. Clifford became a national figure as a result of his ardent advocacy of "passive resistance" to the Education act of 1902 by nonpayment of rates as a protest against the use of public funds to support denominational schools. His goods and those of other Nonconformists were several times confiscated. The failure of the Liberal government of 1906 to end the dual system was a great disappointment to Clifford. In 1899 he was again president of the Baptist union and from 1905 to 1911 served as the first president of the Baptist World alliance. The world alliance for promoting international friendship through the churches had his active support, but he was hesitant in his reaction to the Lambeth Quadrilateral of 1920 (*see* ENGLAND, CHURCH OF: *20th Century History and Development: Relations with other Churches*). At the end of his long life his main emphasis was upon personal evangelism. His chief writings were *The English Baptists* (1881), *The Christian Certainties* (1893) and *The Ultimate Problems of Christianity* (1906). He died in London on Nov. 20, 1923.

See *Dr. John Clifford, C.H.: Life and Letters,* ed. by Sir James Marchant (1924). (E. A. PA.)

CLIFFORD, WILLIAM KINGDON (1845–1879), English mathematician and philosopher, was born on May 4, 1845, at Exeter. He was educated at King's college, London, and at Trinity college, Cambridge, where he was elected fellow in 1868. He was appointed professor of mathematics at University college, London, in 1871 and was elected a fellow of the Royal society in 1874. In 1875 he married Lucy, daughter of John Lane of Barbados, who became well known under her married name as a novelist, her most successful story being *Mrs. Keith's Crime* (1885). Clifford died of pulmonary tuberculosis at Madeira on March 3, 1879, leaving his widow with two daughters.

Clifford impressed all his contemporaries as a man of originality; he had a lucid style, wit, poetic fancy and social warmth. Contrary to the analytic tendency of the Cambridge mathematicians, he was "above all and before all a geometer." He developed the theory of biquaternions as a generalization of W. R. Hamilton's quaternions and linked them with the general idea of a linear associative algebra. He recognized the serious difficulties created for Kant's theory of a priori synthetic propositions by the non-Euclidean geometries of Nikolai Lobachevski and Georg Riemann (*qq.v.*). He showed that spaces of constant curvature could have several different topological structures in the large and proved the topological equivalence of a Riemann surface to a box with holes in it.

His suggestion (1870) that matter is a type of curvature of space foreshadowed Einstein's general theory of relativity. Other important papers of his dealt with Abelian functions, algebraic forms and projective and algebraic geometry.

Karl Pearson further developed Clifford's views on the philosophy of science, which were related to those of H. von Helmholtz and Ernst Mach. In philosophy, Clifford's name is chiefly associated with two phrases of his coining, "mind-stuff" and "the tribal self." The latter gives the key to his ethical view, which explains conscience and the moral law by the development in each individual of a "self" that prescribes conduct conducive to the welfare of the "tribe."

His works included: *Elements of Dynamic* (1879–87); *Seeing and Thinking* (1879); *Lectures and Essays* (1879); *Mathematical Papers*, ed. by R. Tucker (1882); and *The Common Sense of the Exact Sciences*, completed by Karl Pearson (1885).

CLIFFORD OF CHUDLEIGH, THOMAS CLIFFORD, 1ST BARON (1630–1673), English statesman, lord treasurer in Charles II's Cabal ministry, was one of the king's most inept advisers, although he was a man of undoubted personal sincerity. Born Aug. 1, 1630, at Ugbrooke near Exeter, he matriculated at Exeter college, Oxford, in 1647 and entered the Middle Temple in 1648. He represented Totnes in the Convention parliament of 1660 and in the parliament of 1661, and became a steady supporter of Henry Bennett (who became Lord Arlington in 1665) in opposition to the chancellor, the earl of Clarendon. On the outbreak of the second Dutch War in 1664 Clifford was appointed commissioner for the care of the sick and of prisoners. Afterward knighted and appointed ambassador to Denmark and Sweden, he served with the fleet in 1665 and 1666, and in Oct. 1667 was one of those selected by the commons to prepare papers concerning the naval operations. In 1666 he was made controller of the household and a privy councilor, in 1667 a commissioner for the treasury and in 1668 treasurer of the household.

As one of the Cabal ministry, Clifford co-operated zealously with the king in breaking through the triple alliance with the United Provinces and Sweden and in effecting an understanding with France. He was the only minister, besides Arlington, entrusted with the secret treaty of Dover of 1670; he signed it as well as the ostensible treaty shown to all the members of the Cabal. In 1672, during the absence abroad of Arlington and Coventry, Clifford acted as principal secretary of state. He was chiefly responsible for the "stop of the exchequer" (which, through the suspension of all payments for 12 months, gave Charles the use of all revenue) and probably also for the attack upon the Dutch Smyrna fleet. In the same year he was appointed a commissioner to inquire into the settlement of Ireland. On April 22, 1672, he was raised to the peerage, and on Nov. 28, by the duke of York's interest, was made lord treasurer. This excited the jealousy of Arlington, who had always aspired to that office. It was, however, the Test act of 1673 which brought about Clifford's downfall. On the passing of the bill Clifford followed the duke of York into retirement. He had, it would seem, been gradually moving toward Roman Catholicism and probably the Test act precipitated his conversion to the Roman faith. His resignation caused astonishment, since he had never publicly professed his religion and in 1671 had even built a new Protestant chapel at his home at Ugbrooke. According to John Evelyn, however, his conduct was governed by a promise previously given to James. He gave up the treasurership and his seat in the privy council in June. On July 3, 1673, he received a general pardon from the king as a safeguard against a possible impeachment by the commons. In August he said a last farewell to Evelyn, and died at Ugbrooke on Oct. 17. In Evelyn's opinion the cause of death was suicide, but this seems very unlikely. The evidence is not strong nor was such an action in keeping with his character. Evelyn declares him "a valiant, uncorrupt gentleman; ambitious, not covetous; generous, passionate, a most constant, sincere friend." He was succeeded by Hugh, his fifth but eldest surviving son.

See C. H. Hartmann, *Clifford of the Cabal* (1937). (H. G. Ro.)

CLIFTON, a city of Passaic county, in northeastern New Jersey, U.S., on the Passaic river, 8 mi. N. of Newark and 12 mi. N.W. of New York city, between Passaic and Paterson cities. Founded in 1685, it was part of the Acquackanock tract bought by the Dutch from the Lenni Lenape Indians of the Algonkin tribe, an area which early became a major fur trading centre. The settlement was renamed Passaic in 1854 and in 1917 Clifton was detached from Passaic (*q.v.*). It has a council-manager form of government, in effect since 1934. Principal manufactures are steel, chemicals, textiles, electrical equipment, electronics, machinery and paperboard. It is the site of the U.S. department of agriculture animal quarantine station for the eastern United States. Clifton expanded rapidly after World War II. Pop. (1960) 82,084; for comparative population figures *see* table in NEW JERSEY: *Population*. (D. N. A.; M. P. M.)

CLIMACTERIC, a critical period in human life. In a medical sense, the period known as the "change of life," marked in women by the menopause (*q.v.*). The word is also used to describe any turning point in the history of a nation, a career, etc. *See* also ENDOCRINOLOGY: *Ovaries*.

CLIMATE AND CLIMATOLOGY. Climate is the average condition of the atmosphere at a locality or over an area. Climatology is the science dealing with climate; it is a subfield of meteorology (*q.v.*). Climate is determined by the daily weather events and their seasonal patterns. It is usually described in terms of a variety of climatic elements. In common practice these include temperature, humidity, amounts of rain and snow, duration of sunshine, cloud amounts, wind direction and speed, weather phenomena such as fog, frost, rain and thunderstorms.

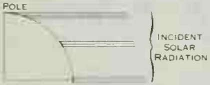
In this article the subject is dealt with under the following main headings:

I. Observations and Controls
    1. Climatic Observations
    2. Climatic Controls
II. Solar Radiation
III. Hydrologic Cycle
IV. Energy Transformations
    1. Wind Currents
    2. Air Mass Climate
    3. Continental and Oceanic Climatic Types
    4. Mountain Influence on Climate
    5. Mesoclimate and Microclimate
    6. City Climate
    7. Bioclimate
V. Climate and Man
    1. Climate and Race
    2. Climatic Comfort Conditions
    3. Climatic Changes
    4. Comparative Climatology
VI. Climatic Change
    1. Quaternary Ice Age
    2. Pluvial Periods
    3. Postglacial Period
    4. Climatic Changes During the Christian Era

I. OBSERVATIONS AND CONTROLS

Strictly speaking all atmospheric characteristics are involved, in line with the broad definition given by Alexander von Humboldt in 1845. He refers to climate as "designating in its general sense all changes in the atmosphere which sensibly affect our organs: the temperature, the humidity, the changes in barometric pressure, the calms or the effect of the different winds, the electrical field, the purity of the atmosphere or its contamination with more or less gaseous exhalations; finally the degree of the usual transparence and clearness of the sky which is not only important for the increased heat radiation of the soil but also for the well-being and moods of humans." Humboldt's all-inclusive definition postulates as important climatic elements several that are even now not always observed: barometric pressure, radiation intensity, visibility, evaporation, state of soil, atmospheric ionization and atmospheric pollution.

Observations of the climatic elements should cover several decades in order to describe the climate adequately. From these observations the frequency of various weather events and the range and frequency distribution of measured quantities can be obtained. The arithmetic means of the observed values of various elements have often been used exclusively as a basis for describing and comparing climates. This approach has considerable limitations because it conveys essentially only a static picture of the atmospheric surroundings. These, as everyone knows, belong to the most fickle environmental factors in human life. The mean is mainly useful because it is a statistic readily derived from large numbers of observations. However, the mean is not necessarily the most often observed value (mode) nor does it always split the observations in half (median). All mean values given or depicted in this article should be viewed with this reservation in mind.



BY COURTESY OF H. E. LANDSBERG

FIG. 1.—ANGLE OF SOLAR INCIDENCE ON HORIZONTAL PLANES IN VARIOUS LATITUDES OF THE EARTH

1. Climatic Observations.—The climatic elements are observed at many places on earth. Part of these observations serve primarily the purposes of weather forecasting (*q.v.*), but they constitute a most valuable source of climatic information. It is estimated that complete surface and upper air weather observations are made at about 2,500 weather stations. These are usually manned by full-time, trained meteorological personnel. In addition, there are many observing posts which are primarily devoted to climatology. Most of these take instrumental readings only once or twice a day; often interested laymen act as volunteer observers at these posts. There are about 40,000 such auxiliary stations in the world. Temperature and precipitation are the main elements observed; humidity and sunshine duration are also often recorded. Because rainfall is of such great importance for agriculture and water-supply problems there are about 100,000 supplemental stations, which are only equipped with rain gauges. Solar radiation intensity is recorded at probably not more than 500 stations and even fewer measure atmospheric electricity and air pollution.

Although the networks for observations in many parts of the earth and for many elements are still sparse, the total number of observations is staggering. Some estimate it at 20,000,000 per year. It requires the use of tabulating machines to digest this material to any appreciable degree. In this scheme the observations are punched into a card, the holes in the card corresponding to the observed values. The U.S. hydrographic office first considered the use of punched cards for summarization of marine climatological data in 1895. Actually, the first moderate start with this scheme was made in 1920 and it became the standard processing medium. The punched cards with weather observations have collected at a rate of more than 10,000,000 per year since that time and in the archives of the National Weather Records centre of the U.S. weather bureau constitute a valuable source of raw material for climatological studies. Modern electronic processing machines permit compilations of various statistics from these data at high speed.

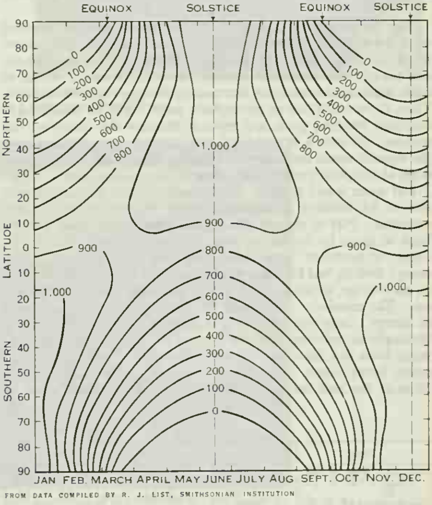
2. Climatic Controls.—The climate of a locality is basically governed by solar radiation. This was apparently known to the Greek scholars of the classical period. It was probably Eratosthenes (*c.* 276–192 B.C.) who recognized that the angle the sun's rays make with horizontal plane is of importance. The inclination (Gr., *klima*) of this plane at a given latitude to the horizontal at the equator governs the average incidence of solar radiation (fig. 1). Ptolemy in the 2nd century A.D., possibly following leads given by Hipparchus (*fl.* 146–127 B.C.), divided the earth into "climates" (*klimata*) or zones with a change of angle of incidence of solar radiation.

From this the notion of climatic zones developed that were labeled as follows: torrid belt around the equator where the sun is usually close to vertically overhead; two temperate zones, north and south, with intermediate angles of incidence; two frigid zones around the poles where the rays of the sun always have a low slant or are even absent part of the year. It is quite clear that the ancients centred their notions of climate around temperatures as induced in the atmosphere by solar radiation. Long afterward and into the early 19th century the idea prevailed that latitudinal differences alone could account for the varying climates of the earth. Only after actual meteorological observations from all over the globe began to accumulate did the great complexity of climate become evident.

There are four major controlling factors of climate: (1) Intensity of the primary solar radiation at the upper boundary of the atmosphere. (2) Reflection of the radiation (albedo) from clouds, snow, soil and water surfaces. The last two are small, the first two large; fresh snow may reflect as much as 90% of the incoming radiation, but a black soil may absorb over 90%. (3) Distribution of continent and oceans. On land the distance from and direction to the ocean is an important climatic control. (4) Topography, which includes the elevation; the distance to major mountain ranges and the exposure on peak, ridge, plateau, slope or valley. The climate produced by these major controls is technically called macroclimate and it usually characterizes a whole region. In addition, there are a number of smaller local influences. They include the local land forms; the character of vegetation, if any; effects of lakes, ponds, swamps; and effects of human activity, such as the cultivation of soil, city and factory influences. The small-scale variations of climate are designated as microclimate.

II. SOLAR RADIATION

There exists, as yet, relatively little direct information on the



FROM DATA COMPILED BY R. J. LIST, SMITHSONIAN INSTITUTION

FIG. 2.—TOTAL DAILY SOLAR RADIATION RECEIVED IN VARIOUS LATITUDES AT UPPER BOUNDARY OF THE ATMOSPHERE ON A HORIZONTAL SURFACE IN LANGLEYS

TABLE I.—*Estimate of the Terrestrial Heat Budget*
(In per cent of radiation received from the sun)

Gains	Per cent	Losses	Per cent
At the upper boundary of the atmosphere			
Directly from sun	100	Cloud reflection and radiation	27
		Particle scattering	8
		Atmospheric radiation	53
		Earth's radiation	12
Within the atmosphere			
Directly from sun	20	To space	53
From the earth	135	To earth	102
At the ground			
Directly from sun	25	Directly to space	12
Scattered radiation	20	To atmosphere, radiation	110
From the atmosphere (including latent and sensible heat)	102	Latent and sensible heat	25

extraterrestrial solar radiation. Rocket flights, starting in the mid-1940s, and earth satellites, starting in the late 1950s, have been able to collect measurements in the high atmosphere. (*See* also INTERNATIONAL GEOPHYSICAL YEAR.)

All available evidence points to a value of solar radiation of about two langleys per minute, received on a surface normal to the radiation at the mean solar distance. One langley (ly.) is equivalent to one gram calorie per square centimetre. This value (2.00 gm. cal./cm.^{2}/min.) is called the solar constant. For the cross section of the earth this amounts to the stupendous energy of $5\frac{1}{4}\times10^{21}$ kw. per year. According to the measurements the solar constant (despite the term) shows some small fluctuations, probably less than 2%. There has been speculation that in the course of the millenniums it might fluctuate over wider limits and cause appreciable climatic changes. Astrophysical views on this point diverge widely.

TABLE II.—*Average Precipitable Water Contents in the Atmosphere*
(In inches)

Part of globe	January	July
Northern hemisphere	0.8	1.4
Southern hemisphere	1.0	0.8
Whole earth	0.9	1.1

The distribution with latitude of the solar radiation received on a horizontal surface per day, throughout the year, is shown in fig. 2. The relative steadiness of this factor near the equator and the extreme variations near the poles (from zero in winter to quite substantial amounts in summer) is obvious from the diagram. Thus, if the earth had no atmosphere there would be considerable contrasts between poles and equator through the course of the seasons. In such a hypothetical case daytime temperatures near the equator would reach several hundred degrees and in the winter night at the poles temperatures close to the absolute zero (−459° F.) of space would prevail. The presence of the atmosphere and one of its variable constituents, water vapour, prevents these extremes. Part of the energy received from the sun goes directly back to space by scattering from atmospheric molecules or particles, or reflection from cloud tops and other surfaces. The energy directly lost by reflection amounts for the earth as a whole, on an average, to about one-half of the energy received from the sun. The remainder is absorbed and transformed into other forms of energy. Only very little of it is stored through photosynthesis. Atmospheric processes dissipate most of the energy. It vapourizes water from soil, lakes and the sea. This water vapour condenses again, forms clouds and ultimately is precipitated back to earth. Most of the heat becomes kinetic energy. The balance sheet of these processes is shown in Table I.

III. HYDROLOGIC CYCLE

Considerable transport and transformation of energy take place because of the hydrologic cycle, the change of water to water vapour and back to water. The amount of water stored in the atmosphere is quite substantial. The total amount held at any one time is a function of the mean atmospheric temperature. This amount is called precipitable water. It is larger in the hemisphere in which summer prevails and so the northern hemisphere, which because of its larger land surface has colder winters and warmer summers than the southern hemisphere, also shows a wider range of precipitable water. Likewise, the earth's atmosphere as a whole shows a higher water vapour content during the northern summer season. Table II shows the estimated amounts. In the transition seasons there is some interhemispheric transport of water vapour. Most of the excess in the northern hemisphere between summer and winter must be deposited or precipitated. Autumnal hurricane rains, frost and early winter snow deposits account for most of it. In the heat balance sheet of the earth condensation and evaporation processes contribute probably less than 10%.

IV. ENERGY TRANSFORMATIONS

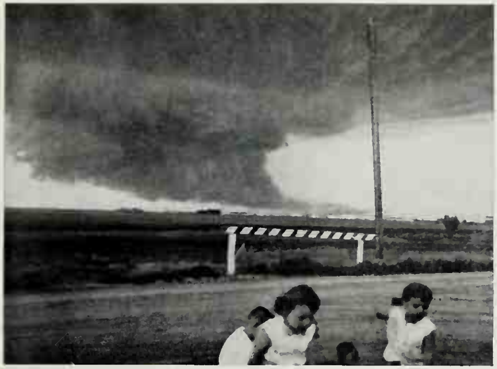
1. Wind Currents.—The major energy transformations within the atmosphere find expression in the general circulation. This is an equalizing and dissipating mechanism. Cold air is transported from the poles toward the equator, warm air from the equator toward the poles. It maintains the large wind systems which, in turn, are the main motive power of the ocean currents. Through these flows of air and water there is a continuous transport of heat energy from one place of the earth to another. This flow does not take place in smooth currents, but forms a system of rather turbulent streams. Embedded in meandering broad air currents are eddies in the form of low-pressure systems called cyclones (*q.v.*). Guided by longer waves in the currents, these pass in unending sequence over various localities on the earth. They bring alternately cooler or warmer, drier or moister air masses. The relative frequency of each of these determines the climatic character of a place. Although the position of the large air currents is not fixed by firm banks as water in a river, the general location is governed by the sources and sinks of heat, the distribution of land and water and the mountain barriers. Therefore each region bears the stamp of a specific climate even though many areas show frequent day to day or marked seasonal changes of weather.

The hubs of these atmospheric currents are a series of semipermanent high-pressure areas (anticyclones), which in some regions are more or less fixed features even though the absolute pressure values vary seasonally. These anticyclones exist as a result of combinations of dynamic forces and thermal conditions. Other anticyclones, strictly seasonal in character, form in higher latitudes over the continents during winter. Air from these reservoirs is fed to the areas with lower pressure. Fig. 3 and 4 show the mean pressure distribution over the globe for the mid-months of the extreme seasons, January and July, and the semipermanent high-pressure cells in the subtropical latitudes, 20° to 35°. These anticyclones are particularly pronounced as an almost continuous belt on the southern hemisphere at the height of the southern winter (July). In the northern hemisphere they are best noticed in the western quadrant. Toward the equator the circulation is fairly simple. The surface air flows there from both subtropical high-pressure belts, with northeasterly winds on the northern hemisphere and southeasterly winds on the southern hemisphere. Over the oceans these winds are so steady that they earned the name trade ("steady on course") from the mariners of the sailing ship era. Near the equator the trade winds slacken and converge into a general, weak easterly drift. At the origin of these winds, the outflow area,

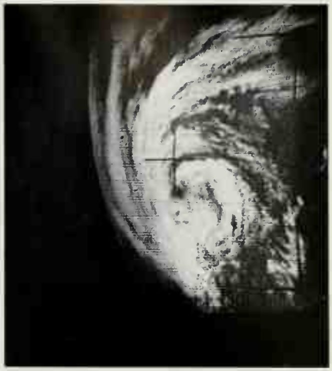
TABLE III.—*Equatorial Rainfall Regimes*
(Mean monthly values)

Place	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Lukolela, Rep. of the Congo (1° 05′ S., 17° 11′ E.)	5.0	5.3	7.3*	5.1	5.1	2.3	1.0	3.7	5.4	7.8*	6.3	6.5
Nauru Island (0° 32′ S., 166° 55′ E.)	11.9*	9.4	6.9	5.6	6.3	4.8	9.7*	7.5	5.5	5.1	4.2	9.6

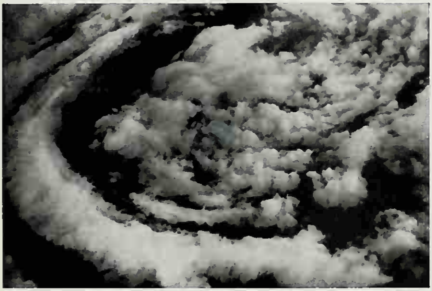
*Extremes.



A tornado in process of formation near Fargo, N.D.

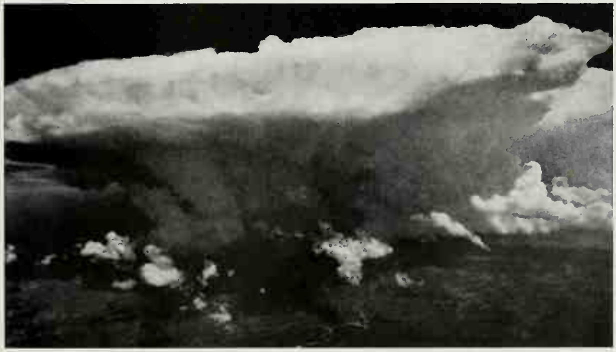


A hurricane, about 600 mi. S.S.W. of Los Angeles, as photographed by a Tiros weather satellite



The eye of a major hurricane, photographed from a U.S. Weather Bureau aircraft at 20,000 ft.

Tracking a storm on a radarscope. This instrument has a detection and tracking range of 250 mi.



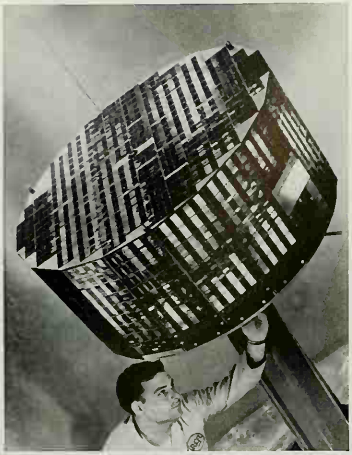
A fully developed cumulo-nimbus cloud (thunderhead) taken from an altitude of about 30,000 ft. The top of the thunderhead is more than 45,000 ft. high

WEATHER PHENOMENA

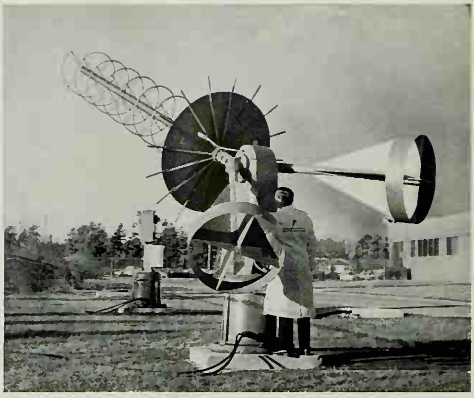
BY COURTESY OF (ALL EXCEPT BOTTOM) U.S. DEPARTMENT OF COMMERCE, WEATHER BUREAU, (BOTTOM) U.S. AIR FORCE; PHOTOGRAPH, (TOP LEFT) ALF T. OLSEN, FARGO, NORTH DAKOTA

CLIMATE AND CLIMATOLOGY

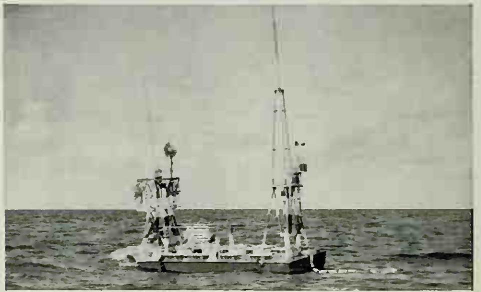
WEATHER INSTRUMENTS



Tiros weather satellite containing two television cameras, one of which is wide angle, and transmitting equipment powerful enough to reach ground monitors



Ground monitor station receives, records and displays cloud cover pictures taken and transmitted by the Automatic Picture Transmission (APT) system aboard Tiros weather satellites

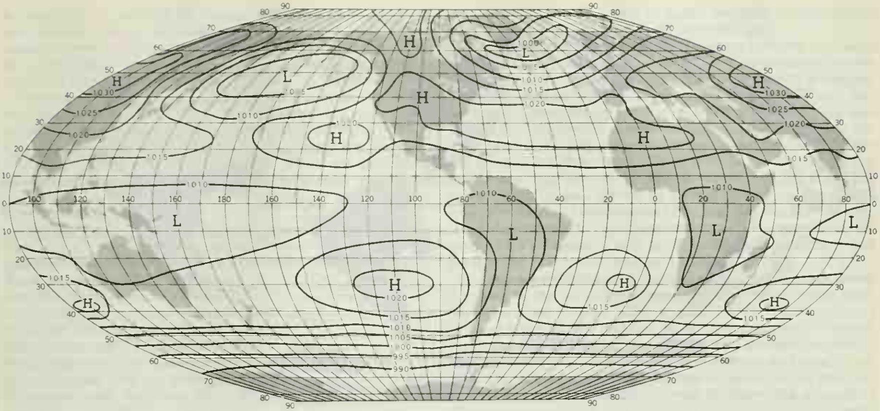


The Nomad I automatic weather station, which transmits weather data to its receiving station at three-hour intervals

A scientist at the International Geophysical year Little America station, Antarctica, taking a reading with an instrument which measures the intensity of radiation from sun and sky

U.S. and Canadian technicians installing atomic generator for the first nuclear-powered weather station, on Axel Heiberg Island, Canada

BY COURTESY OF (ALL) U.S. DEPARTMENT OF COMMERCE, WEATHER BUREAU, PHOTOGRAPHS, (CENTRE RIGHT) NATIONAL BUREAU OF STANDARDS, (BOTTOM LEFT) U.S. NAVY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BY COURTESY OF H. E. LANDSBERG

FIG. 3.—WORLD DISTRIBUTION OF MEAN ATMOSPHERIC PRESSURE AT SEA LEVEL IN JANUARY (H=HIGH; L=LOW; PRESSURES IN MILLIBARS)

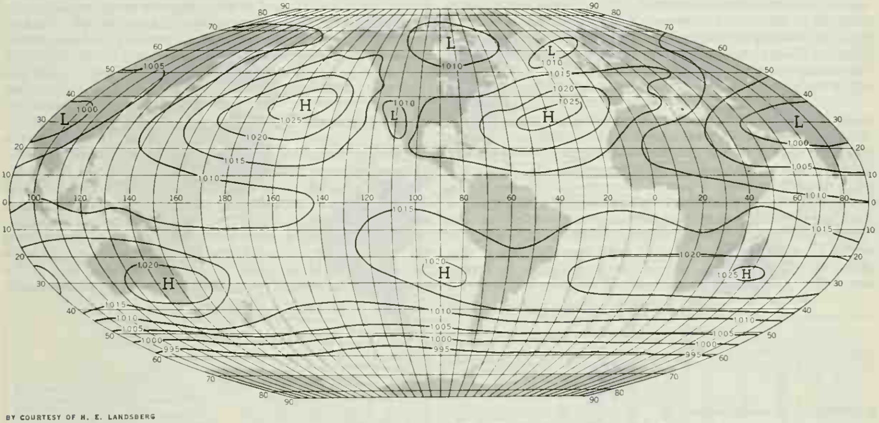
there is generally subsidence in the atmosphere. Few if any clouds form in the descending air, there is a scarcity of rain and the sun often blazes mercilessly for days or even months on end (*see* fig. 5).

Where the trade winds converge, ascending, occasionally colliding, air currents become prevalent; clouds and heavy showers are frequent. (*See* fig. 6.) The position of the convergence zone shifts through the year from about lat. 10° N. to 10° S. The continents somewhat disrupt the latitudinal regularity of these zones, but even over land the effect is well pronounced in the occurrence of the rainy seasons. Some localities which are passed twice when the conflicting currents cross the equator from one hemisphere to the other have a characteristically double-peaked rain regime during the year. Table III shows two examples: one represents a continental case from equatorial Africa where the peaks of rainfall about coincide with the equinoctial zenith of the sun; the other is from an equatorial island in the Pacific where the rainfall peaks occur after solstice. This probably corresponds to the maximums of development of the moisture-bearing trade winds.

Poleward of the semipermanent high-pressure systems are the realms of the westerly winds. On the southern hemisphere these westerlies are again a well-pronounced belt between about 40° and 60° latitude. There is almost no land to introduce complications into the circulation pattern. Into an endless procession of low-pressure systems, embedded in the broad westerly current, flow the warm air of the subtropics and the cold air from the Antarctic.

Since the cold air masses are warming in the process and the warm air is cooling, they compensate the inequalities introduced by the primary radiative processes and dissipate the energy imparted by the sun.

The described mean pattern of circulation represents primarily the conditions in the lower layers of the atmosphere. At higher levels quite different conditions exist. Aloft the winds are usually moving with much higher speeds than near the surface. In the middle latitudes the dynamics of the system produce currents of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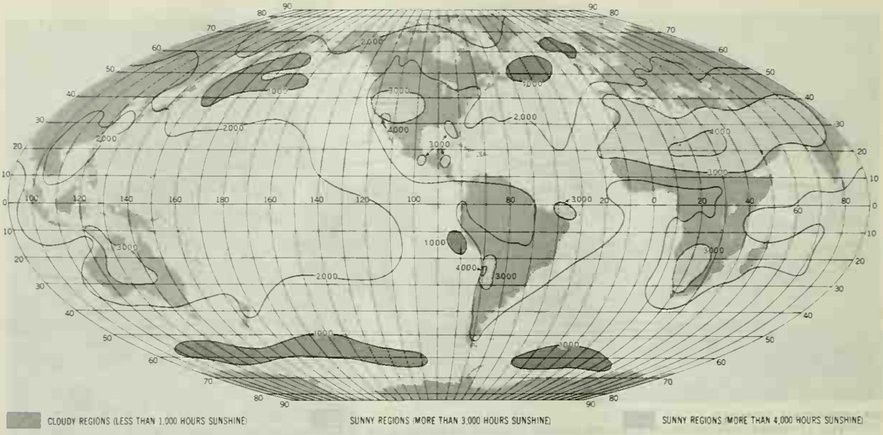
BY COURTESY OF H. E. LANDSBERG

FIG. 4.—WORLD DISTRIBUTION OF MEAN ATMOSPHERIC PRESSURE AT SEA LEVEL IN JULY (H=HIGH; L=LOW)



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CLOUDY REGIONS (LESS THAN 1,000 HOURS SUNSHINE)
SUNNY REGIONS (MORE THAN 3,000 HOURS SUNSHINE)
SUNNY REGIONS (MORE THAN 4,000 HOURS SUNSHINE)

BY COURTESY OF U.S. WEATHER BUREAU

FIG. 5.—WORLD DISTRIBUTION OF MEAN ANNUAL HOURS OF SUNSHINE

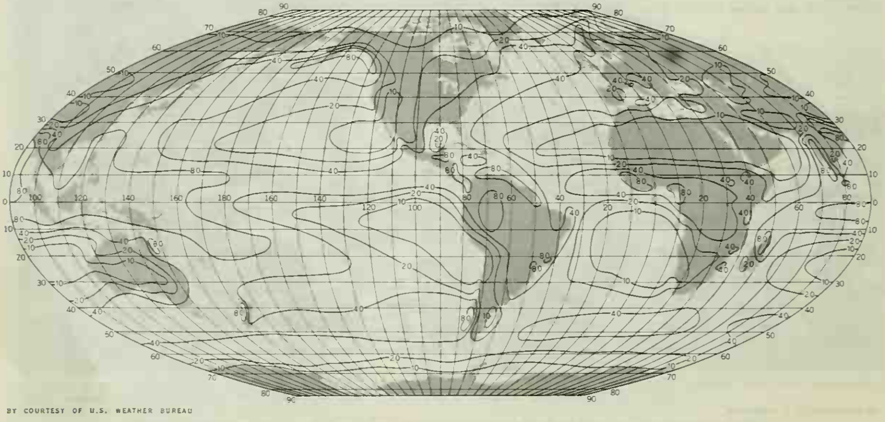
extraordinary velocities, called the jet stream. Speeds in excess of 200 m.p.h. are occasionally observed and, in the cold season, mean speeds of 100 m.p.h. are prevalent. The core of these jet streams is located just below the tropopause, which is the boundary between the troposphere and the stratosphere. The whole upper air motion, up to the stratosphere in nearly all latitudes—except for the zone nearest the equator—is westerly.

An idealized picture of the velocity vectors at 30,000 ft. can be seen from fig. 7. Near the equator easterlies still prevail even at that height.

In the northern hemisphere the alternation of continents and oceans produces major modifications of the simple planetary circulation, which would be present in the atmosphere of a rotating planet with a uniform surface. This can readily be seen from fig. 3 and 4 which show the mean conditions. In January (winter) high pressure has been built up over the continents by radiative cooling and lack of heat reserves, such as are available in the ocean, through heat capacity, convection and currents. Over the oceans, therefore, relatively low air pressures prevail on an average.

In summer the opposite pattern prevails; the continents in moderate and high latitudes show lower air pressure, mainly caused by quick radiative heating, than the slowly warming oceanic water masses. Hence north of the subtropical high-pressure belt the zone of the prevalent westerly winds in the northern hemisphere becomes a complicated battlefield of air masses. In winter the dominant flow is from the northwest. Winds come from the cold high-pressure cells which form over the continents. This may lead to pronounced seasonal winds (monsoons), which in winter blow from land to sea, such as the well-marked east Asiatic land monsoon.

The cold, dry air transported by these winds interacts with



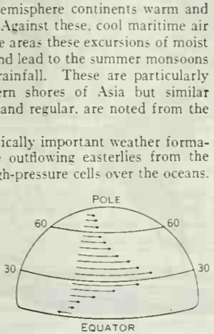
BY COURTESY OF U.S. WEATHER BUREAU

FIG. 6.—WORLD DISTRIBUTION OF MEAN ANNUAL RAINFALL (IN INCHES)

warmer, moister maritime air masses from the ocean. Along the interface, or front, of the continental polar and the maritime air masses snow or, in lower latitudes, rain ensues. Eddies often form along this polar front. These circle the middle latitudes as migrating low-pressure systems.

In summer over the northern hemisphere continents warm and dry continental air masses form. Against these, cool maritime air advances from the ocean. In some areas these excursions of moist oceanic air are relatively regular and lead to the summer monsoons which are coupled with copious rainfall. These are particularly pronounced along the southeastern shores of Asia but similar tendencies, if not quite as steady and regular, are noted from the other continents.

In the late summer other climatically important weather formations occur. Waves form in the outflowing easterlies from the poleward-displaced subtropical high-pressure cells over the oceans. These may be provoked by high-level invasions of polar air into lower latitudes. These waves often curl into tropical cyclones. They affect the east coast of North America, the Caribbean, east Asia, the Bay of Bengal, Madagascar and the South Pacific islands. Their climatic significance, aside from the destructive winds, is the abundant rains precipitated from the extremely unstable, moist, maritime tropical air masses.



BY COURTESY OF H. E. LANDSBERG

FIG. 7.—SCHEMATIC DIAGRAM OF UPPER WESTERLY WIND AT 30,000 FT. ON THE NORTHERN HEMISPHERE

The circulation and climate of the two polar regions, too, are primarily governed by the geographical features and the great yearly swing from dark to light. There are still large gaps in our knowledge because of the paucity of observations from these areas. In the arctic basin there are frequent migratory pressure systems. These are more prevalent in summer than in winter. In winter the contrasts to the surrounding continents is not too pronounced. If anything, the high-pressure centres with outflowing air and the poles of surface cold are well to the south of the geographical north pole. In general, a light easterly circulation is prevalent near the surface. In summer moving low-pressure areas, reminiscent of but usually a little weaker than in the zone of westerlies, govern the exchange of air masses.

In the antarctic a rather different pattern prevails. The highland terrain of the continent surrounding the south pole with its permanent ice cover strongly tends to be a source of outflowing cold air. To the north is only ocean territory, governed by an intense zonal low-pressure trough with its roaring westerly winds. The antarctic air feeds into the eddies of the westerly current, but there is less influence of these eddies upon the polar zone than in the arctic. The cold pole and the geographical pole coincide closely.

Table IV gives the general features of the climate of the earth, as related to the latitude.

2. Air Mass Climate.—The general circulation, in part provoked and modified by the continents, oceans, mountains and ice fields, transports a variety of air masses hither and yon. The high-pressure cells become the source regions of air masses. The semipermanent high-pressure areas of the subtropics over the ocean are the breeding grounds of warm-moist tropical maritime air; when located over land they furnish hot-dry continental air. The winter high-pressure areas of the polar latitudes produce cold polar continental or arctic air masses. Their usually less stable counterparts over the oceans in higher latitudes during summer are the sources of cool-moist maritime polar air.

Every locality derives its climatic character from the air masses which pass over. The frequency of various types usually changes with the seasons. In some locations circulation and geographic position cause few changes, consequently the climate is very monotonous. Examples are tropical islands in the trade wind zone where even temperature, high humidity, variable cloudiness, frequent rainfall and steady wind cover the same range day after day and often month after month. In some of the low-latitude deserts similar monotony prevails. There, of course, humidity is low and rainfall nearly absent. In fact, in some of these places the diurnal (daily) variation of temperature is greater than the annual swing. It is not uncommon to have daily maximums and minimums 40° F. apart with a difference of only 10° F. of the mean temperatures of the warmest and coldest months.

In contrast to these monotonous climates, we find many places, especially in the belts of westerlies, which are subjected to rapid, and occasionally violent, changes of air masses. The borders of the continents in latitudes 40° to 60° are particularly affected. Continental and maritime, tropical and polar air clash frequently; bright sunshine alternates with overcast, showers with steady rain, calm with brisk winds turning through all points of the compass. Rarely does the same air mass prevail for more than a couple of days.

The changeability of weather in Scotland and New England is proverbial and typical of this kind of climate. In these regions there are wide swings from day to day in all climatic elements but the difference between the extreme months may not be so great. The seasonal amplitudes of climatic elements are largest in the interior of the continents, especially in the higher latitudes, where they come about in a less turbulent fashion. A weather type once establisbed is apt to last for days or even weeks.

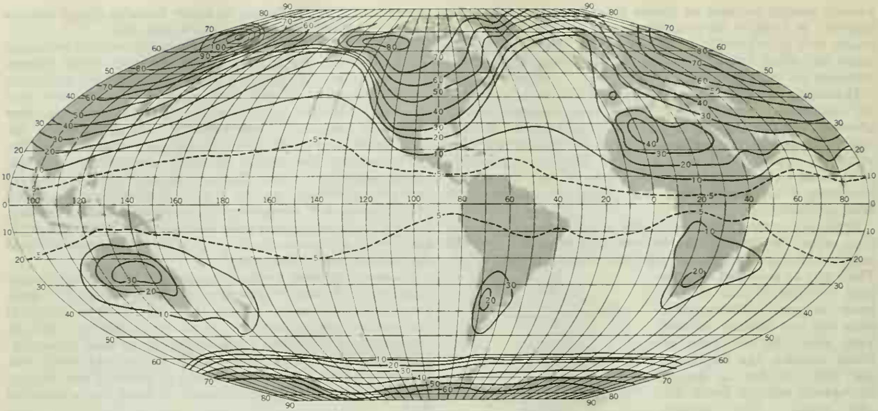
3. Continental and Oceanic Climatic Types.—The contrast of the seasons can be described by the annual range of temperature. This range is defined as the difference of the means of the months having the largest and the smallest value. The widest swings are found in mid-continental areas; this condition contrasts with small ones in mid-ocean areas. (*See* fig. 8.) The annual temperature range can be used to distinguish between maritime and continental climatic types. In the most extreme case of continentality, in north-central Asia, the range is about 120° F. On the North American continent the largest annual ranges approach 90° F. In the southern hemisphere where the continental expanses are much smaller than in the northern hemisphere the annual ranges, even inland, rarely exceed 30° F. In typically oceanic climates the annual ranges stay below 20° F.; exceptions exist only in the polar oceanic regions where permanent or seasonal ice produces the same effects as a land surface. Ice surfaces lose heat rapidly by radiation and the winters become very cold. In the warmer season until the ice disappears the temperatures stay, of course, close to the freezing point.

Aside from the great range, another characteristic of continental climate is the rapid transition from warm to cold in autumn. The lag of the temperature extremes behind solstice is usually quite short. In the northern hemisphere January is the coldest month and July the warmest. Spring in some subpolar localities is retarded because solar energy is first used in melting snow and ice. Typically continental climates are apt to have their precipitation maximum in summer, often in the form of showers.

In oceanic climates there is commonly more time lag of the thermal extremes behind the solstices. In the oceans of the northern hemisphere August is often the warmest month. The shore

TABLE IV.—*Mean Value of Climatic Features on Earth as Functions of Latitude*

Features	Latitude north									Latitude south								
	90°-80°	80°-70°	70°-60°	60°-50°	50°-40°	40°-30°	30°-20°	20°-10°	10°-0°	0°-10°	10°-20°	20°-30°	30°-40°	40°-50°	50°-60°	60°-70°	70°-80°	80°-90°
Net radiation balance, 10^3ly /yr.	−88	−86	−54	−40	−18	7	23	29	32	31	28	18	0	−28	−50	−66	−86	−89
Mean annual temperature, ° F.	0−2	14	30	42	57	69	78	80	79	79	78	73	65	54	42	28	11	−4
Mean annual temperature range, ° F.	—	59	63	49	49	29	16	7	2	3	6	12	12	11	14	31	—	—
Mean annual rainfall, inches	4	7	16	30	36	35	32	45	73	57	46	34	37	48	42	18	3	—
Mean cloudiness per cent sky cover	—	50	61	48	49	42	40	40	58	58	57	48	46	56	66	75	—	—
Mean elevation of eternal snow in 10^3 ft.		2	4	7	10	15	17	16	16	17	18	17	10	5	3	0		



BY COURTESY OF H. E. LANDSBERG

FIG. 8.—WORLD DISTRIBUTION OF MEAN ANNUAL TEMPERATURE RANGE (IN DEGREES F.)

areas benefit from the oceanic effect. In regions where onshore winds prevail, warm temperatures may persist long into autumn. Likewise, extreme summer heat rarely occurs because of transport of cool maritime air ashore. The influence of ocean currents and prevailing winds on the shore areas is quite marked. In the zones of the westerlies this leads to considerable contrast in climate of the west coasts and east coasts in the same latitudes. For example, in western Europe the onshore winds carry the maritime influence hundreds of miles inland; this results in mild winters, cool summers, considerable cloudiness and even precipitation throughout the year. In the same latitude in east Asia cold, dry winters and hot, wet summers are the normal rule. On the west coast of the Americas the maritime influence does not carry far inland because of the north-south mountain chains rising close to the shore lines.

Maritime climates, in general, have ample precipitation. There is, however, no uniformity in the course of the year. It depends on the circulation belt in which an area is located. Some have pronounced rainy and dry seasons, particularly in the tropical and subtropical areas where the belt is tied to the shifting trade and monsoon winds. In the zones of the westerlies the distribution of precipitation is more even. The same holds for the variability of rainfall from year to year.

The maritime climates of the moderate latitudes show the greatest reliability of rainfall. The highest variability is encountered in some of the subtropical areas under the influence of the semipermanent high-pressure cells, including some islands which have otherwise a typically maritime climate. However, the shift of ocean currents following changes in the wind patterns may bring about very dry years followed by extremely wet years. An example is Malden Island (4° S., 155° W.). During a 30-year period the mean annual rainfall there was 28.5 in.; the lowest annual value was 3.9 in., the highest 93.3 in. This example not only shows the extreme local variability, but also illustrates the care needed in the proper interpretation of mean values. Standing alone they do not reflect the changeability of the atmosphere from year to year; a measure of the range or dispersion of events and values is usually needed as corollary information. World maximum and minimum temperature extremes are given in Table V and maximum and minimum rainfall extremes in Table VI.

The contrast of continental and oceanic climates extends to all climatic elements, including temperature and precipitation. The average difference between the highest and lowest temperature of a day in mid-ocean usually does not exceed 3° F. On small islands and right at the coast this daily range generally remains under 10° F., while a few hundred miles inland it normally exceeds 15° F. Similarly, in maritime climates, the temperature variations from day to day are smoothed; in continental climates the interdiurnal contrasts increase. In the zone of the westerlies the day to day temperature changes on the west coasts of North America and Europe average only about 3° F. and in the mid-continent of North America and Eurasia they average about 6° F. On the east coast of the two continents where the continental influences predominate over the maritime effects, the interdiurnal change is still 5° F.

There is usually a decrease of humidity from the shores toward inland, as well as a decrease of mean cloudiness and wind speed, but an increase in sunshine.

The interactions of atmosphere and ocean have many profound influences on climate besides the broad contrasts between land and water and the effect of distance from shore. The major wind systems and ocean currents are closely linked but the oceanic drifts are, in part, governed by the configurations of the ocean basins. In addition, onshore winds on some coasts cause the upwelling of cold water from the deeper oceanic layers. Wherever this occurs a profound effect on the coastal climate results.

TABLE V.—*World Temperature Extremes*

Continent	Maximum temperature ever recorded, in ° F.			Minimum temperature ever recorded, in ° F.		
	Station	Elevation in ft.	Temp.	Station	Elevation in ft.	Temp.
Africa	Azizia, Libya	380	136.4	Ifrane, Mor.	5,364	−11.2
Antarctica*	Esperanza	. .	58.3	Vostok	11,220	−126 9
Asia	Jacobabad, Pak.	186	127.1	Oimekon, U.S.S.R.	2,625	−89.9
Australia	Cloncurry, Queensland	633	127.5	Charlotte Pass, New South Wales	. . .	−8
Europe	Seville, Spain	98	122.0	Ust-Shchugor, U.S.S R.	279	−67
North America	Greenland ranch, Death valley, Calif.	−194	134.0†	Snag, Yukon Territory	2,120	−81
South America	Rivadavia, Arg.	673	120 0	Sarmiento, Arg	879	−27.4
Oceania	Nemeara, New Caledonia	. . .	103 1	Haleakala, Hawaii	9,750	18

*Temperature records not established sufficiently long to furnish representative data. Those cited are presently recorded extremes.
†A reading of 140° at Delta, Mex., lacks official verification.
Source: U.S. Weather Bureau.

TABLE VI.—*Rainfall Extremes of the World*

Continent	Maximum average annual rainfall (in inches)			Minimum average annual rainfall (in inches)		
	Station	Elevation in ft.	Rainfall	Station	Elevation in ft.	Rainfall
Africa	Debundscha, Cameroon	30	404.6	Wadi Halfa, Sudan Al Karijah, Egy.	410 ..	0.1 0.0
Antarctica*	.	.	.		.	. . .
Asia	Cherrapunji, India	4,309	450	Aden, Arabian Pen.	22	1 8
Australia	Tully, Queensland	.	179.3	Mulka, South Australia	..	4.05
Europe	Crkvice, Yugos.	3,337	182 8	Astrakhan, U S S.R	45	6.4
North America	Henderson Lake, B.C.	20	262.1	Furnace Creek, Death valley, Calif.	—194	1.78
South America	Quibdo, Colombia	138	422.6	Arica, Chile	95	0.02
Oceania	Mt. Waialeale, Hawaii	5,075	460	Puako, Hawaii	...	8.93

*Observations are available only for short periods; reliable data not available.
Source: U.S. Weather Bureau.

As a broad picture we find on the east coast of continents warm currents existing between latitudes of 0° to 40° and cold currents in the higher latitudes. On the west coasts there are moderately warm currents between 0° and 20° latitude. In the moderate latitudes, 20° to 40°, the west coasts have cold offshore waters and above 40° are heated by warm drifts.

One of the remarkable effects of these currents is the distortion of the latitudinal belts of temperature at sea level elevation. For example, places on the west coast of Europe have the same mean annual temperature value as localities 10° farther south on the east coast of North America.

The littorals with cool upwelling waters, as the north Chilean and southwest African coasts, are characterized by a climate with little precipitation but frequent fog or low stratus clouds. Similar conditions occur seasonally along the coast of California in summer.

4. Mountain Influence on Climate.—Equal in magnitude to the effects of ocean currents on shore climates are those produced inland by mountains. The extremely high ranges, such as the Andes, Rockies, Alps and Himalayas, exercise strong modifying influence upon the general circulation. Their effect is by no means restricted to the immediate mountain zone, but reaches somewhat upstream and farther downstream. The extensive upper air data available show that in the case of the Rocky mountains the direct influence extends nearly 1,000 mi. to the east. In all mountains the effects on the upper air currents can generally be detected up to heights of twice the mean elevation of the ranges. In most instances mountains become sharp boundaries between various climates, quite aside from the special climates prevailing in the mountainous areas.

A most noteworthy effect is the decrease of temperature with elevation. This occurs also in the free atmosphere. In mountains it is complicated by diurnal changes in convective and gravity flow of air. During the day, with warming slopes, there is a general tendency for upslope motions; at night, with cooling on the slopes, there is a downward directed wind flow. The flows are most pronounced in clear weather with weak general winds. The regular winds, changing from day to night, are often referred to as mountain and valley breeze, and in some places they are distinct features of climate.

A further effect upon the temperature change is produced by condensation in ascending air currents. In upslope motion air expands according to the decrease in pressure and consequently cools. If it is cooled below its dew point the water vapour condenses and liberates the heat of condensation. Thus, while dry air cools at a rate of 5.5° F. per 1,000 ft., it is considerably less in moist air after condensation sets in. For this reason we find that in the tropics, in the lower layers, the temperatures on the windward slopes decrease about 3.6° F. per 1,000 ft. of elevation. About the same temperature lapse rate prevails in the moderate latitudes in summer. There, in winter, the lower layers and valleys are often filled with dense, heavy, cold air. Then the temperature in lower elevations may be less than on the higher slopes. This is called a temperature inversion, which is often a peculiarly characteristic climatic condition of valley and basin locations in mountainous country. Temperature inversions are most common during clear, calm periods. When fresh winds prevail the normal decrease of temperature with height is reestablished.

The mean decrease in the moderate latitudes during winter is only 2.2° F. per 1,000 ft. The above rates of decrease are generally valid to about 12,000 ft. elevation.

On the windward sides the lapse rate is usually less because of condensation processes. The upslope motion of air crossing mountains causes increased cloudiness, greater humidity and more rainfall, level for level, on the windward side than to the lee. The daily, annual and absolute ranges of temperature are small on the windward side and large on the lee. Usually the wind speed is also higher on the wind exposed slope.

The crests of extended mountain chains, especially if they are at right angle to the prevailing winds, form the boundaries between climatic provinces. In many instances they are climatically a more pronounced demarcation line than coasts. A few examples will illustrate this: In North America the west slopes of the coastal ranges, the Cascades, the Sierra Nevada and (to some extent) the Rocky mountains are cool, wind-swept, rainy and cloudy. The basins east of these chains are sunny, dry, and approach desert conditions. The southern Andes in the west wind zone of South America exhibit the same characteristics. In Europe the Alps block many of the cold maritime polar air mass invasions from the North Atlantic areas. Thus we find the winter contrast of the cloudy, snowy northern slopes in Switzerland, Germany and Austria to the sunny and warm area in Italy on the southern side.

Such dissimilarities in climate are, of course, also found north and south of the Himalaya massif. Not only are most of the cold winter air masses blocked from entry into India but the same range has extraordinary rainfalls on the south slopes in summer from the sea monsoons in contrast to the arid regions to the north.

One of the features of mountainous regions are the descending air currents on the lee sides. They bear the technical name katabatic winds. As a direct consequence of the fact that the air masses in crossing the mountains have lost their moisture on the windward slope, they are usually warm and dry. As they cross the crests and descend they are compressed and heated at the rate of 5.5° F. per 1,000 ft.

In many regions these winds bear special names; in North America the best known is the chinook of the Rocky mountains; in Europe the foehn, a south wind crossing the Alps, is most famous. In winter these winds cause rapid melting of snow. In other seasons, the extreme dryness introduces exceptional fire hazards in the forests, especially if the winds are sustained or recur often. Some have ascribed particular effects on human health to the winds. They are alleged to cause irritability, headaches and to induce asthmatic attacks. The reasons for these effects are obscure. The frequency of the katabatic winds is one of the elements which is used to describe the climatic conditions of a mountain area.

The different prevalent combinations of precipitation, temperature, humidity, sunshine and katabatic winds on the various slopes of mountains determine the height of the snow line. In the high mountains differences of 1,000 to 2,000 ft. between windward and lee sides are quite normal. (For the general latitudinal variation of sea-level elevation of permanent snow *see* Table IV.)

The heavier precipitation on the windward slope plays an important role in the alimentation of glaciers. These, in turn, promote cold mountain winds which descend into the valleys. This exercises an important local climatic influence in the mountains of higher latitudes where glaciers occupy the higher valley areas.

A special type of katabatic wind is caused when cold air masses are forced by pressure differences to descend from cold, sometimes frozen, highlands to a warm sea. Even after their descent and warming by compression they still are colder than the warmed sea air they replace. These cold downdrafts are often called bora after the name they bear locally on the east coast of the Adriatic sea. They are well known on the shores of Greenland and the Antarctic continent.

High, extended mountain ranges show all of the various climatic influences just outlined, but even smaller ranges produce considerable effects locally. If exposed to moist air masses they wrest more water from them than lowlands, thus influencing water supplies and flood hazards in the region. The most important climatic influences of smaller ranges are the cold nighttime slope flows and the formation of cold air pools in topographic depressions and valleys. The temperature inversion with cold bottoms and warm crests leads to more frequent ground fog formation. In the cool regions this inversion is the cause of increased frost frequency. Wherever human activity leads to air pollution the contaminating products will accumulate under such conditions. In the cold season the inversion may continue through the day and, with stagnating weather, even persist for prolonged periods, leading to an obnoxious and irritating combination of smoke and fog, popularly named smog. Industrialization and urbanization have brought about this new climatic element. Mountainous topography favours high smog frequencies. (*See* also WIND.)

5. Mesoclimate and Microclimate.—Smaller features of terrain and landscape have a locally significant effect on climate. If the influence extends horizontally over several miles and vertically a few hundred feet it creates a mesoclimate, as distinct from the regional or macroclimate. If the effect exists only on a small scale from feet to a mile horizontally and up to tree or house height it creates a microclimate.

The mesoclimate is governed primarily by smaller ranges of hills, lakes, rivers and individual glaciers. The influence of hills is different from that of mountains only in the degree to which it becomes measurable. The differences of precipitation between windward and lee sides are usually overshadowed by the effects of hills on wind speeds and temperature.

In winter, particularly, the inversion conditions become most obvious, and the effects of larger lakes are definitely pronounced. In spring they develop notable lake breezes which exercise a cooling effect on the shore areas. In winter, if not frozen, they furnish heat and moisture to cooler air masses which cross them and this leads to additional precipitation and higher mean temperatures on the lee shores. Lakes which freeze tend to depress the temperatures of their shores in spring until they thaw and become warm. These same lakes cause autumn to linger a little longer in the vicinity until the ice cover forms. The effects of glaciers have already been discussed.

In the microclimatic realm the horizontal and vertical scales of the phenomena are even smaller; nonetheless, the climatic effects remain pronounced. In fact, microclimates are often more readily accessible to differentiation by measurements than mesoclimates. Vegetation, soil conditions, small-scale topography and man's structures and activities cause the microclimatic differences. Trees, hedges, furrows, grassland, houses, asphalt and concrete surfaces, concave and convex land forms are the governing elements of microclimate. Radiation exchange greatly influences the layer of air near the surface. Therefore sizable differences in short distances develop on clear days and nights; on cloudy days the differences are less.

Wind is next in importance. On calm days the microclimatic differences have the best opportunity to develop. Strong winds tend to minimize and equalize the spot differences. The water balance, precipitation and evaporation, are markedly affected by soil type, soil condition and vegetation. Their rapid variation within small areas will cause additional, though secondary, gradations of the microclimate.

The temperatures of air and soil are the most readily available indicators of microclimatic differences. Although the temperature changes in the course of a year penetrate 30 to 50 ft. into the ground, depending on soil type, the diurnal variations stay mainly within the first two feet.

In the air the major microclimatic differences are often found below the normal 5- to 6-ft. height of thermometer shelters. The typical conditions on a soil with short grass for a dry, sunny day are exemplified by the difference between the highest and lowest temperature:

Item	Air above soil					Soil below surface				
Inches	60	36	20	4	2	0	2	4	20	36
Daily range, °F.	28	30	32	34	38	43	18	12	2	0

Thus the diurnal temperature variation vanishes within the first three feet of soil and is greatest right at the surface. In the case shown the soil surface was 5° F. colder than the air at 5 ft. at the time of the daily minimum in the early morning, while at the time of the afternoon maximum the surface was 10° F. warmer than the 5-ft. air temperature. The soil condition exercises a profound influence on the soil temperature. On the same day the range just below the surface with short lawn was 20° F. but in a patch of bare ground it was 60° F.

In bright sunshine exposed surfaces such as roofs, pavements, parked cars or aircraft can show extremely high temperatures. The rise above the air temperature in the shade depends upon the reflection characteristics of the surface—a black surface will become hotter than a white or shiny one. Temperature measurements on surfaces show common increases for various surfaces in sunshine: concrete road 10° F.; asphalt drives, asphalt shingles 30° F.; car roofs, rails 40° F. Similarly, a black soil will show a higher daytime temperature than a light sand. In nature snow and ice surfaces show particularly high reflectivity. Hence little heat is accumulated in daytime, and nighttime radiation from these surfaces will tend to accentuate low winter temperatures in the blanketed areas.

Plant cover materially alters the microclimate. The tops of plants, whether crowns of trees or tips of crop plants, in a dense stand form a new effective surface. The extreme temperature range otherwise observed at the soil surface may become transferred to this level. Inside the forest or crop stand the temperature variations will be much more moderate. This is shown by the following representative vertical temperature distribution in a dense pine forest in the early afternoon of a clear day and the temperature range between the highest and lowest value during the day:

Forest levels	2 P.M., ° F.	Daily range, ° F.
Forest soil surface	66	10
Six feet above ground	67	11
Half-height of trees	68	12
Tree tops	73	19
Air above tree tops	71	16

The plant cover also has a profound effect on the water cycle. It contributes to the water consumption by metabolism and transpiration, but it also conserves water by preventing direct evaporation and runoff which is rapid on bare soil. The well-known farm practice of mulching is directly designed to change microclimate by reducing evaporation and lowering soil temperature extremes. Widespread removal of plant cover causes greater local extremes of temperature. It also results in desiccation of soil and dust blowing. Conversely, a permanent plant cover will decrease local temperature extremes, increase the humidity of the air and prevent dust storms. There is some evidence that forestation on a large scale results in moderate rainfall increases. It also considerably retards melting of snow in spring, thus reducing flood hazards in mountainous areas. If the slopes become denuded, spring runoff from melting snow occurs with such rapidity over still-frozen soil that the flood danger is greatly increased.

Wind conditions are markedly affected by surface character. For this reason the wind measurements used in meteorology for forecasting purposes are made well above the ground, usually at least 30 ft. high. The low-level wind conditions in the microclimatic zone are governed by the terrain roughness. In the lowest layer of air above a smooth surface, such as a runway, the wind speed increases with height according to a logarithmic law—as height increases by factors of 10, the wind speed doubles. Thus if a wind of 5 m.p.h. is noted at 1-ft. height, it will be 10 m.p.h. at 10 ft., and 15 m.p.h. at 100 ft. Over rough surfaces the wind usually becomes turbulent, particularly in midday when the vertical temperature distribution causes unstable conditions.

Inside of plant growth, whether crops or trees, the wind speed is much reduced, being usually less than half that measured just above the tops of the plants. Close to the ground the frequency of calms increases markedly, which is one of the reasons for the reduced evaporation with plant cover because less water vapour is carried away. In many instances, however, increased transpiration by plants more than compensates for this conservation. Even so, the microclimatic effectiveness of hedges and shelter belts for crop protection is beyond doubt. The decrease of speed downwind in percent at distances of various height-multiples of the shelter is: 65% for 5 heights, 50% at 10 heights, 35% at 20 heights. If the wind in front of a hedge 10 ft. high is 10 m.p.h. it will be: 3.5 m.p.h. 50 ft. downwind, 5 m.p.h. 100 ft. downwind and 6.5 m.p.h. 200 ft. downwind.

6. City Climate.—A specialized case of microclimatic influence is represented by human settlements. Considerable alterations of the natural climate are caused when fields and forests are replaced by homes and factories, by steel and stone. The change in surface conditions from the spongelike structure of the natural soil cover to the well-drained asphalt, concrete and roof area creates an effect approaching desert conditions. As cities grow, domestic and industrial furnaces as well as large numbers of vehicles add heat and combustion products to the air, and these also change the climate.

All climatic elements except atmospheric pressure are appreciably changed in towns. Metropolitan areas, with cities surrounded for many miles by satellite towns and industrial fringes, have a distinct climate of their own.

The most striking change from natural surroundings occurs in the composition of the air as many gaseous and solid suspensions are added. Some of these are noxious in themselves, others become so through photochemical reactions under the influence of sunlight. Whenever natural circumstances are unfavourable, irritating smogs form. The principal conditions are light general winds, clear sky and subsequent development of temperature inversions at or near the surface. In this stable air stratification, pollution products keep accumulating until stronger winds with turbulence, intense surface heating or rainfall permit convective dissipation, dilution or precipitation of the concentrated smoke elements. The buildings of a city cause a decrease of wind speed at street level, comparable with the changes observed inside a forest or to the lee of a shelter belt. The effective surface for radiative processes in the densely built-up areas will be located at roof level. These conditions retard the self-cleansing processes in the atmosphere. The magnitude of the pollution influence can be gauged by the fact that in the major industrial cities several hundred tons of dust settle on each square mile of land per year.

In city areas the visibility decreases and the number of fogs increases markedly, because many of the fume particles act as centres for condensation of water vapour, sometimes even before saturation is reached. Actually, much steam is also added by some industrial processes, which leads to the remarkable apparent paradox that although the average humidity in cities is from 4% to 8% lower than rural areas, cities have ten times as many fog days. In reality, the lower humidity figures apply mostly to the warmer season, the higher fog frequency to the colder part of the year. The contamination of the air also decreases the solar radiation intensities received in cities by 15% to 20% and especially reduces the amount of ultraviolet radiation received, particularly when the sun is low above the horizon.

Most obvious from the climatic records is the temperature increase in urban areas, most pronounced in the nightly minimum. These are, on an average, 2° to 3° F. higher than in the open country; however, on clear calm nights the city may show as much as 8° or 10° higher night temperatures than the rural areas. The annual mean temperature in most cities of the temperate zone shows about 1° to 2° F. excess which has to be attributed to urbanization. It has been noted that for the nonworking days this excess is cut in half.

In the built-up areas wind speed is considerably reduced even at roof height. This amounts to about 25% less than at the same height in the natural surroundings. Yet turbulence and convection on windy and sunny days is increased over the city; on sunny summer days the city air becomes a region of updrafts, often noticed by the formation of cumulus clouds. In low-level flying it is felt as "bumpiness" of the air. In some localities this tendency may even lead to showers. In winter the pollution products introduced into passing cloud layers may, under suitable conditions, act as freezing nuclei, which in heavily industrialized areas leads to added precipitation in the form of drizzle and snow flurries. These regions experience about 10% more days with precipitation of less than .2 in. Although it is an extremely variable factor, added nuclei and water vapour, coupled with the convection have caused rainfall increases from 5% to 15% over some of the industrial conurbations.

7. Bioclimate.—Life processes and climate are intimately related. The atmospheric conditions are perhaps the most powerful environmental factor in plant and animal life. (*See* ECOLOGY, ANIMAL: *Principle of Succession;* PLANTS AND PLANT SCIENCE: *Plant Ecology.*) There is certainly no doubt that climate determines the indigenous plant cover. A plant has to be adapted to the climate in order to survive. In many areas it must be able to withstand the wide swings that are quite common. It cannot migrate as can animals or man. Hence, if a plant, such as a tree, can stand and prosper for years or even centuries in one locality it must certainly be adapted to the prevalent climatic regime. Few species are ubiquitous. Most plants and, even more so, plant associations are quite characteristic of the climatic conditions. This fact has even led ecologists to designate climates by the primary plants which dominate an area in its natural state.

Crop plants are equally dependent upon climate, although modern plant breeding has permitted some leeway by producing varieties which are hardier or mature in shorter time intervals. Technological advances, such as irrigation procedures or orchard heating, have permitted temporary or permanent corrections of climatic deficiencies. Microclimatic ameliorations by mulching, shelter belt planting and combination of greenhouse and free land cultivation have expanded the natural habitats of the more expensive crop plants. Yet, by and large, nature still controls what farmers can grow.

Most animals likewise are bound to climatic zones, with some species of course being adaptable to a relatively wide variety of climatic conditions. They can develop subspecies, varieties or races which may be found in many places. In the domesticated animals man has succeeded in breeding characteristics which make successful survival in nearly all climatic zones possible. In nature many species, commonly among the birds, have developed migratory habits, which permit avoidance of seasonally unfavourable climatic conditions. Even so, the animal associations found are dependent on the food supply, which in turn in herbivorous species is climate bound. This dependency also keeps the range of predators close to a specific climatic region.

Even in the oceans, climatic conditions closely govern many classes and species. Some types with shells are so sensitive to temperature changes that they can be used as index animals; *i.e.*, if their shells are found in geological deposits a direct inference can be drawn about the ocean temperature extant at the time the deposit was formed. This property, mostly encountered among some one-cell *foraminifera*, has been used to deduce paleoclimatic conditions. Actually, fossil evidence of both animal and plant remains has been the principal tool for investigations of the climates of the prehistoric and geological past.

Most marine animals, whether sessile or mobile, are to some extent sensitive to climate directly or to conditions affected by climate, such as salinity. In case of ground-bound species the effect is usually direct. In the mobile species it is more related to the relative abundance of food supplies, particularly plankton which is subjected to climatically controlled elements of drift, temperature and, in coastal waters, precipitation, which affects salinity.

Thus, the natural vegetation and associated fauna are on a broad scale adapted to average temperature and precipitation conditions. Crop plants, although often pushed by cultivation practices to the margins, flourish in specific optimal climates. There is no important vegetation possible in areas where the mean temperature of the warmest month stays below 42° F., nor is there any appreciable vegetation in lands where the mean annual rainfall stays below 10 in. As temperatures and precipitation increase above these limits various characteristic plant associations appear.

The subpolar regions, where the warmest month has at least a mean temperature between 42° and 50° F., is the realm of the tundra, where mosses, lichens, a few flowering plants and low bushes prevail. During the short frost-free season the topsoil is moist, and even though little precipitation falls, evaporation is also minimal. In the short summer mosquitoes are all-pervasive. Caribou, musk ox, reindeer, lemmings and polar bears manage to eke out an existence. In the subpolar seas, however, close to the limits of permanent ice, wildlife is abundant during the summer months, with seal, walrus and whale among the seasonal visitors.

The taiga is found in the subpolar areas where at least one to three months have mean temperatures above 50° F., with usually six months below the freezing point and precipitation between 10 and 20 in. annually. This is forest land composed of conifers—spruce, fir, larch, pine and hemlock. Much economically important lumber is harvested there, and in cleared spaces some marginal agriculture is possible where the freeze-free season lasts from 70 to 90 days. Barley, rye, potatoes and berries are among the possible crops. The long daylight hours of the subpolar regions are important to the ripening process. The forests are the habitat of some of the best fur-bearing animals such as the bear, beaver, ermine, fox, lynx and pine marten.

In the middle latitudes a great variety of climates exists. In the northern hemisphere the cool continental type is quite widespread. About half of the months each year have mean temperatures over 50° F.; in from one to four months the mean stays below 32° F.; snow cover in winter is common, with summer rainfall also adequate. It is the area of deciduous trees: beech, birch, chestnut, elm, maple, oak and poplar predominate. Fruit trees are cultivated and yield commercially important crops of apple, cherry, pear and plum. The growing season lasts from 100 to 140 days. Important cereal crops of spring wheat, rye, oats, barley and buckwheat are grown; also potatoes, flax, soybeans and grass for hay production prosper.

The dense settlement of these areas has left little of the original wildlife, but among it may be counted bear, deer, elk, moose and squirrel, as well as a wide variety of migratory birds. In the freshwater streams and lakes of this zone bass, trout, pike and pickerel abound. In the shore waters of the bordering oceans are some of the most important commercial fishing grounds for cod, herring and salmon.

In the temperate zone, with growing seasons of from 140 to 220 days and 20 to 30 in. annual precipitation with a summer maximum, falls the corn (maize) and winter wheat belt. Where the precipitation approaches 40 in. tobacco will prosper, and where the freeze-free season exceeds 200 days cotton becomes an important crop plant. Among the natural vegetation of these regions are bamboo, cedar, chestnut and magnolia, with the grape, apricot and peach the climatically favoured fruits.

Where freezing temperatures become infrequent and the mean values of the warmest months exceed 68° F. and of the coldest month 43° F., with annual precipitation of 20 to 30 in. falling mostly in the cold season, the climate is often called mediterranean after its famous old-world prototype. Similar conditions prevail also in parts of California, Florida, New Zealand, Chile, South Africa and southern Australia. These are the regions of citrus and fig groves and the olive tree.

Drier areas with annual precipitation of less than 20 in. in the moderate latitudes have wide expanses of grassland, which are called steppe in Asia, prairie in North America, pampas in South America, veld in South Africa and downs in Australia. This is the habitat of such diverse long-legged animals as the horse, deer, ostrich and kangaroo. Toward the rainier margins of these areas the quest for arable land has led to plowing in a gamble to raise winter wheat and sorghum. In dry years, however, the harvest has been dust storms instead.

Where annual rainfall in these latitudes falls below 10 in. only a few grass tufts, sagebrush, thorny bushes, some acacias and, in frost-free areas, cacti may survive in the transition zone to the complete desert. At the other end of the scale, in the areas of abundant rainfalls (more than 40 in.) where the mean temperature of the coldest month is above 43° F., cultivation of rice, sugar cane, pineapple and some citrus fruit is practised. Broad-leaved evergreens and palms are among the indigenous species of these subtropical areas.

Typically tropical conditions prevail where the mean temperatures of all months exceed 64° F., and if rainfall is ample, dense forests of giant trees with ebony, mahogany and teak, or jungles with lianas, mangrove and tree moss develop. The rain forests are the home of elephants, monkeys, leopards, tigers, alligators and giant turtles; many species of bright-coloured birds are also among the natural inhabitants. Plantations of coffee, tea, cacao, bananas, rubber, coconut palms, jute, sugar cane and rice flourish in these climates. In regions where a dry season alternates with wet months, the tropical grassland savanna will develop. There tall elephant grass thrives and a few baobab trees are scattered around. Savannas form the landscape in which antelopes, giraffes, gnus, zebras and their predators—lions, leopards and hyenas—struggle for survival.

V. CLIMATE AND MAN

1. Climate and Race.—Many of the higher animals, although they have general climatic preferences, show a fairly wide range of adaptation to environmental conditions. In this process they often develop regionally distinct varieties or races. The differences are often typified by size, shape and colour, in some instances the specialization leading to distinct subspecies. Under the same climates many different animal classes develop similar characteristics; *i.e.*, the white furs of unrelated inhabitants of the polar regions.

Carleton Coon has proposed that climate is also the basic reason for the original racial differentiation in man ("Climate and Race," Smithsonian Institution, *Annual Report 1953*). Man has settled in all climatic zones, having been aided by hunting ability, shelter and fire. Trade and transport have made it possible to secure food in areas where little can be obtained locally. However, only in the 20th century has man had all the facilities to become essentially independent of climate. But in his million-year history certain adaptations to climatic factors became embedded in his genetical heritage, as in lower animals, applying to properties of skin, size and shape.

There are essentially three skin types: (1) The pinkish-white, which burns when exposed to certain short-wave lengths in the solar and sky radiation. It is found among the descendants of tribes from northwestern Europe where clouds are prevalent and sunshine is rare. (2) The second type is chocolate brown or black, which is completely unaffected by solar radiation. Presumably this pigmentation was originally acquired at the tropical margins of the deserts and in the savannas. (3) The third skin type is changeable, taking different shades in individuals, variously described as creamy white, olive, yellow, red or brown. The primary distinction is that it can pale when covered and darken or tan when exposed to the sun, an adaptation to the widespread climatic type where seasons alternate between cloudy rain periods and bright sky.

Another climatically induced characteristic in man and other warm-blooded animals, is that individuals tend to be larger in colder sections and smaller in the warmer sections of their range. Coon cites the following weight contrasts between north and south: In northwest Europe the average weight of the Irish is 157 lb. compared with the 124 lb. of the Algerian Berbers. In Asia the north Chinese weight average is 142 lb.; the southern Annamites, only 112 lb. In America the Aleuts have average weights of 150 lb. compared with a 119-lb. average for the Mayas of Central America.

This difference is in agreement with the fact that it is easier to keep warm if the ratio of skin surface to bulk is small. Such adaptation to environment can be changed within a generation if migration from one climate to another takes place. Basal metabolism also is clearly related to size. If one sets the metabolic rates found among peoples in the northeastern United States and in Europe as 100, it is found that the Eskimos exceed this by 10% to 30%. In contrast a rate 10% lower is found among the inhabitants of the hot parts of India, Australia and Brazil.

The heat produced by metabolism is lost through the skin, usually by radiation or convection. If the air temperature exceeds 83° F. these processes are insufficient, in which case perspiration starts and cooling by evaporation takes place. At high temperatures and moderate or low humidities man loses large quantities of water. Aside from the problem of replacement, this is also a great strain on the circulatory mechanism. Hence, the wisdom of the environment-adapted peoples of the desert and other hot areas, who avoid exertion in midday, becomes obvious; they hunt or work in the early morning or evening hours and have long siestas between times. In the desert, travel at night is also common. The physiological adaptation to desert conditions is accomplished by large skin surface per unit weight. Coon points out that in this adaptation the size and shape of hands, forearms and foreheads play an important role because these parts have large concentrations of sweat glands. Consequently the desert-adapted tribes show long skinny types with narrow heads, long forearms, large hands and long slender fingers.

In the cold regions protection from heat loss is of primary importance. This requires a large body mass, short extremities and adequate fat deposits in areas where heat loss is apt to be rapid. Protruding body parts are endangered by frostbite; as a result one finds in the cold-adapted Mongolian and Eskimo types short, stocky individuals with small ears and noses.

Humans have also achieved a successful adaptation to high altitude climates where temperature and radiation factors are secondary to the bioclimatically dominating effect of the partial pressure of oxygen in the air—an unimportant factor in altitudes below 7,000 ft. In the highland groups in Tibet and the high Andes one encounters persons with larger lung capacity and higher concentrations of red blood corpuscles than in the low altitudes. This adaptation to smaller oxygen supply is apparently readily acquired or lost from generation to generation, according to the domicile.

2. Climatic Comfort Conditions.—Man has learned to live with the climate. Food habits, clothing and housing are geared to the environmental factors, especially among the so-called primitive societies. From the dawn of mankind secluded spaces, such as caves, lean-tos, tents and igloos have been used, which have a cryptoclimate (hidden climate) apart from, if not independent of, the surrounding atmospheric conditions. Modern man has conquered all climates by mechanical devices. Heaters, air conditioners, fans, filters, humidifiers and dehumidifiers, designed to bring about optimal atmospheric comfort conditions, have enabled him to create completely separate artificial climates in enclosed spaces.

TABLE VII.—*Chill Factor of the Atmosphere*

Chill factor (Kcal./m.^{2}hr.)	Sensation	Skin temperature ° F.	Air temperature, wind at 5 m.p.h. ° F.
100	Warm	96.8	84
200	Pleasant	92.7	76
400	Cool	87.8	60
600	Very cool	82.4	45
800	Cold	—	29
1,000	Very cold	—	13
2,000	Bitter cold	—	−2

The concepts of hot, sultry, cool, chilly and cold show the long preoccupation of mankind with climatic conditions. Physiologically speaking, these terms are vague; in part this is caused by the wide differences between individuals. Their reactions depend on age, sex, state of health and nutrition; however, some closer specifications can be given. The comfort sensations are primarily related to the process of heat loss from the body. If the removal of heat is in equilibrium with the production, which depends on level of activity, the person feels comfortable. If it is less the body heats up; if it is more the body cools. The skin temperature is a good indicator of these uncomfortable conditions; it rises when the environment does not permit adequate heat loss and falls if cooling exceeds the metabolic rate. Below 83° F., when evaporative cooling plays little or no role, the heat loss depends on temperature and wind speed. At the higher temperatures cooling by evaporation becomes dominant and this is governed by humidity in addition to the other two factors. Many attempts have been made to express the comfort sensations in terms of the physical factors of the environment. Several indexes have been developed, variously named as chill factor or cooling power of the atmosphere; they are usually expressed in terms of heat loss in kilo calories per square metre per hour (Kcal./m.^{2} hr.). Table VII shows this measure together with the subjective sensation experienced by a majority of healthy individuals, and indicates the approximate corresponding skin temperature for the higher values of the chill factor, where this temperature has a meaning. At lower chill factors the body has to be properly clothed, otherwise it freezes rapidly. Also shown is the corresponding air temperature at which a wind of 5 m.p.h. produces the particular chill factor. At the hot end of the scale the oppressive sensation of sultriness appears. With light wind speeds humans find it sultry when the humidity exceeds 75% at 80° F., 40% at 86° F., 25% at 95° F. Again, clothing and state of acclimatization play a considerable role in individual reactions.

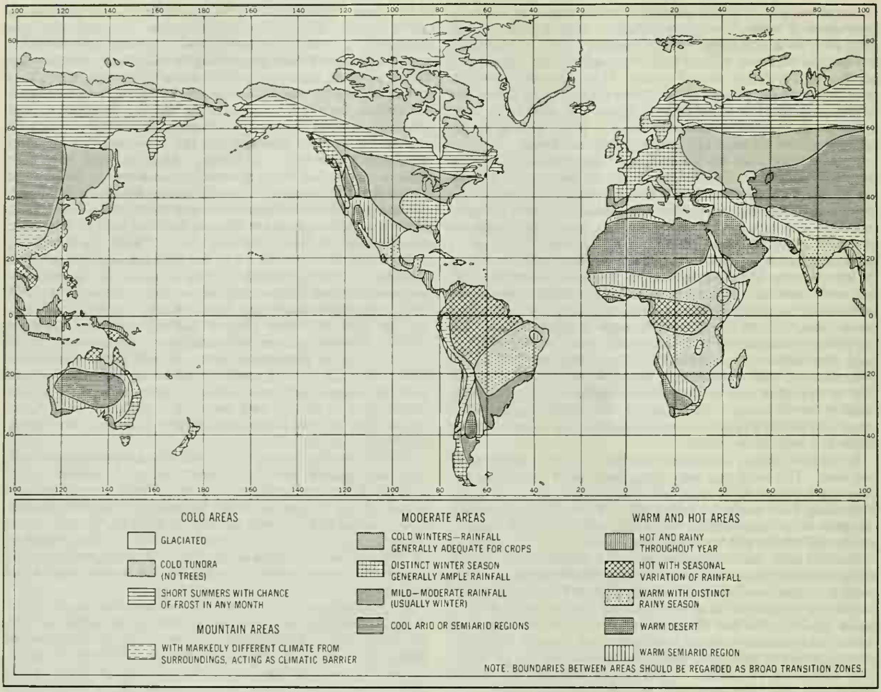
The U.S. weather bureau in 1959 included a temperature-humidity index (originally called a discomfort index) developed by Earl C. Thom, in its summer weather reports. The index is determined by multiplying the sum of the wet bulb and dry bulb temperatures by 0.4 and adding 15: with an index reading of 70, 10% of the people in a given area will be uncomfortable, with a reading of 75, 50% and with a reading of 80, 100%. At index readings of 85 or more precautions should be taken against heat exhaustion and heat stroke.

There have been many claims that certain climates are particularly conducive to health, others stimulating to mental activity, still others particularly suitable for the healing or alleviation of certain diseases. It is difficult to prove any of these claims objectively because climate is generally only one of many factors which act simultaneously on human beings. A few relationships will be listed as indicative of a school of thought represented by E. Huntington and others. (E. Huntington, *Civilisation and Climate;* S. F. Markham, *Climate and the Energy of Nations*). According to their theories the climate of areas in the world in the moderately cool zone with frequent cyclonic activity and rapid changes of weather are apt to stimulate individuals to mental activity and propel nations to leadership. Northwestern Europe, New England and Japan have been cited as such regions. Mysticism and religious activity are supposed, under these hypotheses, to thrive in the semiarid regions at the edge of the tropics. In the regions of extreme cold the struggle for survival is assumed to dominate the psychology of peoples. In the tropical areas, in contrast, extreme lassitude is presumed to pervade the population. Obviously, all these statements depend on judgments rendered in the light of a specific subjective scale of values.

Objectively, beneficial results of climate have been determined for sufferers of chronic respiratory ailments in the dry, sunny plateaus. Equally, persons with circulatory ailments often find a favourable environment in the subtropical climates of even temperature with little day to day change and the lack of seasonal extremes.

3. Climatic Changes.—Climate is not an invariable quantity with time. Aside from the wide variations possible from year to year there are slow trends in climatic conditions, sometimes noticeable even in a single life span. There have been many attempts to attribute these trends to cyclical phenomena. Various climatic cycles have been proposed, foremost among them the so-called sunspot cycle.

Many analyses have been made but the recorded data show that, whatever cycles may be present, their amplitude is small


COLD AREAS
GLACIATED
COLD TUNDRA (NO TREES)
SHORT SUMMERS WITH CHANCE OF FROST IN ANY MONTH
MOUNTAIN AREAS
WITH MARKEDLY DIFFERENT CLIMATE FROM SURROUNDINGS, ACTING AS CLIMATIC BARRIER
MODERATE AREAS
COLD WINTERS—RAINFALL GENERALLY ADEQUATE FOR CROPS
DISTINCT WINTER SEASON GENERALLY AMPLE RAINFALL
MILD—MODERATE RAINFALL (USUALLY WINTER)
COOL ARID OR SEMIARID REGIONS
WARM AND HOT AREAS
HOT AND RAINY THROUGHOUT YEAR
HOT WITH SEASONAL VARIATION OF RAINFALL
WARM WITH DISTINCT RAINY SEASON
WARM DESERT
WARM SEMIARID REGION
NOTE. BOUNDARIES BETWEEN AREAS SHOULD BE REGARDED AS BROAD TRANSITION ZONES.

BY COURTESY OF H. E. LANDSBERG

FIG. 9.—THE WORLD'S MAJOR CLIMATIC ZONES

and their period variable. This may be a consequence of the fact that the inciting phenomena themselves are not strictly cyclical. Even the sunspot cycle is only a general rhythm; while it has a mean duration of 11 years, the time interval between extremes of the same sign has varied between 7 and 18 years in length, according to existing records.

Often shorter and longer cycles and trends have been surmised in the climatic events. These exist over long periods of time, of course, especially if one reckons with a geological time scale. *(See Climatic Change*, below.) In historical times, temperature changes of a few degrees per century and a few per cent of precipitation have been found.

4. Comparative Climatology.—Many systems have been proposed for the purpose of comparing the various surface climates of the globe. These climatic classifications have no universal application, but are limited to specific purposes, some applying to plants, others to human comfort conditions. Still other classifications have been used for specific operational purposes, such as flying conditions, factory locations or construction practices.

There are similarities in climates of localities, even in different regions, provided the major controls of circulation and exposure are similar. These similarities are, however, only a first approximation; the variabilities of the atmosphere in time and space create so many nuances that one cannot carry the comparisons very far. These reservations should be kept in mind, when looking at charts showing climatic types for the world. *(See* fig. 9.)

(H. E. Lg.)

VI. CLIMATIC CHANGE

Geological history is divided into four main periods, Pre-Cambrian (Archeozoic and Proterozoic), Paleozoic, Mesozoic and Cenozoic (Tertiary and Quaternary). There is evidence of many changes of climate, but this article is mainly limited to those which occurred after the appearance of man, roughly a million years ago, at the beginning of the Quaternary *(q.v.)*. The Tertiary is divided into Eocene and Paleocene, Oligocene, Miocene and Pliocene; the Pleistocene is in the Quaternary. The Tertiary began about 70,000,000 years ago, with warm climates and this period was one of gradual cooling which became rapid toward the end. The uppermost beds of the Pliocene contain large numbers of Arctic species, and appear to be contemporaneous with the first glaciations of Scandinavia and the Alps.

The latest bed in England which was formerly attributed to the Pliocene, the Cromer Forest bed, indicates a return of somewhat warmer conditions and is now placed in the first interglacial period. It is succeeded by boulder clays and other deposits of land ice, indicating the oncoming of glacial conditions in England itself.

1. Quaternary Ice Age.—The Quaternary (Pleistocene) Ice Age was characterized by the advance of great glaciers or ice sheets from a number of centres, of which the most important were Scandinavia and the Alps in Europe and the Cordilleras and various other centres in North America. Minor centres of glaciation were located in Spitsbergen, Iceland, Ireland, Scotland and northern England, the Pyrenees, the Caucasus range, the Himalayas, the mountain ranges of central Asia, Alaska and the whole chain of the

Rockies and Andes, the highest mountains of equatorial Africa, New Guinea, southeastern Australia and New Zealand.

The ice sheets of Greenland and Antarctica are remnants of the Quaternary glaciation, and illustrate the character of the great inland ice sheets of northern Europe and North America.

The maximum area occupied by land ice was about 13,000,000 sq.mi., including 5,000,000 sq.mi. in the Antarctic, 4,500,000 sq.mi. in North America, 1,250,000 sq.mi. in Europe and at least as much in Asia, and over 800,000 sq.mi. in Greenland. The present area is about 6,000,000 sq.mi. In addition, there was a great extension of floating ice in the oceans, especially in the North Atlantic and Antarctic. Altogether, nearly one-tenth of the earth's surface must have been ice covered. The ice did not reach its maximum thickness and extension simultaneously; if it had, the amount of water withdrawn from the oceans would have lowered the sea level by almost 400 ft. The actual lowering however exceeded 260 ft., which is sufficient to show that the major ice sheets were all in existence at the same time. (*See* also Pleistocene Epoch.)

2. Pluvial Periods.—In tropical and subtropical land areas the rainfall during the glacial periods was almost everywhere greater than during the interglacial periods. In North America the lakes of the Great Basin spread out to form large inland seas, the best known of which are Lahontan and Bonneville. In east Africa a whole series of lakes has been found and correlated with the Alpine sequence: Kafuan with the Günz and Mindel; Kamasian (Great Pluvial) with the Riss; and Gamblian, consisting of four successive lakes, the first three representing the three maximums of the Würm. The pluvial periods were separated by interpluvials, during which the lakes dried up more or less completely.

3. Postglacial Period.—The postglacial period was marked by alternations of rainy and dry climates. These are clearly shown in peat bog sections by the alternation of rapid growth and drying up, often with tree growth. The succession was first investigated and the periods named by the Norwegian Axel Blytt; in later years G. Erdtman and (in Britain) H. Godwin carried the study into great detail. The rainy Atlantic period was followed by the Subboreal. This was on the whole cooler and drier, with long droughts in which the surface of the peat dried up, followed by returns to more rainy conditions.

The main dry periods were about 2200–1900, 1200–1000 and 700–500 B.C. The latter (Grenzhorizont), was the best developed; it has been described as a dry heat wave lasting for perhaps 200 years. Lakes decreased in area and in a few places trees grew on their floors below the level of the outlet. From four such lakes in Ireland, Germany and Austria it is estimated that the rainfall was only about half that of recent centuries. The drought was not intense enough to interrupt the steady development of the forests, but it caused extensive migrations of peoples from drier to wetter sites. At the end of this dry period, about 500 B.C., there was a rapid deterioration of favourable climate, marked by renewed growth of sphagnum bogs and flooding of lake settlements; this brought in the Sub-Atlantic period.

4. Climatic Changes During the Christian Era.—Increasingly detailed and accurately dated knowledge of climatic changes began with the Christian era. In Europe this depends on peat bogs, lake levels, advances and retreats of glaciers, location of settlements and, later, literary records and old weather journals. In Asia the prime source is the level of the Caspian sea; Chinese annals are also helpful. In northeast Africa there are the levels of the Nile and the history of oases. In the west of North America the rainfall is recorded with surprising accuracy by the widths of the annual tree rings. These varied lines of evidence from the north temperate zone are in general agreement, with some differences of detail.

At the beginning of the Christian era the climate was much as it is at present, or possibly a little rainier, especially in northeast Africa. About A.D. 400 a period of relative warmth and dryness set in, the Caspian sea being below its present level. This dry period reached its greatest intensity about A.D. 700, when there was much traffic over the Alpine passes. There was extensive sea traffic off western Europe, and the civilization of Ireland reached a high level (Irish learning being greatly esteemed in Europe). There were many droughts in China, low Nile levels and a great decline in the prosperity of the north African oases. Ellsworth Huntington's curve of tree growth in western America fell to a very low level; this dry period in America is supported by some evidence of lake levels.

After about A.D. 800 the climate of the temperate belt became rainier, but remained mild. Greenland was explored and colonized in the 10th century under conditions far more favourable than those of the 20th century.

Western Europe became stormy after 1200, and there were many inundations of the North sea coasts of England and the Netherlands, culminating in the destruction of Winchelsea and the coastal defenses of the Netherlands and Frisia. In Greenland, where the Norse colonies had prospered in the 11th and 12th centuries, rapid deterioration set in. The ground became permanently frozen about 1400 and the colonies disappeared.

The next centuries were generally rainy, but were chiefly remarkable for a readvance of glaciers all over the world; this period becoming known as the Little Ice Age. The glaciers began to expand during the 13th century. Their advance was slow at first and probably stopped completely during the second half of the 16th century, but it became very rapid from about 1600 to 1650. In Sweden the latter date marks one of the two points of greatest extension and was followed by a slight retreat, but in the Alps and Iceland it was little more than a temporary halt. The second maximum occurred at or a little before 1750, when the glaciers reached an extension greater than at any other time since the end of the Quaternary Ice Age. Since then there has been a general retreat, slow at first and broken by a halt or readvance about 1850, but again becoming rapid during the 20th century.

Instrumental observations began in England in 1677, when there was a period of dry continental climate. About 1750 this changed to a more oceanic climate, with mild winters and cool rainy summers. There was a brief return of the continental type from 1794 to 1810, with prevailing easterly winds and a notable period of severe winters. After 1850 winters became progressively warmer in nearly all polar and temperate regions, but the colder winters beginning about mid-20th century may indicate a reversal of this tendency.

The broad pattern of climatic change since the end of the Ice Age is consistent with the hypothesis of an alternate weakening and strengthening of the planetary atmospheric circulation, associated with alternate poleward and equatorward shifts of the wind zones. At times of minimum circulation the circumpolar belt of west winds contracts and anticyclones are frequent in middle latitudes. Winds are variable, rainfall is small and the climate continental, with cold winters and hot summers. When the circulation is stronger, westerly winds predominate, storms are more frequent and penetrate into lower latitudes, the rainfall is heavier and climate more oceanic. This, with a few short interludes, was the general condition during the Sub-Atlantic and after about A.D. 1200.

See also references under "Climate and Climatology" in the Index volume. (C. E. P. B.)

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CLIMBING BITTERSWEET (*Celastrus scandens*), a North American climbing shrub of the staff-tree family (Celas-

JOHN H. GERARD

CLIMBING BITTERSWEET (CELASTRUS SCANDENS)

traceae), called also false bittersweet and waxwork. It grows mostly in rich soil, from Quebec to Manitoba and southward to North Carolina and New Mexico, usually trailing on banks or small shrubs but sometimes climbing to a height of 25 ft. on trees. It has smooth, pointed leaves and small greenish flowers and matures in autumn with showy clusters of orange-yellow, berrylike capsules, which split open after frost, disclosing the crimson coverings (arils) enclosing the seeds. The handsome, persistent fruit is often used in winter for indoor decoration.

The true bittersweet or woody nightshade belongs to another family, the Solanaceae (*see* NIGHTSHADE).

CLINIC, an organized medical service offering diagnostic, therapeutic, or preventive treatment to ambulatory patients. The original meaning was a bedside demonstration of a sick patient before a group of physicians or medical students. In medical education clinic is still so used but may also mean a particular lecture, classroom, or outpatient examination where several medical men discuss their views. Often in Europe and occasionally in the U.S. the term covers the entire teaching centre, including the hospital and ambulatory-patient facilities. The term is most commonly applied, however, to any organized medical service for ambulatory patients. Such service may or may not be connected with a hospital. In addition, clinic is used to designate the entire activities of a general clinic or may be used to designate only a particular division of the work; *e.g.*, the psychiatric clinic, the neurology clinic, the surgery clinic, etc. Usually, the entire activity when connected with a hospital is called the outpatient department, and the subdivisions are referred to as clinics.

The first clinic in the English-speaking world, the London Dispensary, was founded in 1696 as a central means of dispensing medicines to the sick poor whom the physicians were treating in the patients' homes. The New York, Philadelphia, and Boston dispensaries, founded in 1771, 1786, and 1796, respectively, had the same object in view. Later, for the sake of convenience, physicians began to treat their free patients at the dispensary. The number of such clinics did not increase rapidly, and as late as 1890 only 132 were operating in the United States. The impetus for the mushroomlike growth that has occurred since that time came with the rapid growth of hospitals and also from the public health movement.

Hospital Clinics.—During the late 1800s the modern hospital as a complex of skilled technical personnel and extensive diagnostic equipment began to take shape. During this period some of the hospitals connected with medical schools inaugurated outpatient departments for teaching, as well as for charitable purposes. The Johns Hopkins and Massachusetts General hospitals are believed to be the American pioneers in this form of medical education. The advantages of providing ambulatory care close to the facilities of a hospital became apparent, and such hospital clinics multiplied rapidly.

A hospital clinic in general follows the same pattern of medical organization as the particular hospital has developed for its inpatient work. Hospital clinics are mostly concerned with acute diseases and the physicians in the clinics are usually the same physicians who treat bed patients in the hospital. Many hospitals that operate charity clinics follow the practice of requiring recent appointees to the medical staff to serve a period in the clinics as a step to senior staff membership.

In many hospital clinics, especially those in countries which do not have national health insurance programs, care is made available only to the medically indigent, and no professional fee is charged. Practically all such clinics, however, charge a small registration fee if the patient is financially able to pay; income from such fees helps pay operating costs. A number of successful attempts have been made to extend hospital clinic care to paying patients. Most of this effort has been in the area of the lower income groups although in a few hospitals no limit is placed on income in determining eligibility for care. The hospitals of the University of Chicago, for example, began operating a clinic on such a basis in 1928.

Public Health Clinics.—The public health movement has been mainly concerned with preventive medicine, child and maternal health, and other medical problems affecting broad segments of the population. The first public health clinics were established in the late 19th century. In 1890 A. Pinard set up a maternal dispensary or antenatal clinic at the Maternité Baudelocque in Paris. Milk distribution centres were set up in France by J. Comby (1890) and in Britain by F. D. Harris (1899). Infant welfare clinics were established in Barcelona, Spain (1890), and clinics for older children in St. Pancras, London, by J. F. J. Sykes (1907). Between 1900 and 1965 more than 6,000 public health clinics were established in the U.S.

Unlike the hospital clinics, which have had their greatest growth in the cities, the public health clinics are located chiefly in smaller towns and villages. In the U.S. the first great movement in creating public health clinics resulted in the founding of the National Association for the Study and Prevention of Tuberculosis in 1904. It was the association's goal to study and prevent tuberculosis by making clinic facilities available for free examination and treatment in every city and county. Other nationwide, private health agencies in specialized medical fields quickly adopted this method to improve the quality and extend the quantity of medical service in their fields. Local governmental health units operate similar clinics in the medical specialties related to the prevention of communicable disease and long-term illness. Such clinics are generally concerned with one particular medical interest, usually one of the following: tuberculosis, venereal disease, prenatal care, well-baby care, teeth, tonsils, eyes, crippled children, and mental hygiene. There was a tendency in the mid-1960s toward the establishment of traveling clinics, such as dental clinics for school children and tuberculosis case-finding clinics in industrial plants. Usually no charge is made for service in public health clinics, and for many medical conditions no income restrictions are imposed. A few are operated in connection with hospitals, but most such clinics use public buildings or space furnished by welfare and other social agencies. Financial support is received mostly from the same sources.

Private Clinics.—The advantages of group medical service, with facilities and technical personnel beyond the means of an individual practitioner plus the added benefits of group consultation, have encouraged the establishment of pay or private clinics. This type of clinic is essentially a voluntary association of physicians engaged in the practice of medicine on an organized group basis. Common administration and facilities are used, and the resulting expense and income are shared according to a predetermined plan. To be classified as a group clinic the relationship between each physician and the organization must be defined in a legal agreement. The relationship usually takes the form of a partnership. Several of these, such as the Mayo Clinic, in Rochester, Minn., have achieved a national reputation and attract patients from a wide geographical area. The majority of these organized group clinics are general clinics; *i.e.*, they have several of the different medical specialties represented on their staffs. A number of private clinics, however, limit their work to one medical specialty. An enterprise of special interest is the London Clinic, established in 1936 by a group of prominent consultant surgeons and physicians who wished to make available to their private patients a place where the comforts and privacy of a nursing home could be combined with facilities for diagnosis and therapy such as normally exist only in the larger general hospitals.

Usually the group is organized independently of any hospital or other agency, but in some instances such clinics own and operate their own hospital facilities. In other instances the clinic is a part of a prepaid health service plan. This latter pattern has received impetus in recent years as labour unions have set up medical clinics supported by welfare benefits contributed by employers. The United Mine Workers, for example, has established a system of such clinics in hospitals constructed by the union in the coal mining areas of Virginia and West Virginia.

Health Centres.—In 1910 the first health centres, or multiple clinics, were established in Pittsburgh and Wilkes-Barre, Pa. Others were opened in 1913 in New York City and in 1916 in Boston and Philadelphia. In 1920 in Britain a consultative council on medical and allied services (Dawson Committee) described a health centre as an institution wherein are brought together various medical services, preventive and curative. Under section 21 of the National Health Service Act, 1946, local health authorities provide, equip maintain, and staff health centres to offer facilities for all or any of the following services: general medical and dental; pharmaceutical; hospital outpatient and health education; and care of expectant and nursing mothers. The prenatal and postnatal clinics include periodic medical and dental examinations, classes in parenthood and relaxation, and the supplying of welfare foods. Activities in child welfare clinics comprise education in all aspects of motherhood; periodic medical and dental examinations; advice on mental health problems; immunization and vaccination; and distribution of welfare foods.

Polyclinics.—In the U.S.S.R., the polyclinic is designed to combine the function of a hospital outpatient department with that of a general practitioner health centre. Factory workers and their families can attend general polyclinics attached to major factories, and there are many special children's polyclinics in the towns. A typical urban polyclinic, which is usually associated with a hospital, includes reception and waiting rooms, registration desk, and consulting and treatment rooms of the following: internist, pediatrician, gynecologist, surgeon, eye specialist, ear, nose, and throat specialist, neurologist, urologist, and dentist. There are often rooms for first aid, reception of infectious cases, and women and children's welfare, as well as a dental department, drugstore, pathological laboratory, X-ray department (sometimes with a special apparatus for mass radiology), gymnasium, and lecture hall. There are always fairly elaborate physiotherapy departments and usually large and small operating theatres.

See also Hospital; Public Health. (R. E. Bn.; J. F. Sk.)

CLINICAL PSYCHOLOGY: *see* Psychology, Applied: *Psychology as Applied to Treatment.*

CLINTON, DE WITT (1769–1828), U.S. political leader and chief sponsor of the project to build the Erie Canal, was born March 2, 1769, in Little Britain, N.Y. He graduated from Columbia College, New York City, in 1786 and the next year wrote a series of articles signed "A Countryman" opposing the ratification of the proposed constitution of the United States. He began to practise law in 1790 and served until 1795 as secretary to his uncle, George Clinton, governor of New York. At the age of 28 he entered the state senate, serving from 1798 to 1802 and again from 1806 to 1811. As a member of the Council of Appointments he sought to fill the more important offices with Republicans and to divide the minor offices between the political parties according to their strength. Because in the process many Federalists were removed and many Republicans were appointed, De Witt Clinton was charged with being the originator of the "spoils system" (*q.v.*) in New York.

In 1802 Clinton entered the U.S. Senate but resigned the next year upon his appointment as mayor of New York City, an office he held for ten of the years between 1803 and 1815. While mayor he also served as state senator (1806–11) and as lieutenant governor (1811–13). As mayor of New York, Clinton advocated free and widespread education and with the aid of public and private funds succeeded in opening Public School No. 1. After a congressional caucus in 1812 had nominated Pres. James Madison for a second term, Republican leaders of New York, desiring to break up the so-called "Virginia dynasty," met and by legislative caucus nominated Clinton for the presidency. In the election Madison received 128 electoral votes, Clinton 89.

For many years Clinton had been interested in a proposal to build a canal from the Hudson River to Lake Erie and in 1811 he introduced a bill in the state senate to appoint a commission to explore the route suggested. He and Gouverneur Morris were sent to Washington to secure federal aid for the project but were unsuccessful. After the War of 1812 the canal project was revived and Clinton became chairman of the new commission. He was elected governor of New York for two terms (1817–1823), and work on the canal began during his first year in office.

While governor, Clinton advocated the gradual abolition of slavery in New York, sought to improve the condition of the poor, and urged training for teachers in state normal schools. As bitter opposition to his administration developed under the leadership of Martin Van Buren and Tammany Hall, Clinton refused to run for a third term in 1822. His dismissal as canal commissioner in 1824 caused such indignation throughout the state that he was swept into the governorship the next year and served until his death. In Oct. 1825 he took part in the formal opening of "Clinton's Ditch," later to be known as the Erie Canal (*q.v.*). He died in Albany on Feb. 11, 1828.

In addition to his interest in politics and public improvements, Clinton had devoted much time to the study of the natural sciences. Among his published works were *Memoir on the Antiquities of Western New York* (1818) and *Letters on the Natural History and Internal Resources of New York* (1822).

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CLINTON, GEORGE (1739–1812), U.S. soldier, state governor, and vice-president of the U.S., was born at Little Britain, N.Y., on July 26, 1739. He went to sea at the age of 18. Within a year he returned home where in 1759 he received a clerkship in his home county of Ulster. He was commissioned a lieutenant in the company commanded by his brother (Capt. James Clinton) and served in the campaign of 1760 that captured Montreal from the French. After the French and Indian War he studied law, was commissioned attorney at law, and in 1764 surveyed the disputed New York-New Jersey boundary line. He was a member of the New York General Assembly from 1768 to 1775 and in the latter year became a member of the Continental Congress. In December of that year he was commissioned a brigadier general of militia by the New York Provincial Congress. The following summer, while still a member of the Continental Congress, he was ordered by Gen. George Washington to assist in the defense of New York and left Philadelphia before he could sign the Declaration of Independence, which he had supported in debate.

Clinton was charged with the defense of the highlands of the Hudson River and, although offering stiff resistance, he was unable to check the advance of the British under Sir Henry Clinton. In March 1777 he was appointed brigadier general by Congress, thus holding two military commissions since New York refused to accept his resignation as brigadier in the militia. So great was his popularity with the people of New York at that time that he was elected both governor and lieutenant governor in the first election under the new state constitution. He declined the lieutenant governorship and on July 30, 1777, entered upon his duties as governor. He served 18 consecutive years as governor (1777–95) and later served an additional three-year term (1801–04). As governor he was a forceful leader and an able administrator. During the struggle in New York over the adoption of the federal constitution he was one of the leaders of the opposition because he feared that the constitution would lead to the destruction of the states and the setting up of a consolidated federal government. In the state convention of 1788, over which he presided, his party was defeated and the constitution was ratified. In national politics Clinton was a follower of Thomas Jefferson; in state politics he led the long-dominant faction known as the "Clintonians."

In 1804 he was elected vice-president of the United States. In 1808 he sought the nomination for the presidency and was much disappointed when James Madison was chosen. However, Clinton accepted the nomination for the vice-presidency and was again elected. In 1811 he cast the deciding vote in the Senate that defeated the bill for the renewal of the charter of the Bank of the

United States, thus showing his opposition to strong central authority in finance and banking. He died in Washington, D.C., April 20, 1812, before the expiration of his second term as vice-president.

See *The Public Papers of George Clinton*, 6 vol. (1899–1902), published by the state of New York; E. W. Spaulding, *His Excellency George Clinton* (1938). (R. E. At.)

CLINTON, SIR HENRY (1738–1795), British general, who was commander in chief in America during the American Revolution (*q.v.*), was born in Newfoundland, where his father was governor. He joined the army in 1757, served in the final three campaigns of the Seven Years' War, and was promoted colonel in 1762. In 1772 he was made a general. He went to America in 1775 as second-in-command to Sir William Howe, fought with distinction at Bunker Hill and Long Island, and was left in command in New York when the main army went south to Pennsylvania. On Howe's retirement (1778), Clinton succeeded to the supreme command. He conducted various minor expeditions in the New York area, but disagreed with Lord Cornwallis, his second-in-command, over the possibility of more decisive operations with the limited forces available. He led his main army in an offensive in the Carolinas in 1780, but after the siege and fall of Charleston he returned to New York, leaving Cornwallis in charge of the subsequent operations which led to the capitulation at Yorktown and the peace treaty recognizing American independence. Clinton resigned his command in 1781, and returned to England. His *Narrative of the Campaign of 1781 in North America* (1783; new ed. by W. B. Wilcox, 1954) provoked an angry reply from Cornwallis. Clinton was appointed governor of Gibraltar in 1794 and died there on Dec. 23, 1795.

His two sons also rose to be generals. The younger, Sir Henry Clinton (1771–1829), saw varied service, and won a good reputation, especially during the Peninsular War. His division held a vital portion of the British line at Waterloo (1815). He died in Hampshire on Dec. 11, 1829. (E. W. Sh.)

CLINTON, HENRY FYNES (1781–1852), British classical scholar and chronologist, was the author of the *Fasti Hellenici* and the *Fasti Romani*, which set classical chronology on a scientific basis. Born at Gamston, Nottinghamshire, on Jan. 14, 1781, he was educated at Westminster school and at Christ Church, Oxford, and from 1806 to 1826 was M.P. for Aldborough, Yorkshire. He died at Welwyn, Hertfordshire, on Oct. 24, 1852. The value of his *Fasti* can scarcely be overestimated, even though later research corrected some of his conclusions. His chief works include *Fasti Hellenici, the Civil and Literary Chronology of Greece From the Earliest Accounts to the Death of Augustus*, including dissertations on points of Greek history and scriptural chronology, three volumes (1824–51); and *Fasti Romani, the Civil and Literary Chronology of Rome and Constantinople: From the Death of Augustus to the Death of Justin II*, two volumes (1845–50). Epitomes of these works were published in 1851 and 1853.

See C. J. F. Clinton (ed.), *The Literary Remains of H. F. Clinton*, including an autobiography (1854).

CLINTON, a city of Iowa, U.S., on the Mississippi river, is the seat of Clinton county and the easternmost city in Iowa.

The original settler, Joseph M. Bartlett, opened a trading store for Indians in the area in the 1830s and named his proposed town New York. The real development of the town was delayed, however, until 1855, when the Iowa Land company purchased the townsite and renamed the town for De Witt Clinton (*q.v.*). It was incorporated in 1859 and reincorporated in 1881. Formerly the largest sawmill centre in the middle west, Clinton was forced by a diminishing lumber supply to turn to such other industries as railroading and the manufacturing of corn products, cellophane, and steel and wire specialties. The city's public education system includes Clinton junior college. Clinton has a number of public parks, among them Eagle Point park, which provides an excellent view of the Mississippi. For comparative population figures *see* table in Iowa: *Population*. (J. F. Wa.)

CLINTON, a village in the town of Kirkland in Oneida county, N.Y., U.S., on Oriskany creek, 9 mi. S.W. of Utica. Founded in 1786 by New England pioneers, it was named for George Clinton, a general in the American Revolution and first governor of the state. It was incorporated in 1843. The village is a residence for professional and businessmen from Utica and Rome. It is the site of Hamilton college, founded in 1793 as an Indian academy by the pioneer missionary Samuel Kirkland and first called the Hamilton Oneida academy, after Alexander Hamilton and the Oneida Indians. In 1812 it was chartered as a college for men and became one of the most distinguished liberal arts colleges in the U.S. Among its many famous alumni are Elihu Root (1845–1937), Henry Wheeler Shaw ("Josh Billings") (1818–1885) and Samuel Hopkins Adams (1871–1958). Early iron mines in the area had mostly closed by the second half of the 20th century. The surrounding farms specialize in the production of vegetables. The population of the village in the 20th century was less than 2,000. (V. C. C.)

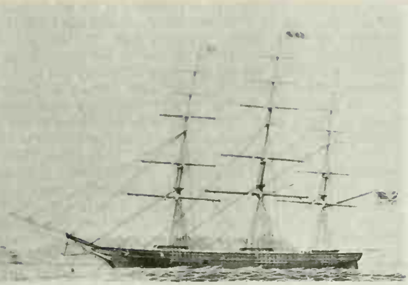
CLINTONIA, a genus of beautiful herbs of the lily family (Liliaceae; *q.v.*), named in honour of De Witt Clinton (1769–1828), governor of the state of New York. There are six species, four North American and two Asian, all stemless perennials, with a few broad leaves rising from a slender rootstock, and lilylike flowers, usually borne in clusters (umbels) at the top of the flower stock (scape). The yellow clintonia (*C. borealis*) is found in woods from Newfoundland to Manitoba and southward to North Carolina and Wisconsin; the white clintonia (*C. umbellulata*) occurs in woods from New York and New Jersey to Tennessee and Georgia; the mountain clintonia (*C. uniflora*), with a single white flower, grows from Montana and California northward to Alaska; the western clintonia (*C. andrewsiana*) is found near the Pacific coast in central California.

CLINTONITE: *see* Ottrelite.

CLIPPER SHIPS, exceptionally fast sailing vessels developed primarily in the United States between 1830 and 1860. The term clipper was probably derived either from "clipping time from previous records" or "going at a good clip." These ships were celebrated for their fast passages between important ports of call.

A ship with a reputation for speed brought large profits to its owners during the period of mass emigration to America, the rush for gold in California and Australia and the expanding trade in tea and wheat. Repeal of British navigation acts in 1849 ended the monopoly of the China trade that had been long held by British vessels and opened it to adventurous American shippers. Their experience in building fast ships to cope with maritime difficulties with France, Tripoli and England during the late 18th and early 19th centuries enabled American designers and shipbuilders to produce the fastest commercial craft that ever sailed. But the successful clipper ship required more than just a good design and good workmanship; it also required a good crew. The true clipper had the following characteristics: a hull that was sharp—with length five or six times its beam—designed for high speed rather than great cargo capacity; a heavy and lofty square rig, usually three masts with spars capable of spreading far more canvas than ships of comparable size; and a captain with a mania for speed who could drive his craft and crew to the limit of their strength.

The origin of this class of ships is not clearly understood. Some historians believe that the French frigate of the late 18th century was the inspiration for the Yankee clipper, while others point to the early Baltimore clippers as the forerunner of the type. Very probably the extreme clipper was evolved by numerous designers using their combined experience gained over a long period of time. It is interesting to note, however, that the French frigate had a rounded bow, a large dead rise (slope of the bottom above the horizontal), greatest breadth forward of amidships, and greatest depth of the hull at the stern. In contrast, the clipper, in its most efficient form as built in the early 1850s, had a long sharp bow with a flare, a comparatively small dead rise, greatest breadth at or just aft of amidships, and a depth of hull slightly greater at the bow than at the stern. That there was a gradual evolution in the development of the clipper is illustrated by the hull lines of the 500-ton Baltimore clipper "Ann McKim" (built in 1833 by the Baltimore merchant Isaac



BY COURTESY OF SMITHSONIAN INSTITUTION

CLIPPER SHIP "NIGHTINGALE" (FROM A LITHOGRAPH)

McKim and considered by some historians to be the first clipper), which have some of the features of both the types compared above. Even among the later clippers the hull lines varied from ship to ship, and tonnage ranged from 470 to 4,500. Some designers produced ships that were fast in rough weather—excellent craft for the roaring forties of south latitude—while other designers built vessels that made comparatively better speed in moderate or light winds.

Among the most famous builders of clipper ships was Donald McKay (*q.v.*), of Boston, who launched the "Sovereign of the Seas," of 2,421 tons register, in 1852. Described by one historian as being "stately as a cathedral, beautiful as a terraced cloud," this clipper achieved a speed of 411 nautical miles in one day. But it was the "Lightning," another McKay ship, that established on its maiden voyage the best record for a single day's run—436 mi.—a record that was not surpassed by a steamship for many years. For sustained speeds on long runs in all kinds of weather the honours probably go to two of the last British tea clippers, the "Thermopylae" and the "Cutty Sark" of 1868–69. The "Cutty Sark," fully rigged and equipped, is preserved in a permanent dry dock at Greenwich, Eng.

Construction of the extreme clipper, capable of making up to 18 knots, stopped generally after 1854 because of a financial slump. With resumption of ship construction, builders in both the United States and Europe favoured a modified form in both hull and rig, one that would carry more cargo and be less costly to build and maintain. This type of ship, built during and after the American Civil War, was termed a medium clipper or a modified clipper.

Some of the famous clippers and their records are: "Nightingale," Shanghai to London, 91 days; "Sea Witch," Canton to New York, 81 days, and New York to Valparaiso, Chile, 59 days; "Challenge," Hong Kong to San Francisco, Calif., 33 days; "Flying Cloud," New York to San Francisco, 89 days; and "Andrew Jackson," Liverpool to New York, 15 days.

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(M. H. I.)

CLISSON, OLIVIER DE (1336–1407), French magnate and military commander who served England, France and Brittany one after the other and ultimately did much to keep Brittany within the French sphere of influence. Born in Brittany, he was brought up in England and learned from the English tactical methods that he was later to use against them. In the War of the Breton Succession (*see* BRITTANY), he fought on the English side for John IV (John of Montfort) against the French-supported Charles of Blois and won the battle of Auray (1364), in which Charles was killed and Bertrand du Guesclin taken prisoner. In 1365, however, he left John IV (who would not reward his services adequately) and induced the Black Prince (Edward of England) to release Du Guesclin. Clisson then went over to the French. Appointed lieutenant of Guienne by Charles V in 1369, he conducted a fierce struggle against the English there and became notorious for cruelty. After serving as lieutenant general in Brittany (1374), he succeeded Du Guesclin as constable of France in 1380. In 1382 he defeated the Flemings at the battle of Roosebeke. In 1392 Pierre de Craon, at John IV's instigation, made an attempt on his life in Paris. This provoked a French expedition against Brittany that was cut short by Charles VI's attack of madness. The new French government deprived Clisson of his office as constable, whereupon he withdrew to Brittany and, in 1395, became reconciled with John IV. On his deathbed (1399) John appointed him guardian of his children and protector of Brittany. Clisson died at the castle of Josselin on April 23, 1407. Eager for gain and for glory, at once warlike and pious, he was the typical feudal lord.

See A. Lefranc, *Olivier de Clisson, connétable de France* (1898); A. Naudin-Hérot, *Le Connétable Olivier de Clisson* (1938). (J. D'A.)

CLITHEROE, a municipal borough of Lancashire, Eng., 26 mi. S.E. of Lancaster by road. Pop. (1961) 12,147. It stands on a limestone ridge between the river Ribble and the foot of Pendle hill (1,831 ft.), described by William Harrison Ainsworth as a haunt of the "Lancashire Witches" in his novel of that name.

The honor of Clitheroe was first held by Roger de Poictou, almost certainly the builder of the castle. From 1310 it was part of the duchy of Lancaster until Charles II bestowed it on Gen. George Monck. It is now held by Baron Clitheroe of Downham. The first charter was granted in 1147 by Henry de Lacy, the privileges being confirmed and enlarged by a second charter granted about 1283 (confirmed by Edward III, Henry V, Henry VIII and James I). The remains of the Norman castle (the keep and parts of the wall) stand overlooking the town and valley at the southwestern end of the limestone ridge on which the town was anciently located. It is surrounded by a municipal park acquired in 1919 as a war memorial. A grammar school founded in 1554 is still in existence. The church of St. Mary Magdalene is a comparatively modern structure on ancient foundations. Stonyhurst college, the Roman Catholic public school, lies 5 mi. S.W. of Clitheroe.

Clitheroe's principal industries are cotton processing, limestone quarrying, the manufacture of clothing and agricultural appliances and light engineering. A large cement works and a chemical works are also located there. The Ribble and Hodder provide trout and salmon fishing.

CLITUNNO (anc. CLITUMNUS), a river in Umbria, Italy, rising from an abundant spring by the road between Spoleto and Trevi, 12.9 km. (8 mi.) from the former, 6 km. (4 mi.) from the latter. After a short course through the territory of Trevi it joins the Timia, a tributary of the Tiber. Pliny described and the emperors Caligula and Honorius visited the lake, a clear pool surrounded by poplars and weeping willows. The stream was personified as a god, whose ancient temple lay near the spring; close by were other smaller shrines, and it occurs under the name Sacraria ("Shrines") as a Roman post station.

The building, generally known as the Tempio di Clitunno, close to the spring is an ancient Christian chapel, its decorative sculptures being contemporary with those of S. Salvatore at Spoleto (4th century). (G. KH.)

CLIVE, KITTY (CATHERINE RAFTOR) (1711–1785), British actress, who became one of David Garrick's most famous leading ladies, was born in London, the daughter of William Raftor, an Irishman of good but impoverished family. About 1728 she began to play at Drury Lane under Colley Cibber and soon became a favourite. She married George Clive, a barrister, but they separated by mutual consent. Her first great success was as a comedienne and singer in *The Devil to Pay*. Almost her whole career belonged to Drury Lane, where in 1747 she joined Garrick, with whom she remained for 22 years, always playing comedy roles. She also sang in some of the oratorios of Handel, whose friend she was. In 1769 she left the stage and retired to a villa (the gift of Horace Walpole) at Twickenham, where she lived for 16 years and where she died on Dec. 6, 1785.

Kitty Clive had no beauty but possessed considerable fascination and was certainly the best comedy actress of her day. However, she was temperamental and led Garrick (who was afraid of her) a troubled life. Her private life was above suspicion and she supported her father and many friends. Horace Walpole, a great admirer of her art, placed an urn to her memory in his garden. On it was inscribed:

> The comic muse with her retired
> And shed a tear when she expired.

See P. Fitzgerald, *Life of Mrs. Catherine Clive Together With Her Correspondence* (1888). (W. J. M.-P.)

CLIVE, ROBERT CLIVE, Baron (1725–1774), British soldier and statesman who was one of the creators of British power in India, was born on Sept. 29, 1725, at Styche, the family estate, in the parish of Moreton Say, near Market Drayton, Shropshire. The Clives were one of the oldest families in the county, having held the manor of Styche in the reign of Henry II. One Clive had been chancellor of the Irish exchequer under Henry VIII; another had been a member of the Long parliament; Robert's father for many years represented Montgomeryshire in parliament. Young Clive was a difficult boy of high and unruly spirits and was sent to several schools, including the Merchant Taylors' school in London, without much visible profit. But he was able to read Horace in later life and to write and speak in vigorous English. In 1743, aged 18, he was sent to Madras as a "writer" in the English East India company's service—something of a last resort at that time since the prospects were limited.

First Years in India.—At Madras he was moody and quarrelsome, twice attempted suicide and once fought a duel; he found solace in the governor's library where he virtually educated himself. The outbreak of hostilities between the French and British in south India gave Clive the chance to reveal his latent talents as a man of action. He was taken prisoner at the capitulation of Madras in 1746 but escaped to Ft. St. David where he served as a volunteer and the governor gave him the rank of ensign (1747). The peace of Aix-la-Chapelle in 1748 seemed to end Clive's military career, but the renewed hostilities between the English and French East India companies and their support of rival Indian princes drew him back into military service. In 1751 the French candidate for the Carnatic nawabship, Chanda Sahib, was besieging the British candidate, Mohammed Ali, in the fortress of Trichinopoly. Clive offered to lead a diversion against Arcot, the capital city and Chanda's base. With 200 Europeans and 300 Indians he seized Arcot on Sept. 12 (new style; Aug. 31, old style) and then successfully withstood a 53-day siege (Oct. 4–Nov. 25) by Chanda's brother. This feat proved to be the turning point in the contest with the French commander, Joseph Dupleix (*q.v.*). In the next months Clive established himself as a brilliant exponent of guerrilla tactics. In March 1753 he returned to England with something of a fortune, having been appointed in 1749 a commissary for the supply of provisions to the troops. Before leaving he married Margaret Maskeleyne.

The "Heaven-Born General."—In 1755, after unsuccessfully standing for parliament, he was sent out again to India as governor of Ft. St. David with the reversion to the governorship at Madras and a lieutenant colonel's commission in the royal army. With him went troops intended to dislodge the French from the Deccan in view of the imminence of a European war. On the way, at the request of the Bombay government, he stormed the pirate stronghold at Gheriah on the western coast.

Clive reached Madras in June 1756. He immediately became involved in the affairs of Bengal, with which, henceforward, his fate was to be linked. Hitherto Bengal had been ruled by the Mogul viceroys, progressively more independent of Delhi, and under their protection the English East India company carried on its trade. The principal city, Calcutta, had come to rival Madras as a trading centre and its commerce was the most valuable in India. In 1756 a dispute with the British about fortifying the city caused the new nawab of Bengal, Siraj-ud-Daula, to attack and capture the fort there (*see* Calcutta: *History*). It was this situation which Clive was now called upon to remedy.

News of the fall of Calcutta reached Madras in Aug. 1756. After some delay Clive was given command of the relief expedition and set out on Oct. 16, 1756, with 900 Europeans and 1,500 Indians conveyed by Adm. Charles Watson's fleet. He was supremely self-confident; "it is by far the grandest of my undertakings," he wrote to his father. He felt the touch of destiny and he was not mistaken. The Calcutta fugitives were rescued in December, Calcutta itself taken on Jan. 2, 1757, and peace made with the nawab on Feb. 9, 1757. There was to be restoration of the company's privileges, compensation for losses and permission to fortify Calcutta, the original bone of contention. In so acting, Clive recognized the difficulty of his position, with the French in danger of becoming Bengali allies, the company demanding peace and cooperation with Admiral Watson a matter of some delicacy. Clive refused to return to Madras and used the time thus gained to eliminate the French settlement of Chandernagore. Siraj-ud-Daula stood by for fear of the Afghans who had just sacked Delhi. Clive then determined to take advantage of discontent with the nawab's regime, follow the French precedent in the Deccan and sponsor a new ruler in order to ensure conditions agreeable to the company's trade. Clive's candidate was Mir Jafar, an elderly general secretly hostile to Siraj-ud-Daula. At the last moment one of the conspirators, Omichund (Amin Chand), threatened to divulge the secret and was silenced by explicit promises of reward in a doctored copy of the secret agreement with Mir Jafar. Clive then broke with Siraj-ud-Daula and overthrew him on June 23 at the battle of Plassey. The night before the battle was the only time he showed any signs of indecision. The conflict was more of a cannonade than a battle; only 23 of Clive's men were killed, and Mir Jafar held aloof until treachery had decided the issue. It was a trial of nerves rather than of arms. Nevertheless, the issue was decisive. Clive was now the virtual master of Bengal.

Clive's first government lasted until Feb. 1760. He was confirmed as governor by the company and went about his business with explosive energy. His first task was to buttress Mir Jafar's authority. The rumoured treasure of £40,000,000 turned out to be no more than £1,500,000 and the nawab, finding difficulty in fulfilling his financial obligations, looked to the treasuries of his Hindu officers to fill the gap. The Hindu-Muslim conspiratorial alliance was thus strained and Clive had to protect the Hindu officers from Mir Jafar and Mir Jafar from further intrigues. Another source of danger came from the Mogul crown prince, but he was repulsed from Patna in 1759. The Dutch, who sought to play on the nawab's discontent, sent a force to their settlement at Chinsura, but through a series of adroit moves Clive destroyed this force even though England was at peace with the Netherlands. By 1760 Mir Jafar's authority was unchallenged throughout Bengal and Bihar, and his subservience to the company was complete. In addition, by the dispatch of a force under Col. Francis Forde in 1758, Clive secured the Northern Circars from the French garrison left by Charles de Bussy.

Clive's second task was to settle the company's affairs. In this he was less fortunate. First, he accepted not only full compensation for loss to the East India company and the Calcutta citizens, but also large payments to himself and the council. He himself received in all £234,000 in cash, a Mogul title of nobility and an estate or jagir with an annual rental of about £30,000. It was a venal age, but this example opened a flood of corruption which nearly ruined both Bengal and the company, and which Clive himself later struggled manfully to control. Second, he obtained from the nawab the practical exemption from internal duties, not only of the company's goods, but also of the private trade of the company's servants as well. Since the company possessed paramount force and its servants believed "in doing themselves justice," this had a most harmful effect on the economy of Bengal.

Though stained by corruption and duplicity, Clive's first government was a tour de force of generalship and statecraft. He had snatched the richest province of India over the heads of his political superiors and with the authority of the Mogul regime. The more sinister fruits were yet to appear. Returning to England in Feb. 1760, he was given an Irish peerage as Baron Clive of Plassey in 1762 and knighted in 1764. He was described by William Pitt (afterward earl of Chatham) as "a heaven-born general."

He became member of parliament for Shrewsbury, purchased an estate and cultivated a parliamentary interest. It would seem that he hoped to use his Indian wealth to carve out an English political career. But he had to reckon with the current jealousy toward any upstart, however brilliant, the unpopularity of returned Indian "nabobs" and suspicions within the East India company resulting from his suggestion to Pitt that the state should take over its territories. He had an Achilles heel in his jagir, because its income, necessary to further Clive's political ambitions, depended on the good will of the East India company. His critics, led by his former friend Lawrence Sulivan, chairman of the company since 1758, succeeded in limiting its tenure to ten years. They failed to ruin Clive, but they prevented him from becoming a national statesman. His energy and money were wasted in buying votes in the company's court of proprietors to influence the annual elections of the directors.

Second Government in Bengal.—In 1764 opinion within the company turned in Clive's favour because of the news from India. Clive's protégé Mir Jafar had been deposed in favour of Mir Kasim who in turn had been deposed in 1763. Shah Alam, the Mogul emperor, attacked again and the company seemed to be on the brink of disaster. Clive was appointed governor and commander in chief of Bengal with power to override the council. He arrived in Calcutta for the second time on May 3, 1765. He found that the decisive battle of Buxar (Baksar) had already been won; Shuja-ud-Daula, the nawab of Oudh, was in flight and the emperor had joined the British camp. However, there was a political and military vacuum between Bengal and Delhi and the whole Bengal administration was in confusion.

Clive's chief claim to fame as a statesman rests upon the achievements of his second governorship. His work falls into three parts: external policy, the settlement of Bengal and the reform of the company's service. In his external policy Clive had to face one of the most difficult tests of statesmanship: that of knowing where to stop. There was nothing to prevent him from restoring Shah Alam to Delhi and ruling north India in his name as the Marathas did later, but he wisely decided to limit the company's commitments to Bengal and Bihar. Oudh was returned to Shuja-ud-Daula as a buffer state between Bengal and the turbulent northwest. The emperor was solaced with Allahabad and Korah and an annual tribute; in return he conferred the revenue administration or dewanee of Bengal on the East India company. This grant formed the key to Clive's second achievement, the settlement of Bengal. It gave legal authority to the company to collect the revenues of Bengal and Bihar, sending only an annual tribute to the emperor. The administration of the dewanee was organized through a deputy nawab appointed by the company. The police and magisterial power was still exercised by the nawab of Bengal as the emperor's deputy, but he in turn nominated the company's deputy to act for him. This was Clive's famous "dual system" which made the company the virtual ruler of India's two richest provinces. It was the real beginning of the British empire in India.

Clive's third task was the reform of the company's service. Within two days of landing he superseded the Calcutta council, which had defied his predecessor, Henry Vansittart, and had gone to war over his head. He re-established discipline by accepting all resignations, enforcing others and bringing replacements from Madras. All company servants were required to sign covenants not to receive presents worth more than Rs. 1,000 (about £100) without the consent of the governor. Private trade, abuses of which had caused the war, was forbidden. This was the least successful measure because the company's officials were not adequately paid and had no other means of livelihood. Clive tried to meet the difficulty by forming a Society of Trade which administered the salt monopoly and in which the servants received shares according to their rank. These two measures were only partially successful, but they marked the end of nearly ten years' reckless plunder in Bengal. Finally Clive dealt with the army with equal rigour. He cut down swollen allowances and faced with dauntless courage the "White mutiny" of discontented officers, when for a time he stood almost alone in Bengal.

Attacks in England.—Clive left Calcutta in Feb. 1767. His second government was his crowning achievement, but it was deeply resented by those who regarded him as a poacher turned gamekeeper. His enemies had friends in the court of directors and awaited their opportunity. At first he was welcomed and was voted an extension of his jagir for another ten years. But there grew an active group, supported by Lord Chatham himself, who feared the corrupting influence of Indian wealth on English public life. This group joined with Clive's enemies when in 1772 the company appealed to the government to save it from bankruptcy. It appeared now that Clive's system of government in Bengal had not been as successful as had been hoped. Two parliamentary committees uncovered the facts of corruption among the company's servants, and this set off an attack on Clive as the instigator of the whole process. He defended himself in parliament (1772) with characteristic vigour and conviction, complaining of being treated like a sheep stealer and declaring "I stand astonished at my own moderation." After an all-night debate it was declared that he "had rendered great and meritorious services to his country." This triumph was his last. With his already shaken health, the strain on his melancholic temperament was too great: on Nov. 22, 1774, he died by his own hand at his house in London.

Clive suffered from reaching the top too soon. The faults of his first years in Bengal were those common in his day, magnified out of proportion, rather than heinous offenses. When maturity came he found himself enmeshed in the consequences of his early mistakes. His talents were outstanding, his character no more unscrupulous than that of many men of his day. He must equally receive the credit for the acquisition of Bengal and bear the blame for the temporary ruin of the province.

Clive's son and successor Edward (1754–1839) was created earl of Powis in 1804.

See INDIA-PAKISTAN, SUBCONTINENT OF: *History; see* also references under "Clive, Robert Clive" in the Index.

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CLOACA, the Latin term for a drain or sewer. The most famous is the Cloaca Maxima at Rome, built to drain the marsh where the Forum Romanum was situated. The Cloaca Maxima was constructed originally in the late 6th century B.C. as an open stone-lined channel; some side channels were vaulted in the 5th century; the main channel was vaulted in the 3rd century and later with a stone barrel vault.

Cloaca is also the name given to the joint opening of the urinogenital and alimentary systems characteristic of all the vertebrates except the mammals, among which it is retained only in the monotremes.

CLOCK, a machine designed to record or indicate the time of day. The way to construct such a machine is to link a device that performs regular movements in equal intervals of time to a counting mechanism that will record the number of these movements. All clocks, of whatever form, are made on this principle.

An ordinary clock consists of a series of toothed wheels and pinions (small toothed wheels) driven by a weight or spring and linked by an escapement (*see* below) to a pendulum or, alternatively, to a balance and hairspring, which has the property of even, isochronous motion. Such a machine, though popularly called a clock, is strictly a timepiece, the term clock being properly applied only to a timekeeper which, by an additional mechanism, strikes the hours on a bell or gong.

The earliest known timekeepers are the sundials (*q.v.*) and water clocks (*see* CLEPSYDRA) of ancient Egypt, and devices of the same type were in use throughout the periods of the Greek and Roman empires, whence they passed to medieval Europe. A parallel development of water clocks on somewhat different lines took place in China between about A.D. 100 and 1100. The origin of the all-mechanical escapement clock is still unknown; there are various references to public striking clocks in Europe from about 1290 onward, perhaps the first definite one being in Milan in 1335.

The oldest surviving clock in England is that at Salisbury cathedral, which dates from 1386. A clock erected at Rouen, France, in 1389 is still extant and one built for Wells cathedral in 1392 is now in the Science museum, London. The Salisbury clock strikes the hours and those of Rouen and Wells also have quarter chiming mechanisms. Other clocks of somewhat later date are at Cotehele house, Cornwall and Rye church, Sussex. These clocks were large iron-framed structures. They were operated by means of a mechanism known as a verge, or crown wheel, escapement controlled by an oscillating weighted bar, a device which preceded the pendulum by more than 300 years (*see* fig. 1).

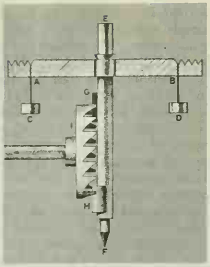


FIG. 1.—FOLIOT BALANCE CONTROL MECHANISM (*See* TEXT)

A crossbar, or foliot, AB carries two regulating weights CD and is mounted on a vertical spindle EF carrying two projections or pallets, GH. As the foliot swings to and fro, the teeth of the escape wheel I are released one by one. As each tooth is released it gives an impulse to the pallet and thus keeps the foliot swinging. The time of a swing depends on the driving weight and even on the shape of the individual teeth of the wheel, so that the accuracy of foliot clocks was low and their errors must have been as large as half an hour per day.

The first domestic clocks were smaller versions of these large public clocks. They appeared late in the 14th century and few examples have survived, most of them extremely austere in design. Domestic clocks of a much more pleasing appearance were made in the 15th century, and spring drive first appeared toward the end of that century. While this made clocks portable, it brought its own mechanical problems: the driving force of a weight remains constant but that of a spring is greater when it is fully wound than when nearly run down. Methods of compensating for this varying force were at once devised; the one usually employed was the "fusee," which gave an almost perfect compensation (*see* WATCH: *The Mainspring*).

The surviving spring-driven clocks of the early 16th century are in the form of flat metal drums or square boxes with the dial on the upper face, but about the middle of the century the vertical type, with the dial on one of the side faces of the case, came into use. Although a few wooden-cased clocks were made on the European continent from the late 16th century onward, wooden cases were the exception rather than the rule until after the invention and application of the pendulum.

The Pendulum.—About 1582 Galileo (1564–1642) noticed the characteristic timekeeping property of the pendulum and later attempted to apply it to clock mechanism. It was, however, the Dutch astronomer and physicist Christiaan Huygens (1629–95) who was responsible for its general application as a time controller in clocks from 1656 onward.

The great virtue of the pendulum as a time measurer lies in the fact that, for small arcs of swing, its period of swing depends only on the length of the pendulum and is almost independent of the extent of the arc. The length of a pendulum beating seconds with a fairly heavy bob and a light rod is about 39 in., and an increase in length of .001 in. will make the clock lose about one second per day. Altering the length of a pendulum is therefore a sensitive means of regulation. The alteration is usually carried out by allowing the bob to rest upon a nut which can be screwed up or down the pendulum rod.

Any expansion or contraction of the rod caused by changes of temperature will affect the timekeeping of a pendulum; *e.g.*, a pendulum clock with a steel rod will lose one second per day for a rise in temperature of 4° F., and will gain one second per day for a similar fall in temperature. If accurate timekeeping is required, the pendulum must be compensated by some device which will keep its length as constant as possible. This may be done in several ways, some of which use the differing coefficients of expansion of different metals to obtain a cancelling-out effect. The most usual forms of this type of compensation are the mercurial, in which the bob consists of a glass or metal jar containing a suitable amount of mercury; the gridiron, in which brass and steel rods are employed; and the zinc-iron tube, in which the pendulum rod is made up of concentric tubes of zinc and iron. A better method, however, is to make the pendulum rod from a special alloy called Invar. This material has such a small coefficient of expansion that small changes of temperature have a negligible effect.

The escapement of a pendulum clock usually consists of two parts: an escape wheel of special shape geared to the clock's main train of wheels, and an oscillating system linked with the pendulum and carrying two projections or pallets which engage alternately with the teeth of the escape wheel. The wheel is allowed to escape through the pitch of one tooth for each double swing of the pendulum, and in escaping it transmits an impulse through the pallets to the pendulum to keep it swinging and make up losses of energy due to friction. An ideal escapement would perform both functions without interfering with the free swing; the more closely an actual escapement approaches this standard, the better it is.

When first introduced, the pendulum was used with the verge escapement like that shown in fig. 1, but adapted to pendulum control. In a short time the verge was replaced by the anchor or recoil escapement, which was a great improvement and is still used for many domestic clocks (fig. 2).

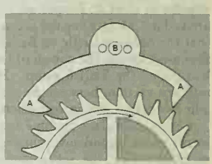


FIG. 2.—RECOIL ESCAPEMENT (*See* TEXT)

The recoil escapement has two pallets A mounted on the ends of a curved bar or yoke B that spans a part of the circumference of the escape wheel. At a point approximately equidistant from both pallets, the yoke is attached to a pivoted spindle linked to the pendulum by a light bar, or crutch. As the pendulum swings it causes the pallet spindle to oscillate, and this in turn engages and disengages the pallets with the teeth of the escape wheel, so permitting the wheel to advance in a step-by-step motion. The inclined acting faces of the pallets not only arrest and release the teeth of the escape wheel but also transmit to the pendulum in the form of impulses some of the energy used to drive the clock. Because of the construction of the pallets, however, any additional swing made by the pendulum after a tooth has engaged with them causes the escape wheel to recoil. This defect was modified by a device known as the deadbeat escapement (fig. 3) invented in 1715 by George Graham (1673–1751), who also devised mercurial compensation for pendulums.

In the deadbeat escapement the acting surfaces of the pallets have two distinct parts, known as the dead and impulse faces. The teeth of the escape wheel fall first upon the dead faces (GF and BD) and rest upon them before the movement of the pallets allows them to reach the impulse faces (AF and BE) and finally to escape.

The dead faces of the pallets are made in the shape of arcs of a circle whose centre is the pivot point C, so that as the pallet system moves with an escape wheel tooth resting upon a dead face, the escape wheel remains at rest. The wheel is then neither pushing the pallet nor recoiling from it, the only interaction being a slight friction. To minimize interference still further by reducing friction, the pallets of very precise clocks have pieces of jewel inserted in their acting faces.

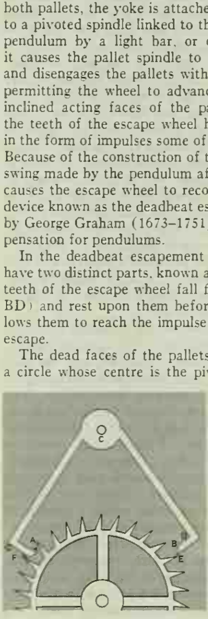
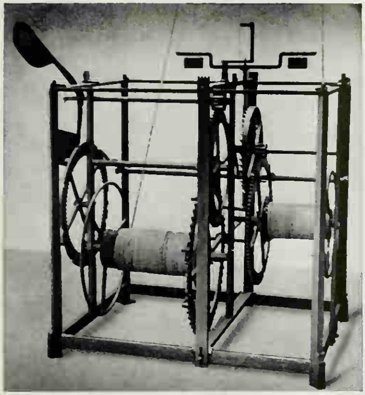
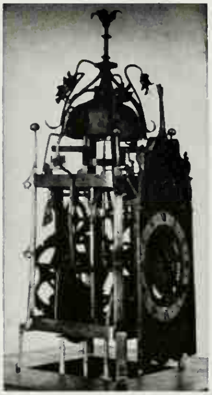


FIG. 3.—DEADBEAT ESCAPEMENT (*See* TEXT)

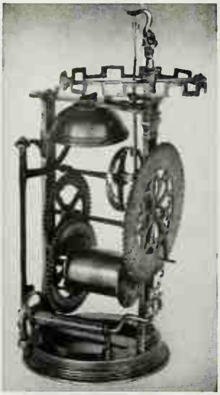
One of the defects of both the recoil and deadbeat escapements is that the impulse they transmit to the pendulum can vary because



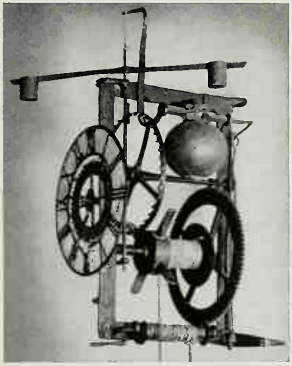
Mechanism of the Salisbury cathedral clock; dating from 1386, it is the oldest surviving clock in England



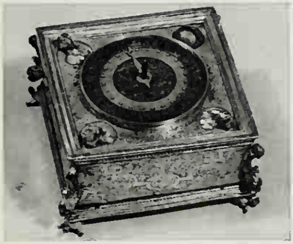
Gothic clock: Swiss, 1579. Victoria and Albert museum, London



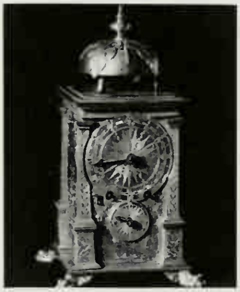
Monastic alarm clock; Italian, 15th century



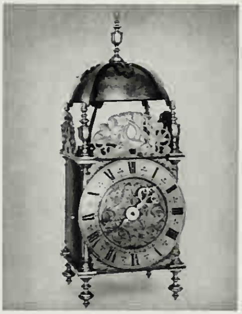
Alarm timepiece, early domestic clock; German, 14th century. Mainfränkisches museum, Würzburg, Germany



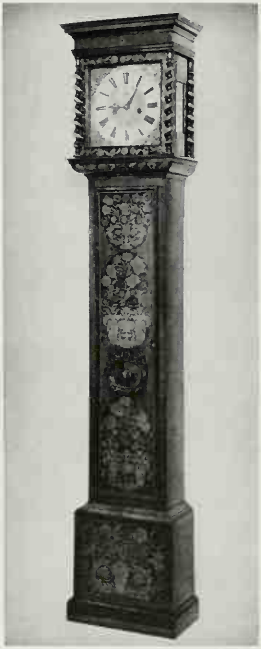
Horizontal table clock with dial designed to be viewed from above; German, 1548. Landesgewerbeamt museum



Vertical table clock; German, late 16th century. Landesgewerbeamt museum, Baden-Württemberg, Germany



Lantern clock; English, c. 1700. Science museum

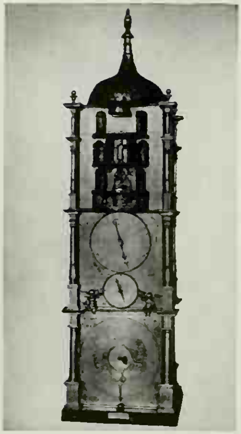


Long-case clock by Edward Speakman; English; 17th century. Science museum

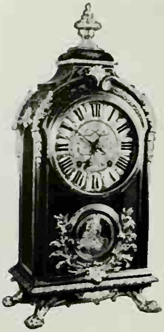
CLOCKS DATING FROM THE 14TH TO THE 18TH CENTURY

BY COURTESY OF (TOP CENTRE) VICTORIA AND ALBERT MUSEUM, LONDON, CROWN COPYRIGHT RESERVED, (TOP RIGHT) SCIENCE MUSEUM, LONDON, CROWN COPYRIGHT RESERVED, A. SIMONI, (CENTRE LEFT) MAINFRANKISCHES MUSEUM, WURZBURG, (CENTRE, BOTTOM LEFT) LANDESGEWERBEAMT, BADEN WURTTEMBERG, (BOTTOM CENTRE AND RIGHT) SCIENCE MUSEUM, LONDON, CROWN COPYRIGHT RESERVED; PHOTOGRAPH, (TOP LEFT) H. CHRIS NEWTON A.R.P.S.

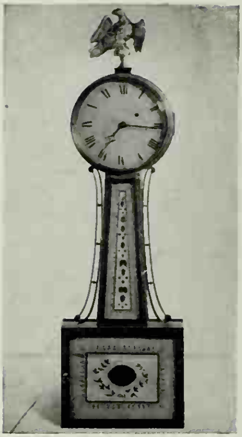
CLOCK



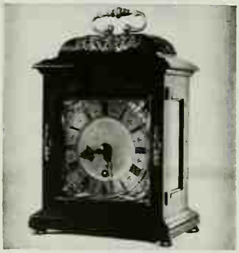
Astronomical clock by Isaac Habrecht; 1589. British museum, London



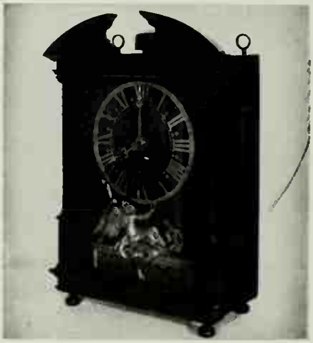
Bracket clock with buhl work; French, early 18th century. Victoria and Albert museum



Wall clock by Simon Willard; American, c. 1810. Museum of Fine Arts, Boston



Bracket clock with dome top by Thomas Tompion; c. 1690. Victoria and Albert museum



Pendulum clock; Dutch, late 17th century. Science museum, London

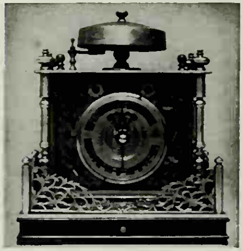
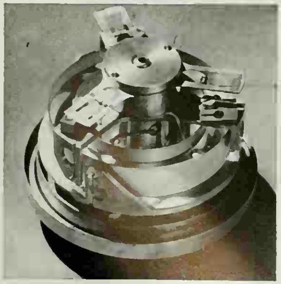
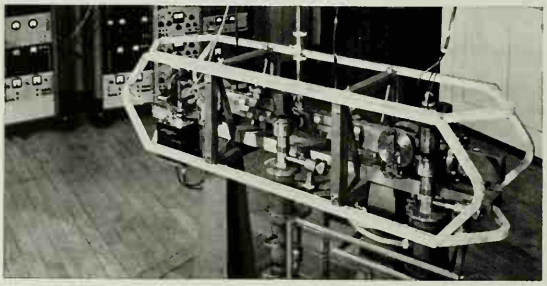


Table clock; Japanese, c. 1800. Owned by the executors of P. L. Harrison



Quartz ring, timekeeping element of a quartz-crystal clock. Diameter: about 2½ in.



Mechanism of cesium atomic clock which utilizes oscillations taking place in individual atoms to effect one of the most accurate means of keeping time

CLOCKS DATING FROM THE 16TH TO THE 20TH CENTURY

BY COURTESY OF (TOP LEFT) THE TRUSTEES OF THE BRITISH MUSEUM, (TOP CENTRE, CENTRE LEFT) VICTORIA AND ALBERT MUSEUM, LONDON, CROWN COPYRIGHT RESERVED, (TOP RIGHT) MUSEUM OF FINE ARTS, BOSTON, M. & M. KAROLIK COLLECTION, (CENTRE) SCIENCE MUSEUM, LONDON, CROWN COPYRIGHT RESERVED, (CENTRE RIGHT) SCIENCE MUSEUM, LONDON, LENT BY EXECUTORS OF P. L. HARRISON, ESQ., (BOTTOM LEFT) H.M. POSTMASTER GENERAL, U.K., (BOTTOM RIGHT) H.M. STATIONERY OFFICE, CROWN COPYRIGHT RESERVED

of variations in the power transmitted by the wheelwork. Such changes arise from thickening of the oil, from dust, wear or, in the case of tower clocks, wind pressure and snow or ice on the hands. To overcome this, a number of inventors designed escapements in which weighted arms were raised by the escape wheel and then delivered the impulse of the pendulum as they descended to their original position. The first really successful escapement of this kind was invented about 1853 by J. M. Bloxam, a barrister. A much better form, the double three-legged gravity escapement, was invented by E. B. Denison, afterward Lord Grimthorpe (1816–1905), and used by him for the great clock at Westminster, now generally known as Big Ben, which was installed in 1859. It has since become standard for all really accurate tower clocks.

Many domestic clocks are fitted with escapements embodying a balance and hairspring as the timekeeping element instead of a pendulum, thus making them more easily portable. The escapements used are the cylinder, lever and, in some cases, the chronometer detent. Their construction is identical with that of similar escapements used in watches and their general layout is that of a large watch. (*See* WATCH: *Escapements.*)

Clock Wheelwork: the Train.—With all but the gravity escapement, it is most important that the energy transmitted by the wheelwork should be as constant as possible and, even with a gravity escapement, a consistent supply of power is an advantage. The wheels and pinions must be made accurately and the tooth form designed so that the transference of power takes place as steadily as possible. Advances in gear design and manufacture have made present-day clocks far better than older ones in this respect.

In a weight-driven or spring-driven clock, the power of the weight or spring is first transmitted by the great or main wheel. This engages with the first pinion, whose spindle is attached to the second wheel which, in its turn, engages with the second pinion, and so on, down through the train to the escapement. The gear ratios are such that one spindle, usually the second or third, rotates once an hour and can be used to carry the minute hand. A simple 12-to-1 gearing, known as the motion work, gives the necessary step-down ratio to drive the hour hand. The spring or weight is fitted with some form of ratchet mechanism so it can be rewound when necessary, and the spindle carrying the minute hand is provided with a simple slipping clutch which allows the hands to be set to time.

Construction.—The timekeeping part of all clocks, including large tower clocks, is substantially the same. Figure 4 shows the side view of a simple weight-driven timepiece with a pendulum. The frame is made up of two plates which carry the pivots of the various wheels and other moving parts and are united and spaced by four pillars (Pi). The driving weight (W) hangs from a line coiled around the barrel (B) and is wound by means of the winding square K, slippage occurring (during winding) at the ratchet wheel (R). The main wheel (G) engages with the centre pinion (c) on the spindle of which is also mounted the centre wheel (C). The front pivot of this wheel and pinion is lengthened to the left of the illustration, and carries the minute hand and part of the gearing necessary to drive the hour hand.

The centre wheel (C) engages with the pinion of the third wheel (d) and on that same spindle is mounted the third wheel (D) which in its turn engages with the escape wheel pinion (e). The escape wheel (E) engages with the pallets (A), which are fixed to the spindle (a) and pivot between the front plate and the pendulum suspension cock (F). Also fixed to the pallet spindle is the crutch (Cr), which terminates at its lower end in a fork (Fo) which embraces the pendulum rod (P). This pendulum, of which only the upper part is shown, is suspended by a thin flat suspension spring (S) from the cock (F), which is reinforced to obtain the utmost possible rigidity by a bar (QQ) spanning the top of the frame plates.

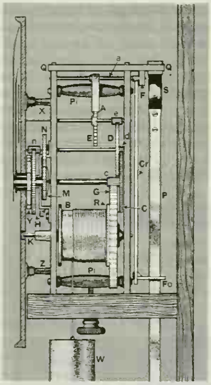


FIG. 4—WEIGHT-DRIVEN CLOCK (*See* TEXT)

The motion work used for driving the hands at their relative speeds is mounted between the dial and the front plate of the frame. The wheel (M), which rotates once an hour and is known as the cannon pinion, is coupled to the centre spindle by a flat spring which acts as a clutch and permits the hands to be set. The cannon pinion (M) engages with a wheel of similar size (N) called the minute wheel, and the small pinion (n) attached to this wheel engages with the hour wheel (H) that pivots on a small supporting bar, or bridge, (L). The winding square (K) is shown behind a hole in the dial plate, and the attachments of the dial plate to the mechanism are at X and Z. The wheel (Y) is connected with the striking mechanism, which consists of a hammer-lifting mechanism, equipped with a counting device, which strikes the hours on a bell or gong. It is released through a train of wheels by the action of the timekeeping part and is usually mounted in the same frame.

Tower Clocks.—In former times the frames of large timekeepers were made up of an assembly of bars fastened together in a sort of cage. For this reason they were known as birdcage-frame clocks. The standard frame now in use is the flat bed, in which the main part is a massive casting resembling a table or platform. The bearings of the various wheels are bolted in such a way that almost every part can be dismantled separately. The adoption of this improved design was largely due to Lord Grimthorpe, who used it for the great Westminster clock (*see* above). The timekeeping and striking parts of a tower clock do not differ very much from those of smaller clocks in basic design.

Hand-wound tower clocks are invariably driven by weights which are usually wound up to the full height of the tower. By the 1960s automatically wound clocks, in which a light weight is hung from an endless length of roller chain and rewound by an electric motor, had become almost standard. In most cases the striking and chiming mechanisms are driven directly by electric motors, which raise their hammers by cams that are rotated by the final spindle of an enclosed reduction gearing.

Sometimes the timepiece has no pendulum and escapement of its own but is released in half-minute steps by a trigger release device controlled by an electromagnet which is in turn connected to a precision master clock. This arrangement enables large dials to be driven accurately and is remarkably simple in construction. A good example is the great Shell-Mex clock on the Embankment, London, where two 25-ft. dials are operated.

Some tower clocks are driven by synchronous electric motors operated from commercial alternating current supplies and are similar to the synchronous clocks described below.

Electric Clocks.—Electric currents are used in two different ways—to replace the weight or spring as a source of power and as a means of signaling time indications from a central master clock to a wide range of distant indicating dials.

Although electric power is used to rewind the weights of a tower clock, it can be more readily applied to give direct impulses to the pendulum or to lift a lever after it has imparted an impulse to the pendulum. In various modern master clocks the pendulum operates a light count wheel, which turns through the pitch of one tooth every double swing and is arranged to release a lever every half-minute. This lever gives an impulse to the pendulum and is then restored to its original position by an electromagnet. The pulse of current which operates the electromagnet can also be transmitted to a series of distant dials, advancing the hands of each through the space of a half-minute. Thus a master clock can control scores of dials in a large group of buildings, as well as such other apparatus as time recorders and sirens.

Electrical master clocks of this type are good timekeepers, since the impulse can be given symmetrically as the pendulum passes through its middle position and the frictional interference with its motion is small. The most accurate mechanical timekeeper is the Shortt pendulum clock, which makes use of a movement of this type. It consists, in fact, of two separate clocks, one of which synchronizes the other. The timekeeping element is a pendulum which swings entirely freely except that once every half-minute it receives an impulse from a gently falling lever. This lever is released by an electromagnetic signal transmitted from its slave clock and, after the impulse has been given, a synchronizing signal is transmitted back to the slave clock which ensures that the impulse to the free pendulum will be released exactly a half-minute later than the previous impulse. The pendulum swings in a sealed box in which the air is kept at a constant, low pressure. Shortt clocks in observatories are kept in a room, usually a basement, where the temperature remains as constant as possible, and under these conditions their errors amount to only a few thousandths of a second per day.

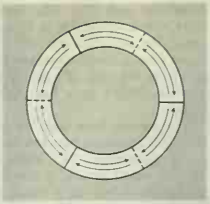


FIG. 5.—QUARTZ RING (*See* TEXT)

Synchronous Electric Clocks.—A clock of this type consists of a small electric motor coupled to a reduction gearing which drives the clock hands. The motor runs in step with the frequency of the alternating current, and so the hands move round at the correct rate. The frequency of commercial alternating current is so carefully controlled that the time shown is normally correct to within a few seconds.

Quartz Crystal Clocks.—In the clocks so far described the timekeeping element has been a pendulum or balance wheel which repeats a purely mechanical motion. Two other types of motion, whose regularity is even greater than that of the best pendulum or balance wheel, have been utilized to produce "quartz crystal" and "atomic" clocks.

The mechanical vibrations of quartz are accompanied by small electrical effects which can be amplified by electron tubes and transistors. A small amount of the amplified power is fed back to the crystal to keep it oscillating and make up for very small losses in internal friction. The timekeeping element of a quartz clock consists of a ring of quartz about 2½ in. in diameter which is suspended by six threads and is enclosed in a heat-insulated chamber. Electrodes are attached to the surfaces of the ring and connected to an electrical circuit whose oscillations are tuned to those of the ring. The vibrations form a stationary wave pattern around the circumference of the ring as shown in fig. 5. The frequencies of vibration are very high, of the order of hundreds of thousands per second, and are reduced by a frequency divider and applied to a synchronous motor connected to a clock dial through mechanical gearing.

If the crystal makes 100,000 vibrations per second and the combined electrical and mechanical gearing gives a reduction of 1 to 6,000,000, then the second hand of the synchronous clock will make exactly one rotation in 60 seconds. The vibrations are so regular that the error of an observatory quartz-crystal clock is only a few ten-thousandths of a second per day, equivalent to an error of one second every 10 years. Small portable clocks can be made accurate to about 1/30th of a second per day.

Atomic Clocks.—Accuracy exceeding even that of quartz crystal clocks can be attained by so-called atomic clocks, which utilize oscillations taking place in individual atoms. These small electrical and magnetic vibrations are almost wholly independent of normal external conditions and, as their frequencies are a property of the atoms themselves, they are identical for all atoms of the same kind.

In one of the most commonly used types of atomic clocks, the atoms used are those of cesium. In a magnetic field, each cesium atom behaves like a small magnet, the magnetic moment of its nucleus setting itself parallel or antiparallel to the field. The polarization of the atoms can be made to change direction if they are placed in an alternating magnetic field where the frequency of the alternations is equal to the natural frequency of the cesium atoms.

Figure 6 shows the basic technique used in a cesium atomic clock. A beam of cesium atoms emerges from the oven A, passes down the evacuated chamber and is deflected by a fixed magnet B to pass through the rapidly alternating magnetic field. If this field has the correct frequency, the polarization of the atoms will change direction and the atoms will then be deflected in the opposite direction by the second fixed magnet C, which will focus them on a detector D. If the alternating field is not of the correct frequency, the atoms will be deflected in the wrong direction at C. In practice, the frequency of the alternating field is varied slowly until the maximum response is obtained at the detector, and the frequency is then known to be exactly equal to that of the cesium atoms. The tuning is so precise that the frequency can be measured to 1 part in 30,000,000,000—equivalent to a discrepancy of one second in 1,000 years. This is the accuracy of the second cesium atomic clock installed at the National Physical laboratory at Teddington, near London. (*See* also TIME MEASUREMENT.)

Collections.—There are famous collections at the Science museum, the Victoria and Albert museum, the British museum and the Museum of the Clockmaker's company, Guildhall, London; Royal Scottish museum, Edinburgh; Musée du Conservatoire National des Arts et Métiers, Paris; Deutsches Museum, Munich, Ger.; Kunsthistorisches Museum, Technisches Museum für Industrie und Gewerbe, Uhrenmuseum der Stadt Wien, Vienna, Aus.; Klokkenmuseum, Utrecht, Neth.; and the James Arthur collection, New York university, New York City.

(T. R. B. R.; F. A. B. W.)

THE CLOCK IN DECORATION

Judged by modern standards, very early timekeepers seem crude; nevertheless they were serious contributions to the scientific life and thought of their day, and in consequence the best endeavours of the craftsmen were lavished upon them. The result was in most cases not merely a utilitarian piece of mechanism but a work of art.

Before the introduction of the pendulum, both the mechanism and the case were usually made of metal, most commonly brass and steel. However simple or elaborate the clock was, it was well finished, but many had fine engraving or overlaid ornament and much of it was gilt. The steel work came in for particular attention and many items were elaborately pierced or wrought, polished and blued. It is true that the earliest-known clocks would not have been so well finished, for they were constructed of wrought iron throughout and were entirely uncased. They persisted for many years in central Europe and are usually referred to as Gothic clocks. The family of Leichti of Winterthur, Switz., made a large number between 1550 and 1650. Gothic clocks may well have been the forerunners of the popular English lantern clocks, which they resemble, and which were made in considerable numbers

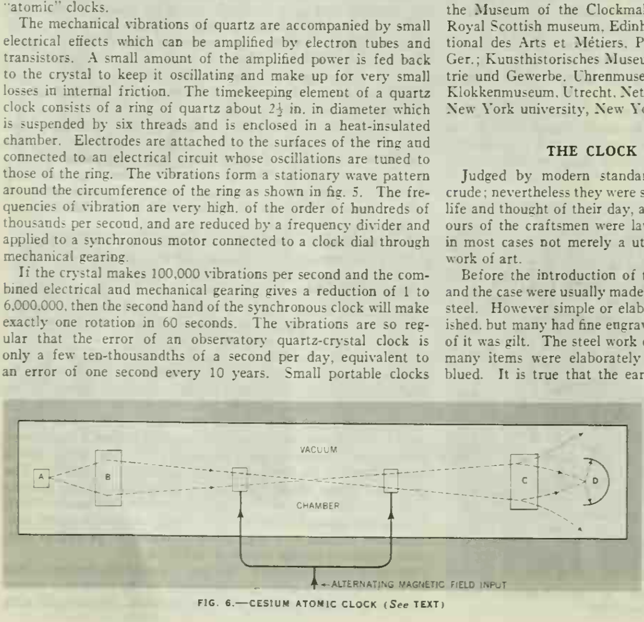


FIG. 6.—CESIUM ATOMIC CLOCK (*See* TEXT)

throughout the 17th and 18th centuries. However, these were constructed almost entirely of brass.

The general adoption of wooden cases for clocks dates from the introduction of the pendulum in 1657. (*See* above.) This invention originated in Holland, where the first clockcases were little more than rectangular boxes hung on the wall. Makers such as Ahasuerus Fromanteel and Edward East, who developed the new mechanism in England, greatly improved the appearance of the clockcase by adding architectural detail and finely finished moldings. The more highly developed designs were completely architectural and were enriched with gilt metal mounts. It was these early makers who started the tradition for artistic clockcase design that many generations of English clockmakers followed. The cases were constructed of oak and veneered with ebony. Although the anchor escapement using the long pendulum was not introduced until about 1670, weight-driven long-case clocks were made before that date having a verge escapement and short pendulum. These early long-cases were extremely slender.

In the 1670s, ebony was used less frequently as a veneer for long-cases, and olivewood, usually used in conjunction with inlaid box and ebony or small panels of simple marquetry, became popular. The dial was normally of brass and was ten inches square. The chapter ring (the circle containing the numerals) was silvered; the corners enclosed between the outside of the circle and the frame, known as spandrels, had gilt cupid-head mounts. Walnut soon superseded olivewood in popularity and was used with and without marquetry panels. As the 17th century drew to a close the marquetry panels tended to cover larger areas and the detail became more elaborate. At the end of the century the standard long-case dial was 12 in. square.

During the same period (1670–1700) most spring-driven clocks were veneered with ebony. The architectural basis of design was discarded and the small, dome-topped case with a carrying handle took its place, a style characteristic of the clocks of Thomas Tompion. Toward the end of the century these cases were often lavishly ornamented with gilt mounts, the entire dome sometimes being of *repoussé* brass.

Early in the 18th century the break-arch dial (in which the square dial has a semicircular addition at the top) was introduced and the spring clock became taller in proportion. Decorative woods gradually replaced a black finish for spring clocks but it was not until the second half of the century that mahogany was used in any quantity. Late in the 18th century a much greater variety of designs was used, influenced in part by the belated general introduction of the anchor escapement into spring-driven clocks.

Decorative woods, at first walnut and later mahogany, were used throughout the century for long-case clocks, while there was a short vogue for floral, arabesque and seaweed marquetry and for Chinese lacquer.

A number of attractive small mantel clocks, which utilized 30-hour watch movements, were made in the late 18th and early 19th centuries, but during the 19th century they were superseded by small eight-day pendulum and lever clock movements.

English provincial clock design has, in the main, followed the London fashions, with local variations of detail. The vast majority of oak long-case clocks are of provincial origin, the most prolific period being 1750–1850. The dials of these clocks are often enameled with painted decoration ranging from floral subjects to rural scenes.

In the early days of pendulum clocks, French design was very similar to the Dutch. The French flair for decoration, however, soon created distinctive styles. The use of boulle work was one of the first departures from the soberness of Dutch design, while in the 18th century ormolu was increasingly used.

American design stems from the English and frequently bears a relation to the London designs similar to that of the English provincial work. However, early in the 19th century really distinctive designs emerged with the Banjo clock of Simon Willard and the shelf clock of Eli Terry.

See also references under "Clock" in the Index volume.

(P. G. D.)

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(F. A. B. W.)

CLODION (CLAUDE MICHEL) (1738–1814). French sculptor, very prominent in the rococo movement, was born on Dec. 20, 1738, in Nancy. In 1755 he went to Paris and entered the workshop of Lambert Sigisbert Adam, his uncle, and on his death became a pupil of J. B. Pigalle. In 1759 he obtained the grand prize for sculpture at the Académie Royale de Peinture et de Sculpture; and in 1762 he went to Rome. Catherine II was eager to secure his presence in St. Petersburg, but he returned to Paris in 1771. There he had a success and frequently exhibited at the Salon. D'Angiviller, Louis XVI's architectural director, ordered a statue of Montesquieu from him (now in the Institut), intended to be one of a series of great Frenchmen.

Clodion worked mostly in terra cotta, his preferred subject matter being nymphs and satyrs, bacchantes, Nereids, etc. He was also (with his brothers) a decorator of objects such as candelabra, clocks and vases. Perhaps because of his apparent unwillingness to be seriously monumental he was never admitted to the Académie Royale. Nevertheless, after the Revolution had driven him in 1792 to Nancy (where he lived until 1798), he was flexible enough to adapt himself to the new neoclassic tendency. The relief on the Arc de Triomphe du Carrousel, representing the entry of the French into Munich, is an example of this. Among his many patrons were the chapter of Rouen, the states of Languedoc and the *Direction générale*. One of his last groups represented Homer as a beggar being driven away by fishermen (1810).

Clodion died in Paris on March 29, 1814. (A. K. McC.)

CLODIUS, PUBLIUS (surnamed PULCHER) (*c.* 93–52 B.C.), a disruptive politician and gangster in late republican Rome. Sprung from two distinguished families, the Appii Claudii and the Caecilii Metelli, he adopted the spelling *Clodius* instead of *Claudius*, and his three sisters, one of whom was the Lesbia of Catullus' poems, did likewise. Serving under his brother-in-law L. Lucullus against Mithradates, he instigated the troops to mutiny in winter 68–67. In Dec. 62, when the winter ceremony of the Bona Dea, from which men were excluded, was celebrated in the house of Julius Caesar, a man was discovered in the house disguised as a female harpist. The senate instituted a trial for *incestum* (on the ground that the offense was akin to misconduct with a Vestal Virgin), and in 61 Clodius, then quaestor, was prosecuted and acquitted, whether because the jury had been bribed, or because they were unconvinced by the evidence of Caesar's mother. Clodius claimed to have been at Interamna, 90 mi. from Rome. Cicero, who abused Clodius intemperately and gave evidence to break his alibi, was ultimately the chief sufferer from the case, for Clodius set out to prosecute him on a capital charge for the execution in Dec. 63 of the associates of Catiline (*q.v.*). Clodius was adopted into a plebeian family in 59, and elected tribune for

58. Of his tribunicial legislation, the abolition of payment for the monthly corn ration at Rome was a vote-catching measure, but other bills were defensible, such as that which put an end to such unprincipled obstruction of public business on religious grounds as Bibulus (*q.v.*) had practised in 59. In March he re-enacted a series of laws forbidding execution of a Roman citizen without trial, after which, Cicero having fled from Rome, he passed a second law declaring Cicero an exile.

In the following two years Clodius worked for Caesar, then in Gaul, to ensure that Pompey did not abandon his political alliance with Caesar in favour of the *optimates* (*see* Caesar, Gaius Julius); this he did by repeatedly frightening Pompey into the belief that his life was in danger.

A tribune of 57, T. Annius Milo, who did much to secure Cicero's recall from exile in that year, organized gangs to counter those of Clodius. As aedile in 56, Clodius made an abortive attempt to prosecute Milo for disorderly conduct. In Jan. 52 he was killed in a running fight on the Appian way at Bovillae. His body was cremated in the senate house, which was burned to the ground. Milo was prosecuted, defended unsuccessfully by Cicero, and went into exile.

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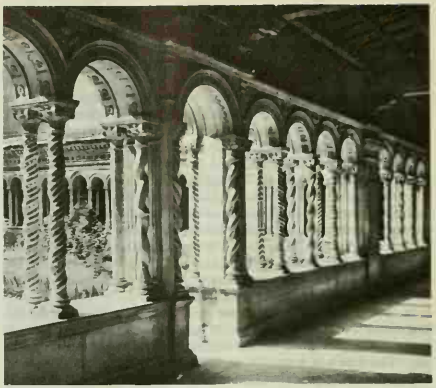
CLODOMIR (495–524), one of the Merovingian kings in France, was the eldest son of Clovis and Clotilda. In the division of territory that followed the death of Clovis in 511, he obtained the Loire valley from Orléans to Tours and the cities of Chartres, Sens, Auxerre and Poitiers. In an attack on the Burgundians in 523, he captured and murdered their king Sigismund, but he was himself killed in the battle of Vézeronce, near Vienne, on June 25, 524. To secure his inheritance his brothers Childebert I and Clotaire I then murdered all his young children save one, Clodoald, who escaped to become a monk and was the founder, at Nogent-sur-Seine, of the monastery later named after him, St. Cloud. (Je. H.)

CLOG DANCE, a type of solo step dance performed in clogs in which the dancer marks the rhythm by tapping with the toes and heels. The clogs used are a light form of the wooden-soled clogs once common in industrial areas of northern England, southwest Scotland and south Wales. Clog dances were performed in all these regions by men and girls from at least 1870, but since about 1930 they have survived only in Northumberland and Durham. Clog dancing probably originated in Lancashire, for the two most widely distributed clog dances are the Lancashire and Liverpool Hornpipes. Clog dancing, after being introduced into the U.S., became one of the basic elements in the development of tap dancing. *See* Tap Dance. (T. M. Fl.)

CLOGHER (Clochar Mac nDaimhín), a village in the Clogher valley, County Tyrone, N.Ire. Pop. (1961) 197. It gives its name to the dioceses of the Church of Ireland and the Roman Catholic Church, the Protestant cathedral being dedicated to St. Macartin, an associate of St. Patrick. Myler Magrath, the pluralist, was the first Protestant bishop in Elizabethan times. Clogher was a parliamentary borough under the old Irish parliament. The name may be derived from *clochoir*, a "stone of gold," as there is a tradition of a local stone cult until the 15th century; or simply *clochar*, a "stony place." The novelist William Carleton (*q.v.*) was born at nearby Prillisk in 1794. (Hu. S.)

CLOISTER, most commonly an enclosure surrounded by covered ambulatories, usually attached to conventual and cathedral churches and sometimes to colleges. The term is also used in a narrow sense of the ambulatories themselves, in a general sense of monasteries as a whole, and in a generic sense to denote places of retreat for religious purposes (in contrast to convent, which emphasizes more the idea of community life).

Generally speaking, a cloister is the quadrilateral area in a monastery around which the principal buildings are ranged, and which is usually provided with a covered way or ambulatory running all around and affording a means of communication between various centres of the ecclesiastical establishment. In developed medieval practice, cloisters usually followed either a Benedictine or a Cistercian arrangement.



ALINARI

CLOISTER OF ST. PAUL'S OUTSIDE THE WALLS, ROME, DESIGNED BY GIOVANNI COSMATI IN THE 13TH CENTURY

According to the Benedictine arrangement, which from its suitability to the requirements of monastic life was generally adopted in the west, one side of the cloister was formed by the church, the refectory occupying the side opposite to it, so that the worshipers might have the least annoyance from noise or smell. On the eastern side the chapter house was placed, with other apartments adjacent to it, belonging to the common life of the brethren, and, as a rule, the dormitory occupied the whole upper story. On the opposite or western side were generally the cellarer's lodgings with the cellars and storehouses in which the necessary provisions were housed.

In Cistercian monasteries the western side was usually occupied by the *domus conversorum* or lodgings of the lay brethren, with their day rooms and workshops below the dormitory above. The cloister, with its surrounding buildings, generally stood on the south side of the church, to secure as much sunshine as possible, although local requirements occasionally caused it to be placed on the north.

The cloister of a religious house was the scene of a large part of the life of its inmates. It was the place of education for the younger members and of study for the elders. A canon of the Roman council of 826 enjoined the erection of a cloister as an essential portion of an ecclesiastical establishment for the better discipline and instruction of the clerks. Peter of Blois described schools for the novices as being in the west walk, moral lectures being delivered in that next the church; stone benches running along the side provided places for auditors to sit. At Canterbury the monks' school was in the western ambulatory, and it was there that the novices were taught at Durham. The other alleys, especially that next to the church, were devoted to the studies of the elder monks. For this purpose small studies (known as "Carols" or "Carrels") were often found in the recesses of the windows, and in the cloister, too, supplies of books were kept. Particularly in rainy weather, the cloister served for exercise and general recreation. And in its central area and alleys were the customary places of burial.

Larger monastic establishments commonly had more than one cloister; there was usually a second connected with the infirmary, of which there are examples at Westminster abbey and at Canterbury, and sometimes one giving access to the kitchen and other domestic offices. The cloister was not an appendage of monastic houses exclusively. It was also attached to colleges of secular canons, as at the cathedrals of Lincoln, Salisbury and Wells, and a cloister forms an essential part of the colleges of Eton and Winchester, and of New College and Magdalen at Oxford.

Historically, the earliest cloisters consisted of open arcades, usually with sloping wooden roofs. This earliest form of cloister was generally superseded in England by a range of windows, usually unglazed but sometimes, as at Gloucester, provided with glass, lighting a vaulted ambulatory, of which the cloisters of Westminster abbey, Salisbury and Norwich are typical examples. In southern climates, the open-arcaded cloister remained standard; of this type are the cloisters at Le Puy-en-Velay and Arles in southern France (the columns of which are among the finest pieces of Romanesque sculpture), and Laach in Germany.

It was in Italy, however, that the open cloister attained fullest development. Fine examples are the cloisters of St. John Lateran and St. Paul's Outside the Walls at Rome, where the coupled shafts and arches are richly ornamented with ribbons of mosaic. Perhaps the finest example of all was the Campo Santo at Pisa, which consisted of four ambulatories as wide and lofty as the nave of a church, with inner walls covered with important early Renaissance frescoes; it was damaged beyond full repair during World War II.

Of Renaissance cloisters, the most significant was perhaps the one Donato Bramante designed for the church of Sta. Maria della Pace at Rome in 1504. Later Renaissance cloisters tended more and more to become duplicates of palace courtyards. *See* also Monastery. (An. G.)

CLONAKILTY (Clanna Chaoilte), an urban district of County Cork, Republic of Ireland, at the head of Clonakilty bay, 33 mi. S.W. of Cork by rail. Pop. (1961) 2,417. There are megaliths in the neighbourhood. Richard Boyle, first earl of Cork, granted it a charter in 1613, and in 1641 the town was almost destroyed in a fight between the English and Irish. Sam's Cross, about 3 mi. W. of Clonakilty, was the birthplace of Michael Collins (*q.v.*), the Irish politician and general.

There are castles at Galley head, Dunnycove and Dunowen. The linen industry was important in the 18th and 19th centuries but trade is now in agricultural produce. The harbour is obstructed but there is a pier for large vessels at Ring, 1 mi. below the town.

CLONMACNOISE (Cluain Mic Nois, "the meadow of the son of Nos"), a famous early Christian centre on the left bank of the Shannon, County Offaly, Republic of Ireland, 9 mi. S. of Athlone by river. After the foundation of an abbey by St. Ciaran (or Kieran) in 548, Clonmacnoise became the most famous of the Irish monastic cities, and by the 9th century it was a great centre of learning. Several books of annals, the oldest being those of Abbot Tigernach O'Braein (d. 1088), were compiled there. *Lebor na Huidre* or the *Book of the Dun Cow* (partly compiled there by Maelmiure about 1100) is a copy of an older collection of romances said to have been taken down by St. Ciaran on parchment made from the skin of his favourite cow.

The remains of the ecclesiastical foundation, called the Seven Churches of Clonmacnoise, still survive. The cathedral or Great Stone church (Daimhliag Mhór) was founded in 904 and rebuilt in the 14th century by Tomultach MacDermot; the other churches (*teampulls*) are those of Finian (or Finghin), Conor, St. Ciaran, Kelly, Ri (or Righ) and Dowling (named after Bishop Edmund Dowling). There are two round towers, O'Rourke's (62 ft. high) and MacCarthy's (56 ft.). The latter, the belfry of Finian church, has a doorway at ground level, an unusual feature. Of the three high crosses, the Cross of the Scriptures (13 ft. high) faces the door of the Great church. Many inscribed stones and elaborate sculptures of the 6th and 7th centuries and later are preserved in the churches. In 1957 these monastic ruins were transferred to the Irish government as a national monument. Clonmacnoise became a bishopric and there are remains of a castle (1214) and bishop's palace (13th century) which were destroyed by Oliver Cromwell's soldiery; in 1568 the diocese was merged with that of Meath. There is an annual pilgrimage to Clonmacnoise on Sept. 9, the feast of St. Ciaran.

CLONMEL (Cluain Meala, "meadow of honey"), a municipal borough and the county town of County Tipperary, Republic of Ireland, 105 mi. S.W. of Dublin by road, standing on both banks of the Suir. Pop. (1961) 10,617. A noted fishing and sporting centre (hunting, horse racing, coursing), it has fine scenery in its vicinity, with the Comeragh mountains on the south and Slievenamon close by. Clonmel, an ancient town chartered during the reign of Edward I, was besieged for two months by Oliver Cromwell in 1650.

Laurence Sterne (*q.v.*), the English humorist, was born in the town in 1713; George Borrow, the English traveler and author, attended the old grammar school. The town was the scene of the trial and execution of Father Nicholas Sheehy in 1766 and in 1815 Charles Bianconi made it the centre for a one-horse, two-wheeler passenger-car service in the south of Ireland.

Clonmel's industries include meat processing and the making of enamelware, tubular steel goods, perambulators, shoes and cider.

CLOOTS, JEAN BAPTISTE DU VAL-DE-GRÂCE, Baron de (Anacharsis Cloots) (1755–1794), revolutionary fanatic, was born near Cleves at the castle of Gnadenthal, on June 24, 1755, of a noble Prussian family of Dutch origin. His father placed him in the military academy at Berlin, but he left and went to Paris in 1776, where he took part in the compilation of the *Encyclopédie*. He left in 1784, traveled widely in Europe and returned to Paris at the outbreak of the Revolution. He then joined the Jacobin club and later became one of the founders of the cult of reason. On June 19, 1790, he presented himself to the constituent assembly at the head of 36 foreigners and, in the name of this "embassy of the human race," declared that the world adhered to the "Declaration of the Rights of Man and of the Citizen." After this he was known as "the orator of the human race," by which title he called himself, dropping that of baron and substituting for his baptismal names the pseudonym of Anacharsis, from the abbé J. J. Barthélemy's philosophical romance. In 1792 he placed 12,000 livres at the disposal of the republic "for the arming of 40 or 50 fighters in the sacred cause of man against tyrants."

In Sept. 1792 Cloots was elected to the convention. He voted for Louis XVI's death in the name of the human race. He was guillotined as an Hébertist on March 24, 1794.

See G. Avenel, *Anacharsis Cloots, orateur du genre humain* (1865).

CLOSE, MAXWELL HENRY (1822–1903), Irish geologist who devoted himself especially to the glacial geology of Ireland, was born in Dublin, Oct. 23, 1822. He was educated at Weymouth and at Trinity college, Dublin, took holy orders and held various charges in England, and in 1861 returned to Dublin. His paper, read before the Geological Society of Ireland in 1866, on the "General Glaciation of Ireland" is a masterly description of the effects of glaciation and of the evidence in favour of the action of land ice. Later he discussed the origin of the elevated shell-bearing gravels near Dublin, and expressed the view that they were accumulated by floating ice when the land had undergone submergence.

Close died in Dublin on Sept. 12, 1903.

CLOSED SHOP. The closed shop, in union-management relations, is an arrangement whereby the management employs, and retains in employment, only persons who are members in good standing of a specified labour (trade) union (*q.v.*). It is the most extreme variant of a series of arrangements for the protection of labour organizations, collectively known as "union security." Less extreme than the closed shop is the union shop, in which the employer may hire a nonmember of a union provided the new employee joins the union within a specified time. Another form of union security is known as preferential hiring. Under this arrangement the employer agrees to hire union members if they are available but, if qualified union members cannot be found, he may hire nonunion workers. Agreements for maintenance of membership provide that all persons in the employ of a company on a specified date who are then members of a union and who do not resign their membership within an "escape period" must remain members of the union for the duration of the agreement, under pain of dismissal from their jobs. These are the basic forms of union security, but in practice there are many detailed variations.

In the United Kingdom, and to a lesser extent in all other industrial nations, a closed-shop provision is seldom found in a written contract, but it is understood in some industries that union members will walk off the job before they will work with nonunionists. This is so commonly assumed among printers, dockers and miners in England that employers rarely attempt to employ nonunion workers. Throughout the nations of northern Europe, labour-management agreements are usually between large industrial segments and a number of unions. In England the closed shop has not been an issue for controversy to the same extent as in the U.S. since union membership of workers is taken for granted. This is assumed even by government boards and commissions, which expect unions to represent all employees in an industry.

Early History.—The closed shop is not a development of modern industry. Medieval British guilds prevented nonmembers from working and whenever possible, the 18th-century trade clubs did the same. Some of the guild regulations of the 16th and 17th centuries decreed that no guild journeyman was to work with a nonmember. These tactics were continued by British trade unions and were conveyed to America. The Cordwainers' society of the city of New York in 1804, the New York Typographical society in 1809 and, subsequently, other unions adopted bylaws forbidding members to work for employers hiring men who did not belong to their organizations or who worked for wages lower than the union scale. The chief weapons used by employers to combat unions until 1836 were old laws that declared combinations of workmen and strikes to be criminal conspiracies. By about 1840 the closed-shop rule had been adopted by the majority of U.S. trade unions. With the repeal or nullification of conspiracy statutes, employers formed local associations to resist the closed-shop movement.

After 1870 local trade unions in the United States gradually merged into national unions, the majority of which made the maintenance of the closed shop a vital rule. During the same period, especially in the last decade of the 19th century, employers formed national associations, one of the purposes of which was to maintain the open shop. Large factories locked out union men for demanding the closed shop. The American Federation of Labor declared in 1890 that the working of union with nonunion men was inconsistent, especially when nonunion men displaced unionists locked out or engaged in strikes. From 1850 to 1898 the major part of more than a dozen court decisions held that strikes for the closed shop were criminal or tortious. In spite of these decisions the unions continued to insist upon the closed shop.

Developments of the 20th Century.—The struggle over the closed-shop question reached an intense stage about 1901 when the unions insisted that employers sign written agreements conceding the closed shop. Previously the granting of the closed shop had been based upon custom or oral negotiation. Declaring that they would not accept "union dictation in the management of business," the large employers' associations aggressively campaigned to destroy the closed-shop system.

The award of the anthracite coal strike commission in the great coal strike of 1902 was of great moral assistance to manufacturers' associations; the commission granted practically every demand of the union except that for the closed shop. Encouraged by this stand, the National Association of Manufacturers in 1902 began a vigorous movement for the open shop. The American Federation of Labor reiterated that the trade-union movement stood for the union shop. Union after union endorsed the closed-shop principle. The proportion of strikes for recognition of trade unions and union rules more than trebled in succeeding years. By reducing employment, the panic of 1907 weakened the trade unions and gave corresponding advantage to employers. The campaigns carried on by the manufacturers' associations also caused a decided shift in public sentiment in favour of the open shop. By 1910 this was established in many industries, notably those which had been consolidated into powerful corporations. The open shop prevailed in the south.

There were several periods of ebb and flow in unionism during the four decades after the United States entered World War I in 1917. Certain main tendencies persisted, however. Union membership increased greatly, from 2,750,000 in 1916 to more than 17,000,000 in 1960. Collective bargaining was established in many industries that had previously been nonunion or open shop. There was widespread improvement of industrial relations as union and management became accommodated to each other and gained experience in collective bargaining. The scope of collective agreements expanded steadily to include not only wage rates and hours of work but also seniority provisions, paid vacations and holidays, retirement plans, and health and accident insurance. Despite these changes, the union security issue remained an active one and occasioned considerable industrial conflict.

"Union security" was probably the most frequent problem faced by the U.S. government in handling unresolved labour disputes during World War II. The National War Labor board (1942–45) developed the maintenance-of-membership formula as a compromise measure, and utilized the formula in thousands of disputes. By the end of the war almost 30% of the workers under union agreements were covered by maintenance-of-membership clauses. Some 45% were employed in closed or union shops, and 3% under preferential hiring arrangements. The remaining workers were in establishments where the union was recognized as the exclusive bargaining agent but did not enjoy formal union security protection.

In the Taft-Hartley act of 1947 the U.S. congress undertook for the first time to regulate union security agreements in private industry. The closed shop was declared illegal. Labour organizations were prohibited from negotiating union shop agreements unless authorized, in a secret ballot, by a majority of workers in the bargaining units. These restrictions, designed to guarantee the right to work and to protect rank-and-file employees from the unions, did not have the intended effect. During the first four years of the Taft-Hartley act, 97.1% of all union shop elections were won by the unions; 84.8% of eligible employees voted, and 91.4% of all voters cast affirmative ballots. Moreover, the proscription of closed shops was widely circumvented by various methods, particularly in the building construction, printing and maritime industries. By 1950, the proportion of unionized employees in closed, union or preferential shops had risen to 58%; and in 1951–52 union shop provisions were adopted in the rubber and steel industries and part of the railroad industry. The Taft-Hartley act was amended in 1951 to permit union shop contracts without first polling the workers.

Meanwhile, leaders of various industries and industrial associations organized a campaign for what they called "right-to-work" laws. Such laws declared the union shop to be illegal. Their proponents argued that a worker who did not choose to join a union should have the right to work wherever an employer might choose to hire him. Labour leaders countered with the argument that, where a union represents the employees in a shop, it is only fair that all of the employees share in the cost of being represented, that majority rule is an accepted practice in the American system, and that right-to-work laws were designed to injure unions rather than to protect the rights of workers. Since the campaign was designed to enact legislation, the issue quickly became embroiled in partisan politics. Right-to-work bills were introduced in legislatures throughout the United States and were enacted by 19 nonindustrial states. Elsewhere the proposed statutes were defeated and, by 1960, the campaign appeared to have lost its momentum.

In large segments of the U.S. economy, the legal prohibition of closed or union shops had lost much of its significance by the beginning of the 1960s. In most of the nation, in the larger industries (as, for example, building construction and the railroads), the closed shop had come to exist in practice even though forbidden by law to exist in a signed agreement. Many employers unquestioningly recruited their labour from union offices. In many cases no nonunion workers were available. In large areas, building trades workers refused to work with nonunionists, and the employer made no attempt to hire the latter. Union security agreements are much more general in the U.S. than in the United Kingdom and northern Europe where union membership is rarely enforced by specific agreement. In this sense, in spite of the illegality of the closed shop, trade union membership is made a condition of employment on a much broader scale in the U.S. than in Britain or Europe.

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CLOSURE: *see* PARLIAMENT: *Procedure in the House of Commons: The Closure.*

CLOT, ANTOINE BARTHÉLEMY (1793–1868), French physician, known as Clot Bey, was born at Grenoble on Nov. 7, 1793, and graduated in medicine and surgery at Montpellier. After practising for a time at Marseilles he was made chief surgeon to Mohammed Ali, viceroy of Egypt. At Abu-Zabel, near Cairo, he founded a hospital and schools for all branches of medical instruction, and for the study of the French language. In 1836 he was appointed head of the medical administration of the country. In 1849 he returned to Marseilles, though he revisited Egypt in 1856.

Clot died at Marseilles on Aug. 28, 1868.

CLOTAIRE, the name of four Frankish kings of the Merovingian dynasty.

CLOTAIRE I (*c.* 497–561) was the youngest son of Clovis and Clotilda. At his father's death (511) he received Soissons (which he made his capital), Laon, Noyon, Arras, Cambrai, Tournai, Maastricht and the lower Meuse basin. After the death of his brother Clodomir (524) and the murder of Clodomir's children, Clotaire acquired Tours and Poitiers. He took part in the wars against the Burgundians (523–534), capturing Autun, and in the eventual division of Burgundy received Grenoble, Die and adjacent territories. When the Ostrogoths ceded Provence to the Franks in 537, he acquired Carpentras, Gap and Orange. Prominent in the hostilities within the Merovingian family, he narrowly escaped murder by his brother Theuderic (Thierry) I in 531, attacked Theuderic's son Theudibert (Thibert) I in 534 and, when Theudibert allied himself with Childebert I against him *c.* 540, was only saved by Clotilda's intervention. Nevertheless he marched with Childebert against the Visigoths in 541. Clotaire fought constantly to defend his eastern border. He crushed the Thuringians near the Unstrut in 531 and captured and married their princess Radegunda; he reduced the Saxons to tributary status (555–556); and even the Bavarians may have acknowledged his overlordship. The death of Theudibert I's son Theudibald (Thibaut) in 555, followed by that of Childebert I in 558, left him sole master of the Frankish kingdom. His last years, however, were disturbed by the revolt of his son Chram, but he destroyed Chram's adherents in Brittany in 560 and had Chram and his family burned to death. Clotaire died at Compiègne late in 561 and was buried at Soissons.

CLOTAIRE II (d. 629) was the son of Chilperic I and Fredegund. An infant when his father was assassinated (584), he was nevertheless assured of the succession by his mother's power and the protection of his uncle Guntram, king of Burgundy. After Fredegund's death (597), his cousins Theudibert II, king of Austrasia, and Theuderic II, king of Burgundy, soon allied themselves against him; they destroyed his army at Dormelles, near Montereau (599 or 600) and took most of his kingdom. In 613, however, when Theudibert and Theuderic were dead, Clotaire drove deep into Burgundy, put their grandmother Brunhilda to death and finally established himself as ruler of the whole Frankish kingdom. At a council of bishops and magnates held at Paris he issued a notable edict (Oct. 18, 614). By this he extended the jurisdiction of ecclesiastical courts; promised specific administrative and fiscal reforms; confirmed the grants of land that he had made to the magnates; and agreed to select his counts from the districts that they would administer. Clotaire recognized the heterogeneity of Neustria, Austrasia and Burgundy, setting a mayor of the palace over each. He assigned much of Austrasia to his young son Dagobert as a separate kingdom in 623 and was obliged at Dagobert's majority to add to it the traditional Austrasian territories immediately west of the Vosges and the Ardennes, which, with Aquitaine, he had wanted to retain. The Burgundian magnates forced him to dismiss their mayor of the palace in 627. He died on Jan. 4, 629, and was buried in the monastery of St. Vincent in Paris.

In the chronicle of the Pseudo-Fredegarius, Clotaire is described as well-informed, devout, upright and a benefactor of the church, but immoderately fond of hunting and unduly susceptible to feminine wiles.

CLOTAIRE III (d. 673) succeeded his father Clovis II as king of Neustria in 657. At his majority (664) he was released from the tutelage of his mother Bathilda and of one mayor of the palace, Erchinoald, only to fall completely under the influence of the new mayor, Ebroin (*q.v.*). He died on March 10 or 11, 673.

CLOTAIRE IV (d. 719), of uncertain parentage, was perhaps a son of Theuderic III. He was placed on the Austrasian throne early in 718 by Charles Martel, mayor of the palace, in order to check the pretensions of Chilperic II, king of Neustria.

See F. Lot *et al., Les Destinées de l'Empire en Occident de 395 à 888* (1928), vol. i of *Histoire du moyen âge.* (JE. H.)

CLOTH, any material woven of wool or hair, cotton, flax, vegetable, animal or man-made fibre. In commercial usage, the word has been particularly applied to a fabric made of wool. The word is Teutonic, though it does not appear in all the branches of the language. The ultimate origin is unknown. The regular plural of "cloth" was originally "clothes," now confined in meaning to articles of clothing, garments, in which sense the singular "cloth" is obsolete.

"Cloths" as the plural form of the word in its modern sense of material dates from the beginning of the 17th century, but the distinction in meaning between "cloths" and "clothes" is a 19th-century one.

See WEAVING; for the different kinds of cloth *see* COTTON MANUFACTURE; FIBRE, MAN-MADE; SILK; WOOL; WOOL MANUFACTURE; etc.; *see* also references under "Cloth" in the Index.

CLOTHING MANUFACTURE, the process of making garments from cloth or other materials. In the Paleolithic Age, in northern Europe, garments were made of skins sewn together with leather thongs. Holes were made in the skin and then a thong was drawn through them with an instrument curved like a crochet hook. In southern Europe fine bone needles of the same period have been found. These must have been made for use with fibre or thread, indicating that woven garments were already worn. Later, although weaving and embroidery were highly developed in the ancient civilizations and the middle east, the equipment used in the construction of clothes remained simple and has, in fact, always lagged behind the development of techniques for spinning and weaving. The next important advance took place in the middle ages, when iron needles were introduced. These are thought to have reached England by the early 16th century. All operations continued to be performed by hand until factory production was made possible by the invention of new machinery for spinning and weaving in the 18th century, and the subsequent appearance of the sewing machine.

Mechanization of the Industry.—Attempts to design a sewing machine began in the 18th century but the first man to use his invention commercially was Barthélemy Thimonnier, a Frenchman who made military uniforms in Paris. The experiment failed when all the machines were destroyed by a mob of persons who feared that the machines would make the unemployment situation more acute. The next important advance came when an American, Elias Howe, invented a lock stitch machine which used two threads, a needle and a shuttle. It was patented but was not accepted in America; Howe then took it to England and sold part of his patent rights. The objections of the American tailors and seamstresses were finally overcome by a machine designed in 1851 by Isaac M. Singer of Pittstown, N.Y. (*See* SEWING MACHINES.)

For many years the sewing machine was the only mechanical tool possessed by the clothing industry, and so the operator of the sewing machine had to wait on the cutter. The next major development was the introduction in 1860 of the band knife machine which cut several thicknesses of cloth at one time. It was introduced by John Barran of Leeds, the founder of the Leeds clothing industry, who substituted a knife edge for the saw edge of a veneer-cutting machine. Many of the subsequent improvements were American. The Reece Machinery company of the United

States pioneered buttonhole machines at the end of the 18th century and later the Singer company developed buttonhole machines and machines for sewing on buttons. The introduction of the Hoffman press enabled pressing to be done more quickly than by hand (although hand pressing is still used at various stages for high-grade garments). All of these developments have made factory production of clothing efficient in industrialized countries. The first manufactured garments were of the shoddiest quality both as regards make and materials but they were welcomed by the poorer people, who had previously had to rely on making their own. As the trade developed it improved the quality of production and materials and catered more and more to the well-to-do.

SOCIAL AND HISTORICAL ASPECTS

Hand Tailoring.—In the middle ages in Great Britain the custom-made, or bespoke, hand-tailoring industry catered solely to wealthy male patrons, a situation that remained unchanged for many centuries both in Britain and later in America. The ladies' custom tailoring industry did not exist as an industry until the early and middle 19th century, when Scandinavian and German tailors migrated to London and New York and brought new skills with them. Although wealthy and fashionable women previously had employed seamstresses or dressmakers to make all their garments, they then turned to the ladies' tailors for their finest suits and coats.

Until the mid-17th century most tailors were skilled both in the cutting and in the sewing of garments, but the master tailors' practice of allocating only the sewing to apprentices and journeymen created a class of mere sewers. By the 18th century the master tailors tended to be recruited from those journeymen who possessed special cutting skills and business acumen. This tendency, plus the high cost of starting a business in the better quarters of the cities, gave rise to a permanent group of wage earners whose skill declined at the end of the 19th century when competition from the ready-made clothing industry led to the division of labour among hand tailors. Production was cheapened further when it became the practice to make portions of custom-made garments by machine.

The journeymen hand tailors were among the first craftsmen to form trade unions in Great Britain and in the United States. In 1720 the London master tailors complained to parliament that their journeymen had combined to demand higher wages and shorter hours. In 1795 journeymen in Baltimore struck for higher wages. From these dates local trade unions spread in both countries. Nevertheless the earliest attempts to amalgamate the local societies into a national union failed. The First Grand Lodge of Operative Tailors, formed by the London journeymen in 1833, joined Robert Owen's Grand National Consolidated Trades' union, led a strike that depleted the Grand National's funds and collapsed within a year. Similarly, the Journeymen Tailors' union, formed in 1865 in the United States, disintegrated in 1876 when an officer embezzled its funds.

Later efforts to form national unions were more successful. The Journeymen Tailors' union of America was reorganized in 1883 and existed until 1936, when it merged into the Amalgamated Clothing Workers' union of America. In Great Britain the Amalgamated Society of Tailors was formed in 1866 and lasted until it united with the National Union of Tailors and Garment Workers in 1932. The hand tailors in both countries sought to regulate the working conditions and number of apprentices and to maintain craft standards; but when handicraft standards fell, the journeymens' unions merged into the ready-made clothing workers' unions.

The Homework System and "Sweating."—The homework system existed on a small scale before the industrial revolution, for the lady of the manor sometimes employed a seamstress who worked in her own home rather than in the manor house. The system spread at the turn of the 18th century when more journeymen tailors started to work at home and to hire female homeworkers to do part of the sewing during busy seasons. "Sweating," the term used to describe low wages, excessively long hours of work and substandard working conditions, became more prevalent as this practice increased. Later when the ready-made clothing industry developed, the homework system became a serious social problem since clothing manufacturers employed large numbers of female homeworkers to sew garments that had been cut by the manufacturer.

Immigrant women in New York and wives and daughters of dockers (longshoremen) in London, whose labour was cheapened by the need to supplement their families' low and irregular incomes, provided the industry with a large and inelastic labour supply that was not driven away by exceedingly low wages. In Leeds where there was no inelastic supply of cheap female labour, the development of the self-contained factory was not impeded. However, the existence of this cheap labour supply in London and in New York meant that manufacturers could avoid the overhead costs of large premises and could dispense with the supervision of their labourers. Thus homework and "sweating" multiplied in London and New York.

After 1875, and after the Russian pogroms of the 1880s and 1890s, Jewish immigrants flocked mainly to New York, but also to London. Finding German-Jewish manufacturers who would give homework, the immigrants took the work home, set up a workshop in a spare room or parlour, employed other male immigrants to work for them, and devised methods of rationalizing their labour to increase production. The immigrants' completely nonindustrial, middleman background from the Russian and Polish ghettos inspired them to emerge from the position of wage earners to that of employers and the number of small subcontractors' workshops multiplied. The "subdivisional" or "sectional" system of production became the exclusive province of the Jewish subcontractor who combined a high degree of division of labour with relatively high wages. The Jewish tailor worked exceedingly long hours in overcrowded, unsanitary and unventilated premises but, with the exception of the first period of his working life when he was learning his specialized section of the trade, his wages were not "sweated" as compared with the wages of the female homeworker.

In Great Britain the immigrants branched out from the small workshops into factory production. In the United States virtually the whole clothing industry came to be regarded as Jewish. However, in both countries the descendants of these immigrants were tending in the second half of the 20th century to shun the industry. Some of their jobs in London were being filled by West Indians, Cypriots and Irish women. In New York the Jews and large numbers of Italian immigrants who had also entered the industry were being succeeded by Negroes and by new waves of immigrants from Puerto Rico and Mexico.

Trade Unions and the Fight Against "Sweating."—With the exception of the retail custom tailoring trade, where collective agreements existed prior to the 20th century, trade unions were weak and there was no adequate machinery for the effective regulation of wages in the clothing industry in Great Britain before 1909. Therefore the fight against "sweating" was undertaken by social reformers who tried to awaken the conscience of parliament. The Trade Boards act, adopted in 1909, provided for the establishment of legal minimum rates of wages by boards composed of equal numbers of employer and worker representatives. Among the first four trades to which the act applied were the "Ready-made and the Wholesale Bespoke Tailoring trades."

The Trade Boards act not only raised the wages of the female homeworkers but also provided an impetus for the employers to form associations and for the competing clothing unions to amalgamate. In 1915 a small industrial union, a cutters' union and two small Jewish unions merged to form the United Garment Workers' Trade union (known in the early 1960s as the National Union of Tailors and Garment Workers). In 1919 this union signed its first national agreement with the Wholesale Clothing Manufacturers' association, and the negotiated rates were jointly submitted to the trade boards. When wages councils replaced the trade boards negotiated rates continued to be submitted in the same way. Negotiated minimum rates are applicable as basic rates and as legally enforceable minimum rates throughout the clothing industry. Piece rates negotiated in individual shops must be set at a level that enables a worker to earn at least the minimum rate. The union is continually engaged in bargaining with individual firms to raise the wages of workers above the minima.

In the United States the fight against "sweating" was won by the trade unions. The Amalgamated Clothing Workers' union was formed in 1914 when a group of Jewish and Italian tailors withdrew from the United Garment Workers' Union of America. In the early 1960s the parent union, which was formed in 1891, was mainly composed of shirt workers; the breakaway union, however, catered to all workers in the men's clothing industry. The International Ladies' Garment Workers' union, formed in 1900, served all the workers in the ladies' clothing industry.

The U.S. clothing unions fought "sweating" in three ways: they made the manufacturer responsible for the wages and the working conditions not only of his own employees but also of his subcontractors' employees; they made the subcontractor put up a bond guaranteeing that he would live up to the provisions of the agreement; and they devised elaborate agreements that contained detailed time and piecework scales and also included, by descriptive enumeration, every type of work or pattern for which a distinct rate was paid. In the early 1960s collective agreements covered many items other than rates and hours of work; *e.g.*, pension schemes, sick and death benefit funds, retirement and unemployment funds. The U.S. clothing workers' unions also have pioneered in all sorts of social experiments for the benefit of their members; *e.g.*, co-operative housing projects, credit unions and co-operative banks, rest homes, sanitariums and holiday camps. (S. W. L.)

THE MODERN INDUSTRY

Machinery.—It is impossible to describe in detail the hundreds of machines in use in the early 1960s. The lock stitch machine could not perform some of the hand stitching operations although much progress had been made during the 20th century. At the turn of the century a blind stitch machine for felling hems was invented by Charles Dearborn in the U.S.A. By the early 1960s a machine designed for specific tasks was capable of 5,000 to 6,000 stitches a minute. The needles of high-speed machines require cooling to avoid overheating and the melting or fusing of man-made materials. Accordingly, self-lubricating and cooling systems were incorporated into the machines; some machines included a mechanism designed to eliminate vibration at high speed. Embroidery machines could be set to produce a design simultaneously on eight different pieces of material. One machine had 21 built-in patterns that could be selected by turning a dial.

In 1959 a machine that automatically makes buttonholes in a shirt front was introduced. A lock stitch machine sews the seam and also pinks the edges of the material mechanically; the latter operation previously had been done by hand and took as long as the stitching itself since pinking shears were used to produce a zigzag edge on the free material beyond the seam; the free material was then pressed back onto the body of the garment to prevent fraying. The band knife machine of Barran was still being used in the early 1960s although many new forms of mechanical cutter had been introduced; the Eastman cutter, invented in the 1900s, had been adapted and improved for various uses.

The difficulties encountered in working with man-made fibres have been turned to great advantage in the development of heat sealing. Plastic raincoats, which used to be sewn (quite unsatisfactorily), came to be put together by means of a heat-sealing machine. By 1959 electronic machines were capable of sealing seams, facings and buttonholes so quickly that a raincoat factory in the United States was producing 4,000 plastic garments a day with machines tended by four men only. Heat sealing may take the place of stitching if nonthermoplastic material can be appropriately treated but its application to the highest grade of clothes is problematical.

The technique of cutting material in predetermined shapes is used extensively for small items such as collars and cuffs, pockets and basic linings. Since a press cutting machine must be specially designed for each new shape it is not practicable where new designs and new patterns are required in large numbers at the start of every manufacturing season.

An interesting aid to manufacture is the hem leveler, which either measures and cuts the skirt as it revolves on a stand or puffs out a jet of powdered chalk to guide the worker who then cuts the hem along the chalk line. The material is pressed during and after the sewing operations with electric steam irons, which have superseded gas irons and pressing cloths.

One of the most important operations is that of cutting many thicknesses of material, and its success depends on the accuracy with which each piece of material is laid on top of the one underneath. Selvages must be laid together exactly and in the case of patterned materials each part of the design must be immediately above the same part in the cloth beneath. A laying-up machine runs back and forth along a railway on either side of the cutting table and spreads the cloth from end to end. Between 50 and 100 thicknesses may be cut at a time. The cloth is clamped at each end and at intervals along the selvaged edge. The patterns of the various parts of the garments are arranged on the top of the pile to give what is known as the lay, and from this arrangement a marker is produced that is placed on the pile to guide the cutting machine operator. The plan of the cutting lay is most important since it must ensure the most economical use of the cloth. A machine developed in the late 1950s and called a photo marker reproduces the master marker by photography. Sometimes the lay is set from miniature copies on a small drawing board and enlarged to the actual size. The lay is marked by various methods, including chalking by hand or by spraying so that an outline is left for the cutting operator to follow.

An original set of patterns has to be graded to produce similar patterns for perhaps six or more sizes. At one time the skilled pattern grader had to prepare these with a ruler and drawing board but later a grading machine was developed that enabled the operation to be carried out more accurately and swiftly.

Division of Labour.—The principle of allocating one operation to one employee and generally dividing the work so as to achieve greater efficiency was adopted from the start in the ready-made clothing industry, although in higher grade work the dressmaker has continued to "make through"; *i.e.*, virtually all operations are carried out by the same person. In the case of tailoring, the practice of putting vests (waistcoats) and trousers out to specialists while the tailor makes the jacket or overcoat himself has existed for a long time but in mass production tailoring the division goes very much further. Each operation is centrally planned and is allocated to one or more employees. The problem of reducing the time between sewing operations has become a managerial one. After the designer and the cutters have completed their part of the job the cut fabric is made into bundles, each containing the component parts of the garment. These pass through the factory from machine to machine and each operation is carried out in sequence. The bundle system is often varied to achieve greater efficiency and to ensure the least possible handling. Sometimes only the pieces that have to be machined are given out and as each operation is performed the necessary additional pieces are introduced into the production line. Conveyor belts were used after World War I but were generally abandoned on the ground that production was slowed down to the speed of the slowest worker.

Between 1950 and 1960 conveyors were reintroduced and arranged so that a supervisor at a central point can send work to each employee as it is required. Thus the objections raised by the use of the early inflexible conveyors have been overcome and the time of the more efficient worker is not being wasted.

After the operations of main sewing have been completed there still remain the jobs of finishing. Hems have to be basted, buttons, hooks and eyes have to be sewn on, and trimmings including detachable collars and cuffs added. The final operation is pressing, which may be done entirely with a hand iron or by using mechanical presses for the main pressing work and a hand iron for the rest.

Production in the 20th Century.—At first the most important clothing manufacturing countries were the United States and the United Kingdom. In the first six decades of the 20th century the U.S. contributed many of the technical improvements and innovations, while the U.K. concentrated on quality goods. After

World War II the U.K. faced fierce competition from the U.S., especially in South Africa, Australia and New Zealand, where American styles had much influence.

The ready-made dress industry was given a tremendous impetus soon after World War I when new methods of production and organization were introduced and women began to wear less complicated clothing. Many countries, notably Denmark, Norway, Sweden, the Netherlands, Belgium, Canada, South Africa, Australia and New Zealand, renewed their efforts to develop their own ready-made clothing industries. This drive became more pronounced after the end of World War II when communications improved and knowledge of up-to-date machinery and techniques became available to all.

Outstanding developments at the beginning of the second half of the 20th century were the rapid advance of Italian knitwear and the remarkable achievements of the Hong Kong textile and clothing industries. Both the Italian and Hong Kong developments started afresh after World War II with completely modern equipment. Hong Kong was helped considerably by the influx of Chinese from the mainland; factories and housing were built rapidly. Germany also had to rebuild its industry and in 1960 its clothing industry was the biggest in Europe after that of Great Britain. In France and Italy the retail distributive system was less well developed than in such countries as Britain, the Netherlands, Belgium and Switzerland, partly because the people of France have been unreceptive to both domestic and imported ready-made clothing. The state of the industry in the Soviet Union and its eastern European neighbours was unknown in the early 1960s, though it was fairly certain that western techniques were being used in the German Democratic Republic and in the Soviet Union and if the latter lagged behind it could only have been because of concentration on other industries.

Home dressmaking has had a revival in the United States and the United Kingdom although dressmakers have been less in demand. (*See* Sewing, Home.) Made-to-measure clothes for men are now manufactured almost entirely by huge multiple tailoring concerns that have developed as vertical organizations controlling the production of cloth and the manufacture and distribution of garments to chains of shops throughout the country. In some cases, the retail outlets also are owned or controlled. Qualified staff members take the measurements of the customers and send them back to the great factories. This is also true to some extent in continental Europe.

Expenditure.—Clothing purchases in the U.K. have accounted for about 10% of total yearly expenditure for many years but the figure in the early 1960s was somewhat below this. Of the £1,350,000,000 spent annually on clothing in the U.K., about £900 000,000 represents purchases of women's, girls' and infants' wear. In the U.S., with a population roughly three-and-a-half times that of the U.K., the total yearly expenditure was about $20,500,000,000.

Materials.—Even after man-made fibres were introduced, cotton and wool continued to be the principal materials used to manufacture clothing. In the early 1960s cotton accounted for more than two-thirds of the world consumption of fabrics and wool for about 11%. The viscose process was invented in 1892 and after the mid-1920s rayon became increasingly important and in the early 1960s accounted for about 16% of the consumption of textile fibres. The polyamides, polyesters and acrylics were given considerable publicity and indeed, many of these newer fibres may have an important future though their production was still, in the early 1960s, very much behind viscose rayon and acetate. The polyamides are more popularly known under other names, such as nylon, while Terylene and Dacron are the British and U.S. trade names for polyester fibre. Courtelle, Orlon and Acrilan are trade names for acrylics. *See* Cotton Manufacture; Fibre, Man-made; Wool Manufacture; *see* also references under "Clothing Manufacture" in the Index. (A. T. E.)

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CLOTILDA, SAINT (Chrotechildis) (d. 545), queen consort of Clovis (*q.v.*), king of the Franks, in whose momentous conversion to Catholic Christianity she played a notable part. She was the granddaughter of Gundioc, king of Burgundy (436–*c.* 473), who was related to the Visigothic kings and shared their Arian faith. At Gundioc's death his kingdom was divided between his four sons, Gundobad, Godegesil, Chilperic and Gundomar. Clotilda's father Chilperic and her mother (who may have been a Catholic but is not to be identified as the queen Caretena who died at Lyons in 506) were murdered by Gundobad. Clotilda and her sister Chrona, who were zealous Catholics, took refuge with Godegesil in Geneva. The Salian Franks and the Burgundians were then exchanging embassies frequently, and Clovis, hearing good reports of Clotilda, obtained Gundobad's permission for their marriage. Clotilda was tireless in urging her husband to renounce his idols and acknowledge the true God; his final decision (496 or 506) was made to honour a vow taken during a battle against the Alamanni. After Clovis' death (511) Clotilda, who greatly venerated the tomb of St. Martin, made her residence at Tours. Though she was still active in politics, she became famed for sanctity and almsgiving. She died at Tours on June 3, 545 (her feast is celebrated on the anniversary), and was buried in Paris in the church that she and Clovis had built. Of the many other churches alleged to have been founded by her, only that of St. Germanus at Auxerre can be certainly attributed to her patronage.

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CLOTURE (or Closure), a term used in parliamentary procedure to denote a method for ending debate and securing an immediate vote on a measure before a deliberative body even when some members wish to continue the debate. Provision for invoking cloture was made in the British House of Commons in 1882 with the requirement that such a motion could carry only if it received at least 100 affirmative votes. In most parliamentary bodies a cloture motion is not debatable, is not subject to amendment, and requires more than a simple majority vote. Its main purpose is to provide a means to check what is known as the filibuster—endless debate by a minority of the members to keep a motion from being put to a vote. In 1917 the U.S. Senate adopted a rule (known as Rule xxii) that provided for stopping debate on a pending issue upon petition by 16 senators and the affirmative vote of two-thirds of the members present and voting. This latter provision was changed in 1949 to make the invocation of cloture even more difficult: the motion required the votes of two-thirds of all members of the Senate. But ten years later the old rule was restored. Because of the difficulty of obtaining a two-thirds vote, cloture was seldom invoked in the U.S. Senate. Efforts were occasionally made to stop filibusters by southern senators who opposed civil rights bills but no such effort succeeded until 1964 when cloture was invoked to permit a vote to be taken on the bill that became the Civil Rights Act of 1964.

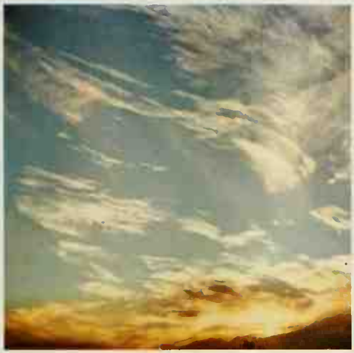
See Filibuster; for cloture in the British Parliament *see* Parliament: *Procedure in the House of Commons: The Closure.*

CLOUD, a visible aggregation of minute water droplets and/or ice particles in the air, usually above the general ground level.

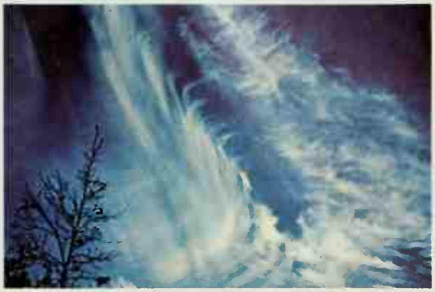
CLASSIFICATION

Although the shapes and general appearance of clouds must have been a matter of interest and speculation from earliest times, no lasting contribution to the development of a scientific cloud classification was made until 1803, when Luke Howard published his classical paper entitled "On the Modifications of Clouds." The Latin terms which Howard adopted were applied with such excellent judgment that his system later became the basis of the internationally accepted cloud classification.

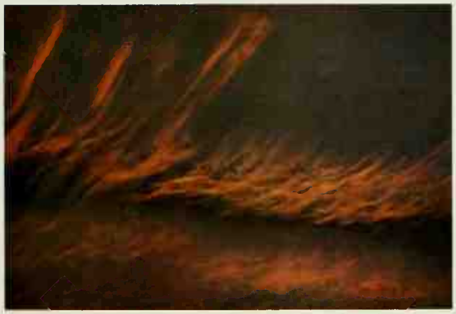
For more than 50 years following the appearance of Howard's treatise little progress in the study of clouds was achieved. It was not until 1874, the year of the first International Meteorological Congress, that important new efforts were initiated in this field.



Cirrus fibratus, nearly straight or irregularly curved fine white filaments, generally distinct from one another



Cirrus uncinus, detached clouds of delicate white filaments, often comma-shaped and ending at the top in a hook or tuft



Cirrostratus fibratus, a thin whitish veil of nearly straight filaments

HIGH CLOUDS

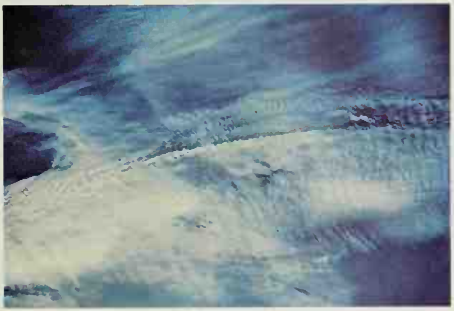
Of the 10 main cloud genera, subdivided into 14 species based on shape and structure, and 9 general varieties based on transparency and geometrical arrangement, the pictures on this plate show some characteristic forms of the three high-altitude genera (mean heights 16,500 to 45,000 ft. [5 to 13 km.]). The three are:

Cirrus (*Ci*).—Detached clouds in the form of white, delicate filaments, or white, or mostly white patches or narrow bands. These clouds have a fibrous (hairlike) appearance, or a silky sheen, or both.

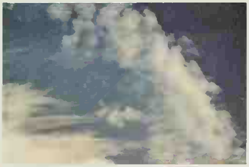
Cirrocumulus (*Cc*).—Thin, white patch, sheet or layer of cloud without shading, composed of very small elements in the form of grains, ripples, etc., merged or separate, and more or less regularly arranged; most of the elements have an apparent width of less than 1°.

Cirrostratus (*Cs*).—Transparent, whitish cloud veil of fibrous or smooth appearance, totally or partly covering the sky, and generally producing halo phenomena.

(Note: Definitions and descriptions on these CLOUD plates are from the *International Cloud Atlas*)



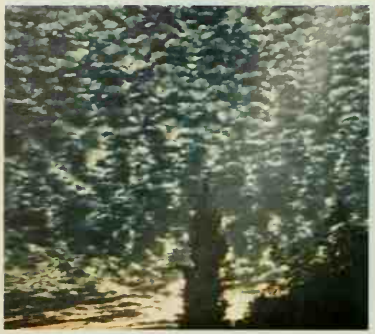
Cirrocumulus, a thin white cloud patch composed of small elements in the form of ripples



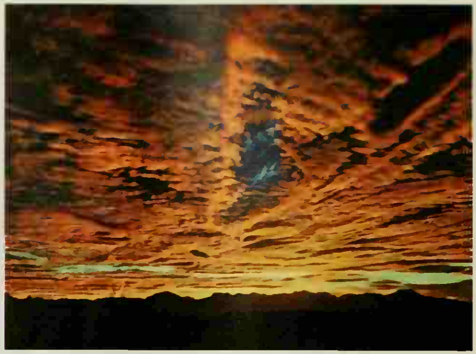
Cirrus spissatus, detached fibrous clouds of sufficient optical thickness to appear grayish when viewed against the sun

Cirrostratus nebulosus, producing halo phenomenon

PHOTOGRAPHS, (TOP LEFT) NICK IMPENNA—PHOTO RESEARCHERS, INC., (TOP RIGHT, CENTRE RIGHT, BOTTOM LEFT, BOTTOM RIGHT) LOUIS D. RUBIN, RICHMOND, VA., (CENTRE LEFT) JOHN G. ROSS—PHOTO RESEARCHERS, INC.



Altocumulus perlucidus, a white and gray layer in which there are spaces between the elements



Altocumulus undulatus, a layer of shaded, regularly arranged rolls

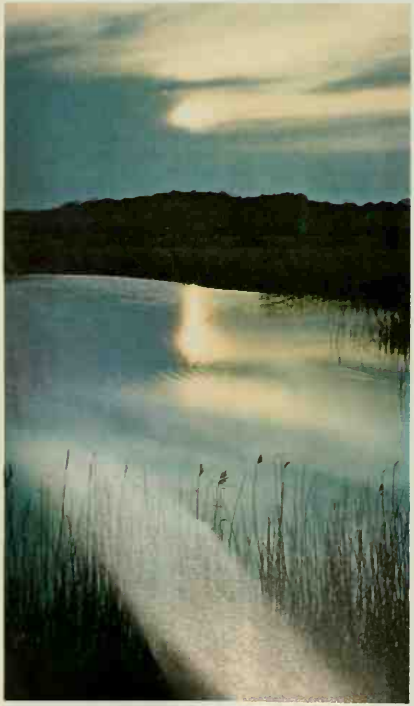
MIDDLE CLOUDS

Some configurations of the three cloud genera occurring at medium altitudes, *Altocumulus*, *Altostratus* and *Nimbostratus* (mean heights 6,500 to 23,000 ft. [2 to 7 km.]), are represented on this plate.

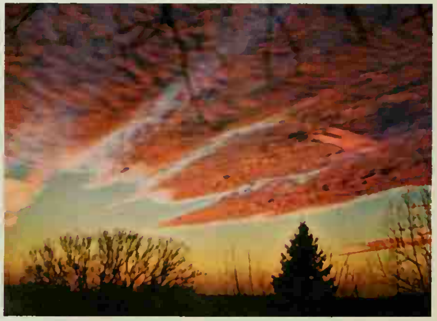
Altocumulus (*Ac*).—White or gray, or both white and gray, patch, sheet or layer of cloud, generally with shading, composed of laminae, rounded masses, rolls, etc., which are sometimes partly fibrous or diffuse and which may or may not be merged; most of the regularly arranged small elements usually have an apparent width of between 1° and 5°.

Altostratus (*As*).—Grayish or bluish cloud sheet or layer of striated, fibrous or uniform appearance, totally or partly covering the sky, and having parts thin enough to reveal the sun, at least vaguely, as through ground glass. Altostratus does not show halo phenomena.

Nimbostratus (*Ns*).—Gray cloud layer, often dark, the appearance of which is rendered diffuse by more or less continuously falling rain or snow, which in most cases reaches the ground. It is thick enough throughout to blot out the sun. Low, ragged clouds frequently occur below the layer, with which they may or may not merge

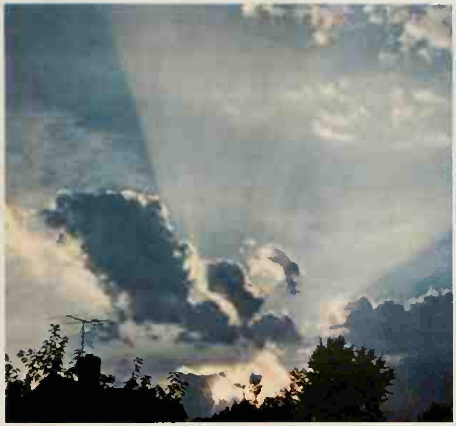


Altostratus translucidus, showing the sun as if seen through ground glass

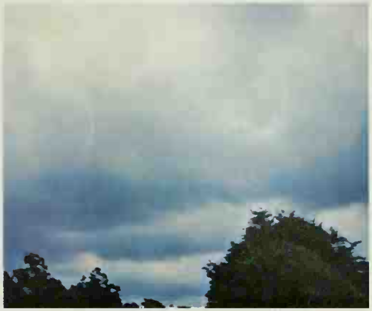


Altocumulus radiatus, a layer with laminae arranged in parallel bands

PHOTOGRAPHS (TOP LEFT) H. VON MEISS-TEUFFEN—PHOTO RESEARCHERS, [illegible] ARD JEPPERSON—PHOTO RESEARCHERS, INC.; (BOTTOM LEFT) RUSS KINNE—PHOTO RESEARCHERS, INC.; (BOTTOM RIGHT) LAWRENCE SMITH—PHOTO RESEARCHERS, INC.



Stratocumulus cumulogenitus (shown here with bright crepuscular rays), a gray layer with dark parts composed of elongated nonfibrous masses. These clouds represent a late stage of daytime development of cumulus



Stratocumulus stratiformis, large rounded, heavily shaded masses arranged in an extended sheet

Stratus nebulosus, a uniform cloud base which may produce drizzle, ice prisms, or snow grains. Note tower fading in the mist at right

LOW CLOUDS

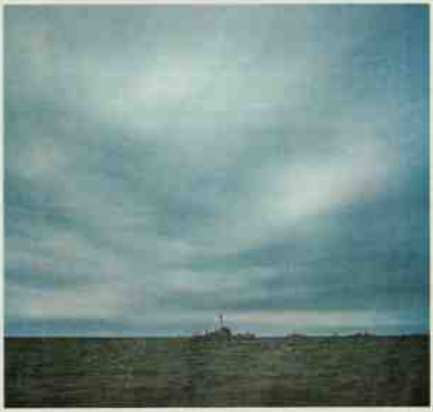
Characteristic forms of the low-altitude cloud genera (mean heights 0 to 6,500 ft. [0 to 2 km.]) appear on this plate and the next.

Stratocumulus (*Sc*).—Gray or whitish, or both gray and whitish, patch, sheet or layer of cloud which almost always has dark parts, composed of tessellations (checkerboard patterns), rounded masses, rolls, etc., which are nonfibrous (except for virga [precipitation trails]) and which may or may not be merged; most of the regularly arranged small elements have an apparent width of more than 5°.

Stratus (*St*).—Generally gray cloud layer with a fairly uniform base, which may give drizzle, ice prisms, or snow grains. When the sun is visible through the cloud, its outline is clearly discernible. Stratus does not produce halo phenomena except, possibly, at very low temperatures. Sometimes stratus appears in the form of ragged patches.

Cumulus (*Cu*).—Detached clouds, generally dense and with sharp outlines, developing vertically in the form of rising mounds, domes, or towers, of which the bulging upper part often resembles a cauliflower. The sunlit parts of these clouds are brilliant white; their base is relatively dark and nearly horizontal. Sometimes cumulus is ragged.

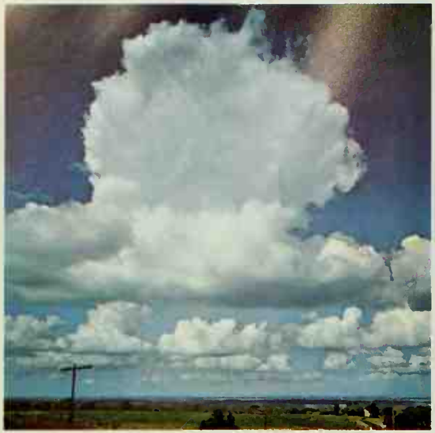
Cumulonimbus (*Cb*).—Heavy and dense cloud, with a considerable vertical extent, in the form of a mountain or huge towers. At least part of its upper portion is usually smooth, or fibrous or striated, and nearly always flattened; this part often spreads out in the shape of an anvil or vast plume. Under the base of this cloud which is often dark, there are frequently low, ragged clouds, either merged with it or not, and precipitation sometimes in the form of virga



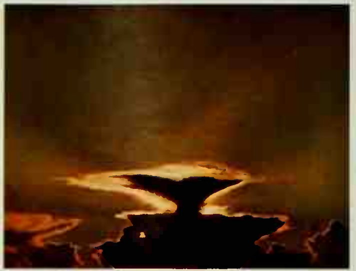
Stratocumulus opacus, an extensive gray sheet with rounded masses, the greater part of which is sufficiently opaque to mask completely the sun or moon

PHOTOGRAPHS (TOP LEFT, TOP RIGHT, CENTRE RIGHT) LOUIS D. RUBIN, RICHMOND, VA.; (BOTTOM RIGHT) RUSS KINNE—PHOTO RESEARCHERS, INC.

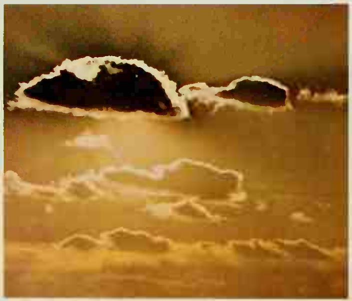
CLOUD



Cumulonimbus capillatus (top of picture), a dense, heavy cloud with top appearing fibrous. *Cumulus congestus* (bottom of picture), generally dense with great vertical extent

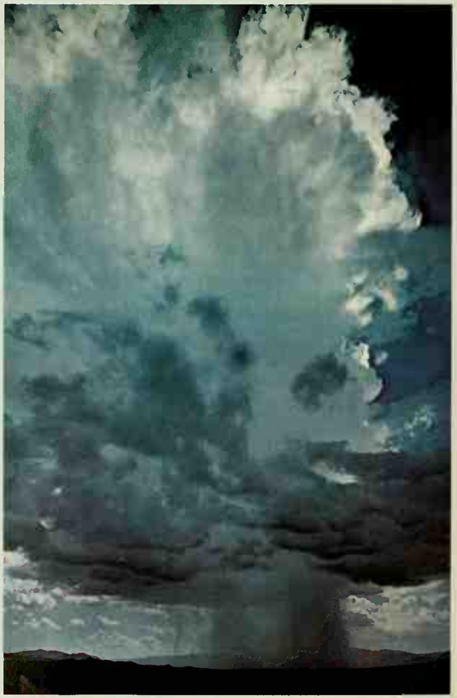


Cumulonimbus capillatus, showing the characteristic anvil-shaped upper portion, or thunderhead



Cumulus humilis, characterized by only a small vertical extent and appearing flattened

Cumulonimbus mamma, a light-coloured cloud sheet which has hanging protuberances on the undersurface



Cumulonimbus calvus, a dense, heavy cloud with a considerable vertical extent, the upper portion of which has already lost its sharp outline

PHOTOGRAPHS, (TOP LEFT, BOTTOM LEFT) IRVIN L. OAKES—PHOTO RESEARCHERS, INC (TOP RIGHT) RUSS KINNE—PHOTO RESEARCHERS, INC., (CENTRE LEFT) JOHN G. ROSS—PHOTO RESEARCHERS, INC., (BOTTOM RIGHT) WILLIAM BELKNAP, JR —RAPHO GUILLUMETTE

During the succeeding 20 years constructive proposals were advanced in many countries by a large number of workers whose combined efforts led in 1896 to publication of the *International Cloud Atlas.*

During the period of World War I and the years immediately following, interest in cloud forms and their prognostic significance was stimulated by the development of aviation, and the preparation of a new and much more extensive cloud atlas was undertaken. The result was the *International Atlas of Clouds and States of the Sky*, with editions in 1932 and 1939.

The exhaustion of the 1939 edition, modifications in cloud codes, and new cloud knowledge prompted the World Meteorological Organization to prepare a carefully documented new *International Cloud Atlas* (1956) in two volumes (vol. i, text; vol. ii, 224 plates of which 101 were in colour). The World Meteorological Organization also prepared an abridged atlas of the two volumes combined and an *International Cloud Album for Observers in Aircraft.* The new unabridged atlas describes the 10 main cloud genera (families), which are subdivided into 14 species based on their shape and structure and 9 general varieties based on their transparency and geometrical arrangement. The genera, listed according to their height, are:

A. High (mean heights 16,500 to 45,000 ft. [5 to 13 km.])
    1. Cirrus
    2. Cirrocumulus
    3. Cirrostratus
B. Middle (mean heights 6,500 to 23,000 ft. [2 to 7 km.])
    4. Altocumulus
    5. Altostratus
    6. Nimbostratus
C. Low (mean heights 0 to 6,500 ft. [0 to 2 km.])
    7. Stratocumulus
    8. Stratus
    9. Cumulus
    10. Cumulonimbus

Usually altostratus, nimbostratus, cumulus, and cumulonimbus clouds and sometimes other clouds extend outside these height ranges, which are only approximate for temperate regions. Clouds of a given genus are generally lower in polar regions and higher in the tropics.

BY COURTESY OF THE U S. WEATHER BUREAU

NIMBOSTRATUS CLOUD LAYER (TOP) WITH ACCOMPANYING LOWER LAYER OF RAGGED CLOUDS

The definitions and descriptions of the cloud genera used in the *International Cloud Atlas* are given in the accompanying colour plates, with illustrations of some of their characteristic forms.

In addition to the cloud classification, there is a classification of 30 code numbers for the state of the sky in the three height groups. The latter classification, coded as one of ten numbers (0 to 9) for each height group, is based on combinations of cloud formations in that height group observed simultaneously. The three selected code numbers (called C_L, C_M, and C_H, corresponding to low, middle, and high cloud formations) are transmitted as part of every international surface weather report. Also included in this report are the amount of cloud cover at the different levels, the direction of motion of the clouds, and the heights of their bases.

In the United States and Canada the term ceiling is used to denote the height of the base of the lowest clouds present in quantity on any occasion. Ceiling zero is reported when the ceiling is 50 ft. or less; ceiling unlimited is reported when either no broken or overcast layer is observed, or the base of the lowest reported broken or overcast layer is higher than 9,750 ft. above the ground.

(G. Es.; E. M. Bs.)

WEATHER ASSOCIATED WITH CLOUDS

Precipitation in significant amounts usually falls only from a few cloud genera: altostratus, nimbostratus, and cumulonimbus; the word nimbus meaning rain cloud. Precipitation may fall from altocumulus, stratocumulus, stratus, or cumulus, but amounts are small except under special circumstances. Cirrus, cirrostratus, and cirrocumulus, high clouds composed exclusively of ice crystals, may produce snow, but the snow generally evaporates before reaching the ground if there are no lower clouds present. On the other hand, when thick clouds of waterdrops are present at lower levels, the snow from above may get heavier and reach the ground as snow or rain, depending on the temperature. Stratus clouds may produce drizzle, whereas cumulus clouds sometimes yield showers, especially in the tropics. Cumulonimbus clouds are usually accompanied by showers of rain, snow, or hail, often with a thunderstorm or even a tornado. Steady rain lasting all day is produced usually by altostratus or nimbostratus.

Clouds are valuable aids in forecasting the weather. If the sky is becoming overcast with cirrus and cirrostratus clouds, thickening and lowering to altostratus clouds, precipitation is imminent, probably from an approaching warm front in temperate latitudes or perhaps a hurricane in the tropics. However, in temperate latitudes in summer or in the tropics, isolated masses of thick cirrus which are not increasing are normally followed by fair weather because these clouds are often remnants of old thunderstorms which have already dissipated.

New active thunderstorms are indicated by cumulus growing rapidly into cumulonimbus on a humid day, even though the sun may be shining brightly between the clouds. A line of cumulonimbus cloud tops appearing in the northwest may indicate thunderstorms with an approaching squall line or cold front, followed by drier weather. An altocumulus cloud sheet, which may result from the degeneration of altostratus, often indicates a layer of stable air or a weak front aloft, which generally does not produce precipitation.

The presence of cloudiness indicates smaller diurnal temperature variations. In the evening a low overcast acts like a blanket, preventing the temperature from dropping much at night; whereas, a clear evening sky indicates rapid cooling leading to dew, frost, or even fog the following morning. Stratus or fog with calm conditions, probably associated with warm air aloft, in the morning indicates that the clouds will evaporate and the sun will cause a rapid heating at the ground. However, a deck of stratocumulus and strong winds in the morning indicate a cloudy day with only a small temperature rise as the colder air aloft mixes with the surface air. (E. M. Bs.)

MEASUREMENTS OF CLOUDS

As an aid to forecasting, the cloud observer should measure the wind at each cloud level. This can be done in the case of an overcast by sending up a free balloon of known rate of ascent and measuring its angular position each minute with a theodolite until it disappears into the cloud deck. Another method is to measure the apparent speed and direction of a selected portion of a cloud by following its reflection for one minute in a nephoscope, an instrument consisting essentially of a heavily silvered horizontal mirror with a scale of 360° of azimuth around its circumference, and a fixed eyepiece. To find the wind velocity from the nephoscope measurement by similar triangles, it is necessary to have the height of the cloud base. Although this height can often be estimated from the type of cloud formation itself, measurement is preferable.

Modern techniques for measuring cloud heights employ such devices as ceiling balloons, ceiling light projectors, ceilometers, and very short-wave length (1 cm.) radar. In addition, cloud heights have been estimated by triangulation methods, by optical range finders, by intersections of clouds with hills or mountains, or by application of the dew point formula. (*See* Humidity, Atmospheric.) In the latter method, when the air is thoroughly mixed as far as the base of the cloud, the height of the base of a cumulus cloud may be calculated from the surface temperature T and the dew point temperature T_d, both in degrees Fahrenheit, by the formula

$$\text{height of base (in ft.)} = 225\ (T - T_d)$$

An accurate and convenient method, available for ceiling measurements during the hours of darkness, is the use of the ceiling light. In this device a small searchlight projects a narrow beam of light, of less than 3° spread, vertically upward to the base of the cloud. An observer, located 500 to 1,000 ft. from the projection, sights on the spot of light on the lower surface of the cloud and measures the vertical angle, h, to the spot. If L is the baseline distance from observer to projector, then the height of the cloud base is L tangent h. The accuracy of this method is adequate for airways purposes, being limited chiefly by the uniformity of the underside of the cloud and by the accuracy with which the vertical angle can be measured. With a 500-ft. base line, an uncertainty of 2° in angle will give an error of 300 ft. for a cloud height of 2,000 ft. Under ideal conditions, cloud heights up to 15,000 ft. have been determined to an accuracy of about 2,500 ft.

In daylight the spot from the ceiling light projector is, of course, invisible, since the sky may be 1,000,000 times as bright as the spot. The difficulty has been resolved by using a light modulated to a known frequency, and observing the spot by means of a special telescope which has a photoelectric cell at the focus of a large lens. Electrical filters used in conjunction with the photoelectric cell reject all signals except those of the modulating frequency. These electric signals are then amplified sufficiently to operate a standard electrical meter. This device, known as the ceilometer, can measure cloud heights up to 10,000 ft. during the daytime and about 20,000 ft. at night. It is widely employed not only at civilian air terminals but by various military services.

A knowledge of the vertical extent and structure of clouds is of great importance. Radar equipment has been developed that not only measures the base of selected clouds but also permits detailed study of the vertical structure of clouds. The development, in the early 1950s, of the radar cloud-base and cloud-top indicator represented a significant advance in meteorological instrumentation. It has been shown both theoretically and experimentally that microwaves of approximately 1 cm. wave length are scattered by cloud water droplets of radii between 10 and 30 μ. Short microwave pulses of a few microseconds duration are radiated vertically upward toward the cloud from a parabolic mirror six feet in diameter. These pulses are then scattered back toward the antenna from the top and bottom of each successive layer of clouds. From the time interval between the transmission of the pulse and the returned cloud echo, the height of the echoing surface above the radar set can be computed.

Radar sets operating at these short-wave lengths have detected clouds to heights in excess of 45,000 ft. It has also been possible to locate clouds through several thousand feet of light rain. However, the minimum cloud altitude that can be measured is about 800 ft., this limitation being due to the recovery time of the radar receiver.

See also references under "Cloud" in the Index.

(W. E. K. M.; Ml. Fe.; E. M. Bs.)

CLOUDBERRY (*Rubus chamaemorus*), a low-growing creeping herbaceous plant of the rose family (Rosaceae), with simple obtusely lobed leaves and solitary white flowers, resembling those of the blackberry, but larger—one inch across—and with stamens and pistils on different plants. The orange-yellow fruit is about half an inch long and has a pleasant flavour. The plant is widely distributed through the more northerly portions of both hemispheres.

In North America it grows in peat bogs and on mountains from Maine and New Hampshire to arctic America and westward to Alaska and British Columbia. In Great Britain it grows in mountainous areas. In Norway and Sweden the fruit is gathered in large quantities and sold in the markets.

CLOUDBURST, a sudden, very heavy rainfall, usually local in nature and of brief duration. Most so-called cloudbursts occur in connection with thunderstorms. In these storms there are violent uprushes of air, which at times prevent the condensing raindrops from falling to the ground. A large amount of water may thus accumulate at high levels, and if the upward currents are weakened the whole of this water falls at one time. Cloudbursts are especially common in mountainous districts. This is probably because the warm air currents of a thunderstorm tend to follow the upward slope of a mountain. The effects of heavy rain are especially striking on mountain slopes because the falling water is concentrated in valleys and gulleys. Mountain cloudbursts cause sudden and destructive floods. The intensity of rainfall in the most severe cloudbursts can only be conjectured. A rainfall of 2.47 in. in 3 min. was registered by an automatic rain gauge at Porto Bello, Pan., on Nov. 29, 1911, and one of 1.02 in. in 1 min. was registered by two automatic gauges, placed side by side, at Opid's camp, on the west front of the San Gabriel range, Calif., on April 5, 1926. There have been cases, however, in which the excavations made in the ground by the falling water of a cloudburst appear to indicate an even greater intensity of rainfall.

(E. M. Bs.)

CLOUD CHAMBERS, apparatus in which the passage of high-speed ionizing particles produces vapour trails of minute droplets which are visible to the eye and can be photographed. The two basic types are the Wilson cloud chamber and the diffusion cloud chamber. When high-speed electrically charged particles such as electrons or atomic nuclei pass through any gas they remove some of the negative electrons from the atoms of the gas, leaving the ionized atoms positively charged and the electrons free of the atoms. These negative and positive free charges then form centres of condensation upon which droplets form if the gas is supersaturated with a vapour. Cloud chambers have been powerful tools in the study of radioactivity, X-rays, cosmic rays and nuclear phenomena (*see* Radioactivity; X-Rays; Cosmic Rays; Nucleus; Particles, Elementary). The positron, meson, neutral V particle and charged V particle were discovered with this device. The bubble chamber (*q.v.*) is similar in function to the cloud chamber. For a general article on radiation-measuring devices *see* Nuclear Instruments.

The Condensation of Supersaturated Vapours.—Water in a closed container filled with air evaporates until the air becomes saturated with water vapour. If the water-saturated air is cooled, the air becomes supersaturated. Droplets will form on any dust particles left in the air, and as the drops fall out the dust is carried to the bottom of the container. When all the dust has been removed and supersaturation has reached a value of 4.2, droplets will form on electrons and charged ions left behind by the passage of an atom through the container. In 1896 C. T. R. Wilson, working at the Cavendish laboratory, Cambridge, Eng., found that ions produced by X-rays could produce droplets in supersaturated gases. A little later he showed that rays from radioactive substances, ultraviolet light and other agencies which produce ions led to the same effect. That the condensation was actually due to ions, and not to some other action of the rays, was proved by applying an electric field before the gas was supersaturated by cooling; this removed the ions, and at the same time stopped the formation of a cloud of droplets.

The first method used to cool the gas was by expanding it, approximately adiabatically, so rapidly that the cooled gas was not appreciably warmed by the walls of the container. The closed tube in which the condensation was to take place was fitted with a glass plunger. Proper cooling resulted from the sudden withdrawal of the plunger through a controlled distance. Wilson found that, once dust particles had been removed by repeatedly expanding, and the drops were allowed to settle, no condensation could be produced unless the ratio of expansion v_2/v_1 (where v_2 is the final, v_1 the initial volume) exceeded a certain threshold value, namely 1.25. This corresponds to a supersaturation of about 4.2, the supersaturation S, defined as the ratio of the amount of water vapour present to that required to produce saturation at the prevailing temperature, being given by the formula

$$S=\frac{\pi_1 v_1 T_2}{\pi_2 v_2 T_1}$$

where T_1 and T_2 are the temperatures before and just after expansion, and π_1 and π_2 are the vapour pressure of water at those temperatures; by a familiar expression $T_1/T_2=(v_2/v_1)^{\gamma-1}$ where γ is the ratio of the specific heat at constant pressure to the specific heat at constant volume, for air. With an expansion ratio exceeding 1.25, a few drops are produced in dust-free air; with an expansion ratio exceeding 1.38, a dense cloudy condensation is produced, but in this case the supersaturation is about 8. The essential observation made by Wilson was that when ions were produced in air with an expansion ratio 1.25, by the action of X-rays or any other agent, a fog was formed instead of the few drops formed by residual ions when there was no radiation. The density of the cloud depends upon the strength of the radiation, but no cloud at all is formed unless the expansion equals or exceeds 1.25. Wilson showed that positive and negative ions are not equally effective as condensation nuclei in the presence of water vapour, negative ions being effective at an expansion ratio of 1.25 and positive ions at 1.31.

The efficacy of charged ions as nuclei of condensation is bound up with the question of the evaporation of drops of different sizes in a saturated atmosphere, for a droplet can form only if there is a tendency for liquid to deposit on it from the vapour state rather than for its liquid to pass into vapour. It was shown by Lord Kelvin that the vapour pressure p at a surface of radius of curvature r differs from the vapour pressure P at a plane surface according to the equation

$$\sigma RT\log\frac{p}{P}=\frac{2\alpha}{r}$$

where σ is the density of the liquid, R the gas constant for unit mass of vapour, and α the surface tension. The vapour pressure at the surface of a spherical drop being greater than that at a plane surface the drop will tend to evaporate, in an atmosphere of saturated vapour, which is in equilibrium with a plane surface, and it will only be stable, or tend to grow, if there is a supersaturation equal to or greater than p/P which by the above formula depends on r. The effect of charging the droplet electrically is to reduce the tendency to evaporate. This can be seen by considering that the electrical capacity of a sphere is proportional to the radius, and hence the electrical energy, with a given charge, varies inversely as the radius. This means that the diminution in size and eventual evaporation of a charged drop requires a supply of energy, and will not take place under conditions in which an uncharged drop of the same size will evaporate. J. J. Thomson worked out the theory in detail, and showed, by thermodynamic reasoning, that the above formula becomes, for a drop carrying a charge e,

$$\sigma RT\log\frac{p}{P}=\frac{2\alpha}{r}-\frac{e^2}{8\pi r^4}$$

While for uncharged drops the supersaturation required to produce condensation on a droplet increases steadily as r is diminished, for a charged drop, as shown by this formula, $S=p/P$ has a maximum at a radius approximately 6×10^{-8} cm., and then decreases. A droplet of radius 4×10^{-8} cm. is in equilibrium with saturated vapour above a plane surface, and so droplets of any smaller size grow automatically to this size without supersaturation. The maximum value of S, at $r=6\times10^{-8}$ cm., works out to be about 4.2, so that for this supersaturation, or any greater value, a droplet once begun will grow large. This agrees excellently with the value found by Wilson for condensation on negative ions: the different value found for positive ions requires subsidiary explanatory hypotheses, which are not altogether satisfactory. All of the above numerical values are for the case of water vapour. Experiments have been carried out with other vapours, and the values obtained for the limiting expansion agree well, on the whole, with Thomson's theory. An indication of the difficulties in giving a complete explanation is found in the fact that the relative efficiency of positive and negative ions is reversed, as compared with water vapour, for the vapours of the organic liquids tested.

Apparatus for Obtaining Cloud Tracks.—*Wilson Cloud Chamber.*—For the successful application of the method it is necessary, first, to produce the expansion in such a way as to avoid stirring up the gas, as this would distort the trails of waterdrops which record the paths of the particles, and, second, to ensure that before the passage of the particle no ions or other condensation nuclei are present. In the first form of the cloud chamber used by Wilson, the apparatus was in the form of a circular glass cylinder with the axis vertical. The chamber was closed on top with a glass plate through which observations were made. In later experiments by other workers the axis has frequently been horizontal, and this has required much more careful control of the temperature to prevent turbulence. When the space under the cylinder is connected to an evacuated vessel, the pressure of the air under the piston is suddenly lowered, causing the piston to drop. The extent of its movement is controlled by contact with the floor of the chamber. The chamber used by Wilson in the period between 1911 and 1929 had a diameter of 16.5 cm. with the depth about 3 cm. The apparatus has been variously modified by other workers since: for instance, T. Shimizu, who used a chamber only 6 cm. in diameter, found that perfect tracks could be obtained when the piston was given a reciprocating motion by a simple mechanical device. The frequency of the motion may be as high as 3 oscillations a second, which permits a large number of photographs to be taken rapidly. This form of apparatus was used by P. M. S. Blackett.

A simpler form of cloud chamber was developed by Wilson in 1933 in which the moving piston was replaced by a flexible rubber diaphragm. This diaphragm was separated from the front part of the chamber by a series of wire gauzes that ensured a uniform expansion of the gas in the chamber. The size of the chambers has varied from 2 in. to 4 ft. in diameter, and rectangular chambers have been built as large as 5 by 8 by 4 ft. deep. Chambers mounted in large electromagnets have been of major importance in studies of cosmic rays and high-energy nuclear physics.

An ingenious modification for this purpose was described by Wilson in 1935. In this chamber the gas was expanded radially. Flat glass plates at the front and back of the chamber permitted observation of the condensed drops by illumination which was only slightly displaced from the line of sight. The intensity of light scattered by small droplets increases considerably as the direction of the line of sight approaches the direction of illumination. This chamber also was used in an arrangement in which the chamber was initially between the poles of a magnet, and was dropped immediately after expansion. The tracks were photographed after it had fallen from between the poles of the magnet and was still in free flight. Under these conditions there is no circulating turbulence in the chamber due to thermal effects as the gas in the chamber experiences no gravitational field while falling freely.

For special applications the character of the gas in the chamber has been varied. The rare gases, *e.g.*, helium and neon, are desirable because of their comparatively inert character and because as monatomic gases the expansion ratio required to produce supersaturation is appreciably less than for diatomic and polytomic gases. The condensation vapour has been varied to include many organic and inorganic substances. The use of mixtures of water and ethyl alcohol produced good drops at an expansion ratio appreciably below that required for either alcohol or water alone.

In the study of very low-energy particles, the pressure of gas in the chamber has been reduced to such a point that only the vapour of the condensing substance is present. For high-energy particles the pressure of the gas has been increased to as high as 80 atmospheres pressure. To withstand pressures of this magnitude, strong windows are required. When it is desired to determine the direction of tracks in the cloud chamber, it is, in general, necessary to take simultaneous pictures in more than one direction so that the direction of motion in space can be determined. From such photographs it is a matter of simple geometry to obtain the true angles between the different branches in the case of a forked track.

To remove the background of stray ions that are formed between expansions it is necessary to have an electrical clearing field in the chamber. This field must either be weak enough not to disturb the tracks after expansion, or it must be removed at the time of expansion. Uncharged condensation nuclei can be removed by a series of slow expansions which do not produce appreciable condensation on ions but will produce condensation on dust particles. When sharp tracks are desired, the expansion of the cloud chamber should precede the admission of the ionizing particles or radiation by a few hundredths of a second. The flash of light with which the photographs are taken should be delayed about a tenth of a second in order to permit the drops to grow to a size that will scatter sufficient light for photography. Where it is desired to count the individual drops, the expansion should follow the passage of the ionizing particle so as to permit the ions along the track to diffuse sufficiently so that the individual drops can later be resolved. Continuance of the clearing field during this time is desirable, as this separates the positive ions from the negative ions and simplifies the counting procedure.

Diffusion Cloud Chamber.—In 1950 E. W. Cowan, T. S. Needels and C. E. Nielsen invented a continuously sensitive cloud chamber which superseded one developed by A. Langsdorf. Called a diffusion cloud chamber, it has become a major research tool, particularly in the study of particles from the high-energy accelerators. It is extremely simple to make and to operate, and its use has led to many important discoveries. Cowan's first chamber consisted of an air-filled glass cylinder 12 in. in diameter and 7 in. deep, sitting in a pan of methyl alcohol which was cooled by dry ice. Warm methyl alcohol in a tray near the top of the chamber evaporates and the vapour diffuses downward toward the cooled pan at the bottom. Cloud tracks appear to a height of from 2 to 4 in. from the bottom of the chamber. The cylinder was covered by a glass plate through which the tracks could be observed when illuminated from the sides. A hydrogen-filled diffusion cloud chamber of this type, 19 in. in diameter, and operating at a pressure of 35 atm. in a vertical magnetic field of 22,000 gauss was built in 1954. In the same year a large continuous chamber measuring 4 by 8 ft. was used in the study of cosmic ray showers. At any one instant 1,100 cosmic rays could be seen traversing the chamber.

Applications of the Cloud Chamber.—The importance and usefulness of the cloud chamber lies in the possibility of following in detail the path of a single elementary particle. This apparatus has been used to study the dynamics of the collisions of single particles with atoms and electrons. In the first photographs published by Wilson in 1912, the Rutherford theory of single scattering of alpha-particles by nuclei was clearly verified (*see* NUCLEUS: *Description and History*). When the mass of the penetrating particle exceeds the mass of the particle that is struck, as in the collisions between alpha-particles and protons, the recoiling proton may have a range that is considerably longer than that of the initiating alpha-particles. An example of this is shown in a picture by L. Meitner. Half of the bundle of alpha-particles shown in this picture have passed through a thin film of wax. Wax, being a hydrocarbon, contains large quantities of hydrogen. A recoiling proton with a long range can be seen coming from the group of alpha-particles that have passed through the wax film. A detailed examination of the track due to alpha-particles and other heavy nuclei indicates that the loss of energy along the path is almost entirely due to the ionization produced in the gas. The distance which a high-energy particle will travel is, therefore, proportional to the energy of the particle.

Pictures by J. Chadwick and K. G. Emeleus show the track of alpha-particles from thorium C and thorium C′. Thorium C disintegrates by the emission of a short-range alpha-particle, followed by a beta-particle to form lead, the end of the thorium radioactive series.

In 1923 Wilson used his apparatus to study the ionization produced by X-ray photons in passing through gases. The tracks of electrons that were ejected by the photoelectric absorption of the X-ray quanta were observed. In addition to these long tracks due to high-energy electrons, many short tracks called fish tracks were observed, which were later interpreted as being due to the recoil of electrons that had suffered elastic collisions with photons. The conservation of momentum and energy in such an elastic collision requires that the gain in energy by the electron be compensated by a loss in energy by the photon. This loss in energy by photons results in a reduction of the frequency of the radiation carried by the photon. This phenomenon, known as the Compton effect, was first reported by A. H. Compton in 1921 (*see* COMPTON EFFECT). The importance of Wilson's observations and the apparatus with which they were made was recognized in the awarding jointly to Compton and Wilson of the Nobel prize in physics for 1927.

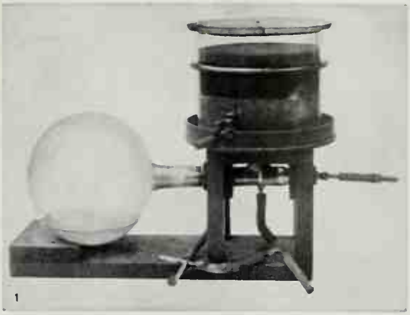
The Wilson cloud chamber has been an unusually powerful and useful tool in the study of cosmic rays. It is possible with a cloud chamber in a strong magnetic field to determine the momentum of a particle and the magnitude and sign of the electric charge carried by it. In 1932 Carl D. Anderson discovered the positron in cloud chamber pictures of cosmic rays. The positron is a particle identical with an electron but with a positive instead of negative sign. Anderson was awarded the Nobel prize in 1936 for this discovery.

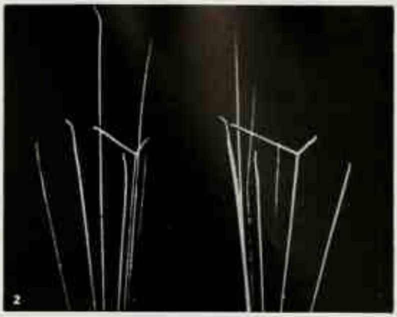
In 1937 S. H. Neddermeyer, Anderson, J. C. Street and L. Fussell presented evidence for the existence in the cosmic radiation of another particle of mass intermediate between that of an electron and a proton. Measurements made in 1946 indicate that the mass of the particle called a meson is very close to 200 times the mass of an electron. It has been observed with both positive and negative charges. From other observations on the properties of these mesons, they are known to disintegrate after a short time, about 2μ sec., releasing an electron with considerable energy. Some cloud chamber pictures have been taken that show the meson disintegrating into an electron. To conserve momentum and energy in these disintegrations it has been necessary to propose the existence of a nonionizing particle that shares in the energy and momentum of the disintegration. This particle is called a neutrino.

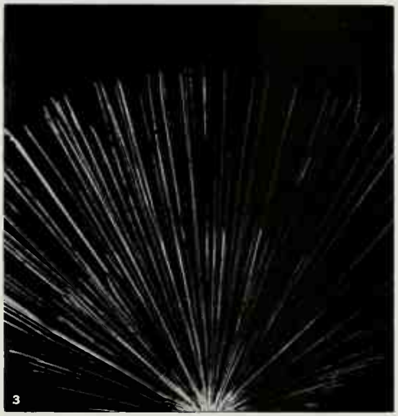
Cosmic-ray showers have been shown to contain cascade production of pairs of positive and negative electrons. Mesons are produced in these showers also.

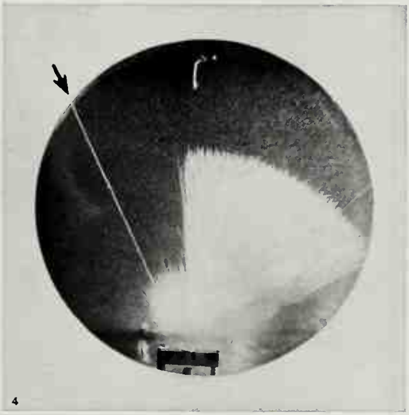
The cloud chamber has been an important instrument in the discovery and identification of new particles. From ionization chamber measurements, Chadwick, in 1932, discovered a neutral particle with a mass nearly identical with that of a proton. This particle is called a neutron. Wilson cloud chamber pictures have given direct and convincing evidence for the existence of this particle. The recoil of protons from hydrogen gas in the chamber due to the neutrons gives information about the energy and abundance of these particles.

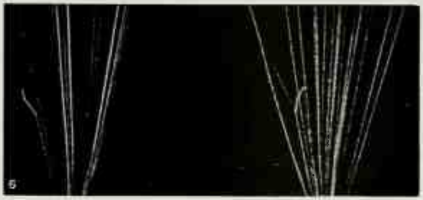
The bombardment of normally stable nuclei by high-energy particles with resulting disintegration of the nucleus was first shown in the cloud chamber pictures taken by Blackett of the bombardment of nitrogen by alpha-rays, in which the proton ejected from the nitrogen nucleus was shown. In this nuclear reaction a helium nucleus with 2 positive charges and a mass of 4 unites with a nitrogen nucleus with 7 positive charges and a mass of 14 to form an unstable fluorine atom with 9 positive charges and a mass of 18. This unstable fluorine atom disintegrates with the ejection of a proton with 1 positive charge and unit mass, leaving an oxygen atom with 8 positive charges and a mass of 17. The production of high-energy protons by the bombardment of nitrogen with alpha-particles was observed first by E. Rutherford in 1919, and he is therefore credited with having performed the first man-made nuclear reaction, but the clear interpretation of this observation was due to the cloud chamber measurements of Blackett. The disintegration of lithium produced by bombardment with protons was first observed by J. D. Cockcroft and E. T. S. Walton in 1932. In 1947 G. D. Rochester and C. C. Butler discovered heavy mesons (K mesons) produced in cosmic rays. Cloud chamber observations of these phenomena and many other reactions have been

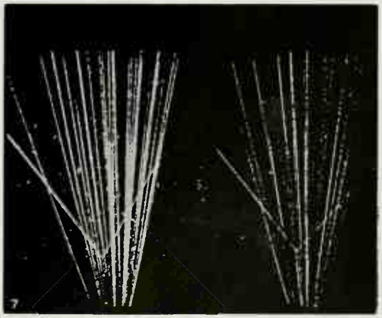










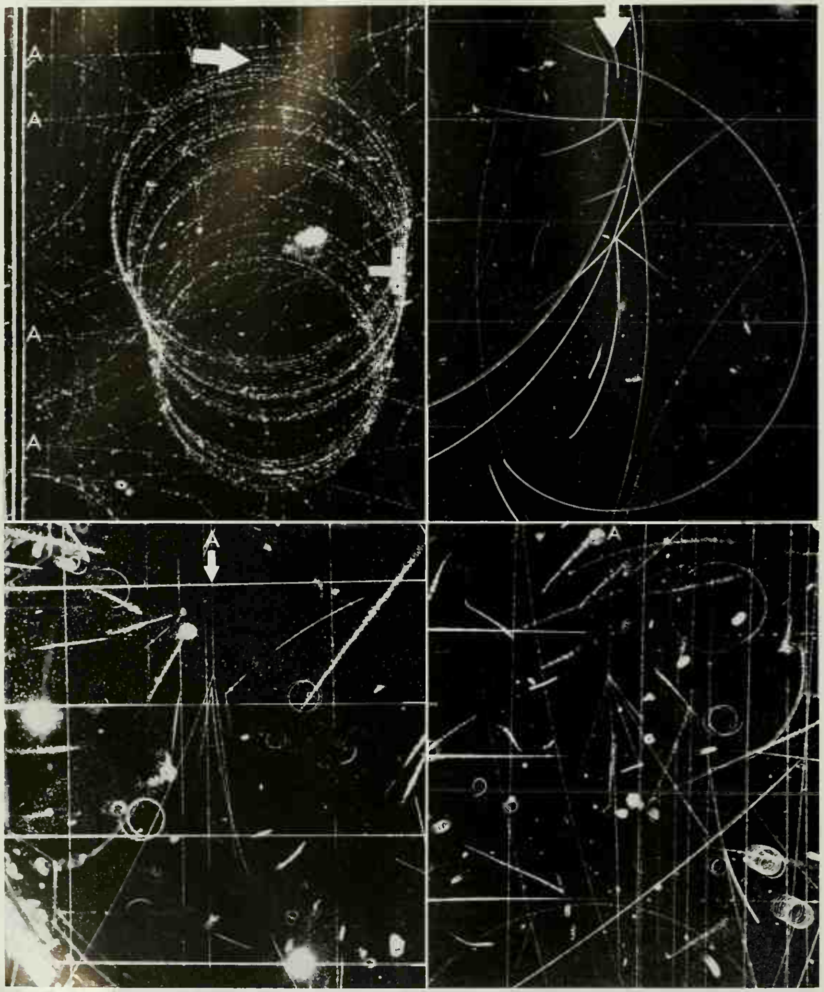


BY COURTESY OF (1, 5, 6, 7) THE ROYAL SOCIETY

RENDERING VISIBLE THE PATHS OF SWIFT ELECTRIFIED PARTICLES BY MEANS OF CLOUD TRACKS

1. The apparatus of C. T. R. Wilson for obtaining cloud tracks. 2. Pair of photographs of α-particle tracks in oxygen showing nuclear collision. (Blackett). 3. Tracks of α-particles from thorium C + C′ showing two distinct ranges, the shorter due to thorium C, the longer to thorium C′. (Chadwick and Emeleus). 4. Track of α-particles, half of which have passed through a film of paraffin wax, showing expulsion of proton (Meitner). 5. Track of single α-particle (C. T. R. Wilson). 6. Pair of photographs of α-ray tracks in nitrogen, showing expulsion of proton. The path of the proton appears as a fine line at extreme left in left-hand picture and next to extreme left in right-hand picture (Blackett). 7. Pair of photographs of α-particle tracks in helium, showing nuclear collision (Blackett)

CLOUD CHAMBERS



BY COURTESY OF THE RADIATION LABORATORY OF THE UNIVERSITY OF CALIFORNIA

MAKING VISIBLE THE EFFECTS OF NEUTRONS AND X-RAYS AND THE PATHS OF PROTONS AND MESONS CREATING V PARTICLES AND OTHER MESONS

Top left: A 42 mev (million electron volt) X-ray coming in from the left creates an electron and a positron in argon gas filling a Wilson cloud chamber. A magnetic field of 12,000 gauss makes the particles curve. The positron and electron tracks start at the tip of the arrow. The positron curves clockwise and forms the long spiral. The electron curves upward in a counter-clockwise direction and leaves the picture at the upper right hand corner. Electrons and positrons can be seen starting in pairs from the left side of the chamber at points marked *A*.

Top right: Invisible 90 mev neutrons break up three oxygen atoms into four fragments each. The long spiral is a 1.8 mev proton. The neutrons are going in the direction of the arrow and do not leave tracks

Bottom left: 5.3 bev (billion electron volt) protons traverse a 35 atmosphere diffusion chamber filled with hydrogen gas. The centre proton, entering at *A*, hits a hydrogen atom and produces two V particles, one just below the collision point, and one to the right. The magnetic field is 22,000 gauss. The small spirals are electrons, the horizontal lines are clearing field wires. The broad tracks are old tracks from cosmic rays

Bottom right: 4.7 bev negative π mesons traverse the 35 atmosphere diffusion chamber. One of them, entering at *A*, strikes a hydrogen atom and creates four new π mesons used extensively in the field of nuclear disintegration and fission.

Bibliography.—For the theory of the condensation on ions, and a general account of C. T. R. Wilson's work *see* J. J. Thomson and G. P. Thomson. *Conduction of Electricity Through Gases,* vol. i (1933). C. T. R. Wilson's chief papers are: "On Condensation of Water Vapour in the Presence of Dust-free Air," *Phil. Trans.,* 189:265 (1897); "On a Method of Making Visible the Paths of Ionizing Particles Through a Gas," *Proc. Roy. Soc.,* A, 85:285 (1911); "On an Expansion Method for Making Visible the Tracks of Ionizing Particles in Gases and Some Results Obtained by Its Use," *Proc. Roy. Soc.,* A, 87:277 (1912); "On Some α-Ray Tracks," *Proc. Camb. Phil. Soc.,* 21:205 (1922); "Investigations on X-Rays and β-Rays by the Cloud Method," *Proc. Roy. Soc.,* A, 104, I, 1923, A, 104, 192 (1923). The best published collection of cloud chamber pictures, together with an extensive discussion of the operation of the cloud chamber is found in *Atlas Typischer Nebelkammenbilder* by W. Gentner, H. Maier-Leibnitz and W. Bothe (1954). Additional excellent pictures can be found in *Cloud Chamber Photographs of the Cosmic Radiation* by G. D. Rochester and J. G. Wilson (1952). An excellent reference book is *The Principles of Cloud Chamber Technique* by J. G. Wilson (1951). The theory of the diffusion cloud chamber is to be found in "A Theory of Diffusion Cloud Chambers" by R. P. Schutt, *Rev. of Sci. Instrum.,* 22:730 (1950).

(E. N. da C. A.; R. B Be.; W. M. P.)

CLOUDED TIGER (Clouded Leopard), a large arboreal cat *Panthera* (*Neofelis*) *nebulosa,* found in southeast Asia, Sumatra, Java, Borneo and Formosa. The coat of this beautifully marked cat—grayish-brown spotted with dark patches edged with black—resembles that of the marbled cat (*Felis marmorata*), with which it is not related, however. It has an elongated head, a body and tail each about three feet long and rather short limbs. The upper canine teeth are proportionately longer than in other members of the cat family, enabling it to kill large game, although it usually preys on small mammals and birds. (J. E. Hl.)

CLOUET, FRANÇOIS (*c.* 1515/20–1572), French painter of portraits and genre subjects, who immortalized in his portraits the society of the Valois court, was born at Tours. The son of Jean Clouet, he was known under his father's surname, Janet, a fact which created a persistent confusion between the works of these two painters. François worked with Jean possibly as early as 1536 and replaced him in 1540 as official painter to the king Francis I. He continued in this office, serving under Henry II, Francis II and Charles IX. He directed a large workshop in which miniaturists, enamel designers and decorators carried out his projects. In addition to portraits he painted genre subjects including nude figures, *e.g.,* "Lady in Her Bath" (Washington), and theatrical scenes attested by an engraving and by a picture representing a "Scene of the Commedia dell' Arte" (Thyssen Coll., Lugano); he also supervised the funeral ceremonies and the triumphal entries of the kings. It has been possible to identify his work on the basis of two signed pictures, "Lady in Her Bath" and the "Portrait of Pierre Quthe" (1562, Paris), and of another one bearing a 16th-century ascription to him, "Portrait of Charles IX, Full-Length" (probably 1569, Vienna). Around the preparatory drawing for the last picture may be assembled about 50 portrait drawings (Chantilly, Paris and Leningrad, etc.) and several painted portraits, the best of which are: "Francis I on Horseback" (about 1545, Florence); "Odet de Coligny" (1548, Chantilly); "Elizabeth of Valois" (about 1558, Toledo, O.); "Henry II, Full-Length" (1559, Florence); "Charles IX as a Boy" (1561, Vienna); and "Elizabeth of Austria" (about 1571, Paris).

In comparison with his father, François Clouet shows a much greater variety both in subject and in style. He seems to have had three different manners. One appears in his court portraits in which he follows the conception of his father; another in his less formal yet monumental portrait of Quthe, influenced by the Italians (such as Giambattista Moroni or Cecco di Salviati, who worked in France); the third manner combines the Netherlandish tradition of genre painting with the stylization of the school of Fontainebleau and bears some analogy to the art of some Italianate Flemings, such as Jan van Hemessen and Jan Massys. On the whole, François's range as an artist is much wider than that of Jean Clouet. He is a typical Renaissance painter, closely related to the humanistic circles and praised by many poets of his day, including Pierre de Ronsard and Joachim du Bellay. As a portrait painter he is less profound than Jean, although he is able to render a more vivid, more fleeting expression of the face. His drawings show an almost dry precision, an elegant stylization and a clear-cut plasticity—features that are typically French. He is in fact the most representative painter of the French Renaissance.

For bibliographical references *see* Clouet, Jean. (C. Sg.)

CLOUET, JEAN (*c.* 1485–1540), known also as Janet or Genet, French painter of royal portraits and religious subjects, celebrated for the depth and delicacy of his characterization. Records show that he was not French by origin and never naturalized; that he had already come to France during Louis XII's reign (1498–1515); was official painter of Francis I as early as 1516; and was appointed groom of the chamber from 1533, thus enjoying the salary and social position granted to the most prominent poets and scholars of the time. In the early 1520s he lived in Tours, and from 1529, in Paris. He painted chiefly portraits but, at least in the earlier part of his career, he also produced religious subjects (a "St. Jerome" in 1522; designs for the "Four Evangelists," 1523). He died in 1540.

Until recently Clouet's work was known only on the strength of an assumption. It consisted of a group of about 130 preparatory drawings representing members of the French court between 1520 and 1540 (most of them in the Musée Condé, Chantilly, and in the Bibliothèque Nationale, Paris) and in a small group of miniatures and oil paintings, the drawings for which can be found among those of the first group. None of these is signed or documented as the work of Jean Clouet. But the discovery and the cleaning of the portrait of Guillaume Budé, now at the Metropolitan Museum of Art, New York city, changed the assumption into a certainty. Indeed, Budé himself stated about 1536 that Jean Clouet had painted a portrait of him and the cleaning revealed in the New York picture a bright blue background like that in the miniature portraits. Since the preparatory drawing for this picture exists in Chantilly and is obviously by the same hand as the other drawings, the attribution to Jean Clouet of all the above-mentioned works ceased to be merely hypothetical. The extant oil paintings by Jean Clouet are: "Dauphin Francis as a Child" (about 1522, Antwerp), "Charlotte de France as a Child" (about 1523, Chicago), "Claude de Guise" (about 1525, Florence), the large "Portrait of Francis I" (workshop of Clouet, about 1525, Paris), "Louis de Nevers" (about 1525–30, Bergamo), "Unknown Humanist With a Volume of Petrarch" (about 1535, Hampton Court) and "Guillaume Budé" (about 1535, New York city). To these should be probably added the "Portrait of a Banker" (1522, Museum of St. Louis, Mo., there attributed to Jan Mostaert), the "Portrait of Madame de Canaples" (about 1523, Edinburgh) and the "Portrait of an Unknown Humanist Holding a Book" (Poznań), which, although a copy, provides information about an important lost original (about 1535–40). In all these portraits the hands differ considerably, and were probably executed by apprentices in Clouet's workshop. This body of works shows Clouet as one of the best 16th-century portrait painters, both incisive and delicate in the psychological characterization of sitters. His drawings are simple, broad and subtle; his paintings are fresh in colour, mellow in modeling and minute in execution. His technique seems fundamentally Flemish (he came probably either from Brussels or from the old Franco-Flemish region of Valenciennes), but his supple drawing, his calm plasticity and his acute analysis of the individual are typically French. In his youth he could have been influenced by the already ancient French tradition of portrait drawing. On the other hand, his monumental composition is influenced by the Italian Renaissance portraiture introduced into France by Andrea Solario. Some of Clouet's portraits show also similarities with those by Holbein, who in his turn borrowed the technique of portrait drawing in coloured chalks during one of his trips to France. The manner of Clouet became the source of continuous tradition of portraiture in France, until the appearance of Degas.

Bibliography.—L. Dimier, *Histoire de la peinture du portrait en France au XVI^e siècle,* 3 vol. (1924–26); E. Moreau-Nélaton, *Les Clouets et leurs Emules* (1924); C. Sterling, *A Catalogue of French Paintings* (1955). (C. Sg.)

CLOUGH, ANNE JEMIMA (1820–1892), promoter of the higher education of women and first principal of Newnham college, Cambridge, was born at Liverpool, Lancashire, on Jan. 20, 1820, a sister of the poet Arthur Hugh Clough (*q.v.*). When two years old she was taken to the U.S., returning to Liverpool in 1836. She opened a school there after her father's business failure in 1841. In 1849 she studied in London, teaching at the Borough road and the Home and Colonial schools, and in 1852 she opened a school at Ambleside, Westmorland. A strong supporter of the movement for the higher education of women, she worked with Emily Davies, Frances Mary Buss, Henry Sidgwick and others. She played a prominent part in founding the North of England Council for the Higher Education of Women and was its secretary (1867–70) and president (1873–74). She persuaded James Stuart, the founder of university extension, to give lecture courses in the north, and this led to the admission of women to the colleges at Manchester and Newcastle. When Henry Sidgwick planned a house for women students at Cambridge, Miss Clough was selected as principal. It opened in 1871 with five students; its success led to the building of Newnham hall (1875) and the foundation of Newnham college (1880). Miss Clough died at Cambridge on Feb. 27, 1892.

See Blanche Athena Clough, *Memoir of Anne Jemima Clough*, 2nd ed. (1903); Mary Agnes Hamilton, *Newnham, An Informal Biography* (1936). (S. J. C.)

CLOUGH, ARTHUR HUGH (1819–1861), English poet, is best known as the author of "Say not, the struggle nought availeth," and for his friendships with Matthew Arnold, who commemorated him in *Thyrsis*, and with Florence Nightingale, whose cousin, Blanche Smith, he married.

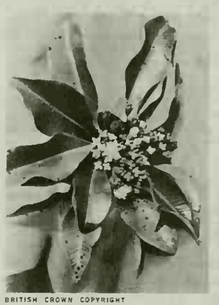
Clough was born in Liverpool on Jan. 1, 1819, and was educated at Rugby, where he was one of Thomas Arnold's most brilliant and devoted pupils, and at Oxford, where he was a scholar of Balliol and fellow of Oriel. He went up to the university intending to become a clergyman, but could not bind himself to the dogmas of the Church of England and resigned his fellowship in 1848. After three years in London as principal of a students' hostel, followed by eight months in Massachusetts, where he was treated with great kindness by Emerson, Lowell and other admirers, he obtained a post as examiner in the London education office. In 1859 his health began to fail, and he died in Florence on Nov. 13, 1861.

Clough was a clever, kindly, thoughtful man of almost passionate intellectual sincerity, who stood firmly by his disbeliefs, but without arrogance or intolerance. Some of his poetry is mild and flat, and little of it is musical; it is curious that, in an age that admired Tennyson, Arnold and Swinburne, his *Poems* (1862) should have been so popular that they were reprinted 16 times within 40 years of his death. But his best verse has a rare flavour, quite unlike that of any other Victorian, much closer indeed to the taste and temper of the 20th century. Unfortunately for his reputation, two of his chief works are in English hexameters, a metre which he handled with exuberant dexterity, but which is strange to ears unused to classical prosody. *The Bothie of Tober-na-Vuolich*, "A Long-Vacation Pastoral" (1848), describes an Oxford reading party in Scotland. "Amours de Voyage," also in hexameters, is based on Clough's visit to Italy in 1849, and contains a brilliant assortment of reflections and descriptions, including an eyewitness account of the siege of Rome. Clough's sharpest shafts against Victorian humbug are in "The Latest Decalogue":

> Thou shalt not kill, but need'st not strive
> Officiously to keep alive.

Bibliography.—H. F. Lowry, F. L. Mulhauser and A. L. P. Norrington (eds.), *Poems* (1951); F. L. Mulhauser (ed.), *Correspondence* (1957). There are memoirs by S. Waddington (1883), J. I. Osborne (1920) and G. Levy (1938). (A. L. P. N.)

CLOVE, the small, unopened flower bud of the tropical *Eugenia caryophyllata* tree, Myrtaceae (*q.v.*) family, was a major item in the earliest spice trade. Centuries before Christ, envoys from Java to the Han court of China brought cloves, customarily held in the mouth to perfume the breath during audiences with the emperor. Southern Arabian peoples plied the Indian ocean coasts before recorded history to bring spices from the East Indies to the Persian gulf, and from there by caravan to Alexandria or other eastern Mediterranean ports. Empires grew from the spice trade. Venice, dominating the Mediterranean, controlled and taxed Arabian trade destined for Europe. Venice fell when Portuguese navigators, learning to circumnavigate the Horn, founded an empire in the far east, only to be ousted a century later by the Dutch.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CLOVES (EUGENIA CARYOPHYLLATA) IN VARIOUS STAGES OF RIPENING

During the late middle ages all Europe depended upon the orient for spices, cloves finding use as food preservative, flavouring and garnish. Clove-growing was confined almost entirely to Indonesia. In the early 17th century the Dutch issued a directive for eradication of cloves on all islands except Amboina and Ternate, to create scarcity and sustain high prices.

In the latter half of the 18th century the French succeeded in smuggling cloves from the East Indies to Indian ocean islands and to the new world. Dutch monopoly was broken, never again to threaten abundant supplies. In 1768 when a Dutch resolution forbade clove tree propagation, there were 1,500 tons of cloves in Batavian warehouses, and enough in Holland to supply European needs for ten years. Cloves still come from Indonesia, but the greatest production is in Zanzibar and Madagascar.

The clove tree seldom reaches 50 ft. The gland-dotted leaves are small, simple and opposite. Trees are usually propagated from seeds, planted in beds having protective shading. A single tree may yield up to 75 lb. of dried buds. Flowering begins about the fifth year, with harvest in late summer and again in winter. Buds are picked by hand as they redden, then are sun-dried. In the dried cloves, the characteristic four sepals can be noted at the base of the bulbous bud.

Cloves are strongly pungent due to the aromatic oil eugenol, extracted by distillation to yield oil of cloves; it is used in clearing microscope slides, germicides, mouthwashes, as a local anesthetic for toothaches, in the synthesis of vanillin and in perfumes as a sweetener or intensifier. (R. W. Sy.)

CLOVELLY, a quaint fishing village, popular with tourists and artists, on Barnstaple bay, north Devon, Eng., 43 mi. N.W. of Exeter by road. Pop. (1951) 533. Its main street is cobbled and descends 400 ft. in wide steps and stages, which are too steep for wheeled traffic. At the bottom is a small cove with a pier and a pebble beach, and down either side cluster little old houses, whitewashed and gaily painted. The village is built in a rocky cleft with thick woods sheltering it on three sides so that the climate is mild. Clovelly is described by Charles Dickens in *A Message From the Sea* (1860).

CLOVEN-FOOTED ANIMAL, the popular designation for any member of the order Artiodactyla (*q.v.*), which includes sheep, cattle, deer, antelopes, goats and swine (*qq.v.*).

CLOVER, the name for plants belonging to the genus *Trifolium*, so-called from the leaf, which has three leaflets (trifoliolate). Clover is a member of the family Leguminosae and contains about 250 species. Many other plants also are called clover, but most of these belong to different genera of the legume family. Species are found on every continent, and in all except Australia certain ones form a part of the native flora. Species of agricultural importance appear to have originated in southeastern Europe and southern Asia Minor. The plants are small, annual or perennial herbs with trifoliolate leaves (rarely with five or seven leaflets) with stipules adnate to the leafstalk, and heads of small red, purple, white or yellow flowers or shades thereof; the small one- to few-seeded pods are enclosed in the calyx. Clovers are best adapted to cool, humid climates, either the summer months in the temperate zones or the winter months in countries that do not have severe cold. The perennials may behave as annuals, depending upon the severity of unfavourable climate, diseases or insect pests.

Many species are extensively cultivated in all countries, while others form an important part of the native vegetation.

Agricultural Species.—The most important agricultural species are red clover (*T. pratense*) (fig. 1), with round, light to dark purplish-red clover heads, the most widely cultivated species from Siberia to Chile, botanically a perennial but agriculturally more of a biennial; white clover (*T. repens*), a stem-creeping, node-rooting perennial, abundant in good pastures, meadows and lawns, the most widely naturalized species, with flowers borne on small round heads, white to pinkish, becoming brown and reflexing as the seed matures; alsike clover (*T. hybridum*), common in meadows and moist habitats, botanically a perennial but agriculturally mostly a biennial, with flower heads resembling those of white clover; crimson clover (*T. incarnatum*), with pointed heads of bright crimson flowers (fig. 2), a winter annual in climates where winters are not severe, or a restricted summer annual in high latitudes; large hop clover, *T. campestre* (*T. procumbens*) mostly a winter annual widely naturalized in pastures and along roadsides, with small round heads of bright yellow flowers; small hop clover, *T. dubium*, in Europe synonymous with *T. minus* and commonly called shamrock, similar in all respects to large hop clover but with smaller and fewer flowers per head; sub clover (*T. subterraneum*), a winter annual with decumbent stems, and heads of few, cream-coloured flowers borne inconspicuously under the foliage (after fertilization the flowers reflex and bury the developing seed under the surface of the soil); Persian clover (*T. resupinatum*), mostly a winter annual, having small flat heads of lavender flowers with calyx inflating as maturing; strawberry clover (*T. fragiferum*), a creeping, node-rooting perennial with round, slightly pointed heads, with pinkish flowers, calyx inflating as maturing, tolerant to soil salinity, preferring moist habitats; berseem clover (*T. alexandrinum*), a winter annual having spikelike heads of white to cream flowers, not tolerant to heavy frosts; cluster clover (*T. glomeratum*), a winter annual with small round heads of dull rose-coloured inconspicuous flowers, the heads borne on short stems in leaf axils, rough and spinelike upon maturity; rose clover (*T. hirtum*), a winter annual with heads similar to red clover, rose nonshowy flowers, leaves and stems densely hairy; and ball clover (*T. nigrescens*), a winter annual, having round small heads, similar in colour to white clover. More than 50 native species of clover occur on the Pacific coast and in the Rocky mountain region, but east of the Mississippi river only 4 native species occur.

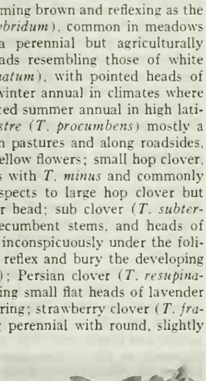
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FIG. 1.—RED CLOVER (TRIFOLIUM PRATENSE)

Cultivation and Uses.—Clover was cultivated in the Netherlands about the mid-16th century and possibly by the Letts 1,000 years earlier. Sir Richard Weston originally introduced clover from Flanders into England as a field crop about the mid-17th century. He was the first to introduce into England the rotation of crops, using clover as a soil-improving crop. Clovers are grown alone or in mixtures with other legumes and different grasses. They thrive in soils having a high phosphorus, calcium and potassium content either natural or supplied by fertilizers. The forage is highly palatable to livestock and is high in protein and in phosphorus and calcium, thus making valuable livestock feed in either the green or the dry stage. In addition to their principal value as animal feed in the form of hay, pasture and silage, the clovers are valuable soil-improving and conserving plants. Depending on the thickness of stands, degree of inoculation and amount of growth when plowed under, clover adds 50 to 150 lb. per acre of nitrogen to the soil and increases availability of other nutritive elements for crops that follow. Diseases and insects are important in the production of clovers, affecting the length of life of the plant and its reproduction; many diseases and insects are worldwide wherever clovers occur; others are limited to specific countries. The length of the photoperiod where the strain or variety originates also is important to its adaptation in different locations.

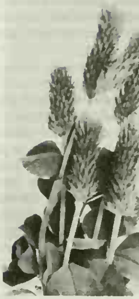
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FIG. 2.—CRIMSON CLOVER (TRIFOLIUM INCARNATUM)

Varieties and Strains.—Many varieties and strains of each species occur, representing forms best adapted to the environments, developed both by natural selection and by plant breeders. The basic chromosome numbers of the genus appear to be six, seven and eight. Of the species studied, the somatic numbers of chromosomes range from 12 to about 130. Many important species, such as red clover, white clover and alsike clover, are principally self-sterile. Cross-pollination resulting in seed setting is brought about by insects, principally bees, which visit the flowers for nectar and pollen. Other species, such as the hop clovers and Persian clover, are self-fertile and self-pollinating; still others, such as crimson clover, are self-fertile but not self-pollinating.

Distribution.—All the above-mentioned clovers are grown in the U.S. Berseem clover is grown only in limited areas in southern Arizona and California; cluster clover in southern Mississippi; sub clover in the coastal section of the Pacific states and limited areas of the southern states; rose clover on the coastal ranges of California; and ball clover in limited areas of the southern states bordering the Gulf of Mexico. Other more widely grown species are Persian, grown on the heavy low-lying soils of the southern states; the hop clovers from Kentucky southward and the Pacific northwest; strawberry clover throughout the irrigated lands of the western states; crimson clover from New Jersey and Kentucky southward as a winter annual and in northern Maine as a summer annual; white clover in all states where there is sufficient moisture and required plant foods; Ladino clover, a large-growing variety of white clover of major importance, in improved humid and irrigated pastures throughout the U.S. and Canada. The principal red clover belt is east of 98° longitude and north of 35° latitude, in the Pacific northwest and irrigated lands of the western states, but its planting was increasing in the southern states in the second half of the 20th century. The planting of alsike clover was decreasing, being replaced by Ladino white clover and red clover. Red clover, white clover, alsike clover and the hop clovers were widely grown in the British Isles; sub clover was the basis of an extensive sheep and cattle industry in Australia; while white clover was the legume of the New Zealand dairy pastures.

Seeding and Growth.—Red clover, alsike clover and Ladino white clover may be seeded with companion grain crops, alone and in mixtures with grasses and other legumes. Chances of obtaining thick legume and grass stands are increased if the green grain crop is grazed off or cut in the dough stage for silage. If there is adequate moisture after the grain is harvested, light grazing or a small hay crop may be produced the first year. Weeds are controlled by clipping once or twice during the seeding year and using specific weed killers. The heavy crop occurs from the second year's growth. If clover is seeded with grass, the stands are usually left through the third year; otherwise, the aftermath is plowed under for cultivated row crops in the fall of the second year or the next spring. Failure to establish and maintain stands may be due to improper seedbed preparation, heavy seedings of rank, late-maturing grain crops, deficiencies of plant foods (phosphorus, potassium and calcium), diseases and insects, the use of unadapted varieties and strains and thick weed infestation. Most other clovers are used principally for pastures and soil improvement and are seeded on turf or with grasses. When the clover is seeded on turf, the grass must be either closely grazed or clipped, or thick sods thoroughly disked or plowed, and adequate quantities of phosphate and potash fertilizers and limestone applied to obtain successful seedings.

Common Types.—In America there are two recognized common types of red clover, medium and mammoth, better called double- and single-cut, which are comparable with but not the same as the English double-cut and single-cut clovers. To conditions in the U.S., none of the European clovers are adapted, and their use leads to poor stands and low yields; likewise, strains adapted to one section of the red clover belt do poorly in another. Improved varieties are developed by state and provincial agricultural experiment stations and the United States and Canadian departments of agriculture. Kenland, Pennscott, and Dollard in the United States; LaSalle and Altaswede in Canada; Montgomery late and Aberystwyth S.123 in England represent improved red clover varieties. White clover varieties differ widely, varying from Ladino and Pilgrim of the large type, Louisiana S.1, Aberystwyth S.100 and New Zealand of the intermediate type to English wild white and Aberystwyth S.184 of the low-growing type. Dixie, Auburn, Autauga, Chief and Talladega are crimson clover varieties of the reseeding type. With their development, the acreage of crimson clover increased many times in the southern states. The Mt. Barker, Tallarook and Nangeela (Australian) varieties of sub clover are widely grown in the coastal section of the western states, while in Australia there are more than 10 extensively used varieties.

Seed Production.—The seed of most clovers, except that of Ladino white clover, is generally produced where the plants are extensively grown for livestock feed and soil improvement; after 1948, more seed of red clover varieties was produced under irrigation in the western states. Weather conditions and other factors in the western states, generally more favourable than in the humid east, are more conducive to the production of large quantities of high-quality seed. The winter annual species produce seed in the spring and are perpetuated by the seed that volunteers in the fall.

See also references under "Clover" in the Index volume.

See publications of the State Agricultural Experiment Stations and the United States Department of Agriculture. (E. A. H.)

CLOVIO, GIORGIO GIULIO (1498–1578), Italian miniature painter and priest, by birth a Croat, was said to have studied at Rome under Giulio Romano and at Verona under Girolamo de' Libri. His book of 26 pictures representing the procession of Corpus Domini, in Rome, was the work of nine years, and the covers were executed by Cellini. The British museum has his 12 miniatures of the victories of the emperor Charles V. A manuscript life of Frederick, duke of Urbino, is superbly illustrated by Clovio (Vatican library), and many other works are doubtfully attributed to him. He sometimes exceeded the limitations of his medium in attempts to sustain the art of illumination.

CLOVIS (CHLOOOVECCHUS) (*c.* 466–511), king of the Franks, the founder of the Merovingian power in western Europe, was only 15 years old when, in 481 or 482, he succeeded his father Childeric I as king of the Salian Franks. Childeric, who was in treaty relations (*foederatus*) with the Roman empire, had established his power in part of the old Roman province of Belgica Secunda, making his capital at Tournai. The exact stages by which, in the course of 30 years, Clovis extended his power from this little kingdom till he was ruling over a domain almost as great as modern France are still a matter of much controversy. Evidence is scarce, and Gregory of Tours, whose *Historia Francorum* is the main source for the career of Clovis, wrote so long after his reign that in his account legend and reality are inextricably mingled.

Clovis' first aim was to conquer the district between the Somme and the Loire, controlled by Syagrius (*q.v.*) the last representative of Roman rule in western Europe. With the assistance of other Frankish tribes under their chieftains Chararic and Ragnachar to whom he was related, Clovis invaded the territory and defeated the army of Syagrius outside Soissons. Syagrius fled to Toulouse, but the Visigothic king Alaric II, fearful of offending the victor of Soissons, sent him captive back to Clovis, who had him put to death (486). In the following years, by means of war, intrigue and murder, Clovis increased his power at the expense of other Frankish tribes: in the words of Gregory of Tours, "he killed many other kings and several of his close kinsmen, fearful lest they should supplant him or diminish his authority."

Clovis married a Burgundian princess, Clotilda (*q.v.*), niece of King Gundobad; she was an ardent Catholic, and at once set about winning Clovis to her faith. Gregory of Tours gives a detailed account of his conversion, which followed a memorable victory over the Alamanni. The Alamanni, who were reputed to be the most formidable of the barbarian invaders of Gaul, were occupying the area between the Vosges, the Rhine and Lake Constance. Prevented by the armies of Theodoric, king of the Ostrogoths, from expanding toward Italy, they turned instead toward the northern lands settled by the Franks. First they attacked the Ripuarian Franks, penetrating deeply into their country until they were repulsed in a battle at Zülpich, southwest of Cologne. The Alamanni then attacked the Salian Franks. It is not clear where the battle took place, but Clovis routed them. According to Gregory, this victory determined him finally to acknowledge Clotilda's God, whose aid he had solicited during the battle. He was baptized, with more than 3,000 of his warriors, by St. Remi, bishop of Reims. According to Gregory of Tours, the conversion of Clovis took place in 496; but his chronology is not necessarily accurate, and A. Van der Vyver has ascribed these events to the year 506.

Clovis had vanquished Syagrius and the Alamanni: there remained, in southern Gaul, the Burgundians to the east and the Visigoths to the west. These two races had been Christian for a century, but adhered to the Arian heresy. The Gallo-Roman population and clergy under their oppressive rule naturally looked for liberation to the victorious and Catholic Salian Franks. Clovis turned his attention first to the Burgundians. Having allied himself secretly with Godegesil, the Catholic king of Geneva, he attacked the Arian Gundobad, whose capital was Lyons, and defeated his army near Dijon. Gundobad fled to Avignon; Clovis followed and besieged him until Gundobad promised to pay him tribute.

Several years later Clovis won a much more decisive victory over the Visigoths who occupied southwestern Gaul. At the battle of Vouillé (507), near Poitiers, their king Alaric II was killed and his army routed. The Franks then took possession of his capital, Toulouse. Despite help from the Ostrogothic king Theodoric, the Visigoths lost to Clovis all their land in Gaul except Septimania, a strip bordering the Mediterranean.

Clovis, victor of Vouillé, returned to Paris in 508, breaking his journey at Tours to offer gifts in the church of St. Martin. Here, according to Gregory, he received an embassy from Constantinople and was given the diploma and invested with the insignia of a Roman consul. This story, once questioned by historians, has been corroborated to some extent by later research.

Fearless in battle, astute and ruthless in eliminating his rivals, Clovis also showed qualities of more considerable statesmanship. The *Lex Salica*, a Latin redaction of the penal law of the Salian Franks, was drawn up on his orders (*see* SALIC LAW). He moreover convened, at Orléans, in July 511, the first church council held in Gaul which can be described as national rather than provincial. Clovis died in Paris, which he had made "the seat of the kingdom" (*cathedra regni*) and his normal place of residence, on Nov. 27, 511. He was buried in the church of the Holy Apostles SS. Peter and Paul (later known as the church of Ste. Geneviève) which he and Clotilda had built on the hill on the south bank of the Seine overlooking the island where his palace stood.

See also references under "Clovis" in the Index volume.

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CLOVIS, a city of eastern New Mexico, U.S.; seat of Curry county. In 1907 the Santa Fe railroad set aside a half section of land for a townsite on its new route across New Mexico and Alice Ripley, daughter of the president of the railroad, who was studying the reign of King Clovis, suggested the town name. The chant of the cattle auctioneer is a familiar sound, for Clovis is a major livestock centre. Flour and feed milling, wheat raising, irrigation farming, trade and transportation activities and the Cannon air force base contribute to a prosperous economy. Eastern New Mexico university is 19 mi. distant at Portales. For comparative population figures *see* table in NEW MEXICO: *Population*. (G. M. FI.)

CLOWN, a familiar comic typed character of pantomime and circus (*qq.v.*) with recognizable dress and make-up whose aim is to induce hearty laughter. He usually follows a permanent routine which most commonly is to fail miserably in all that he does.

Early ancestors of the clown were the bald-headed, padded, stupid fools in Greek and Roman mimes. They persisted through the middle ages in secular farces and as court fools. In the Commedia dell'arte (*q.v.*), comic types appeared with mountebanks in theatres and fairs and Zanni, Arlecchino and Pierrot improvised dialogue and developed professional routines. Elizabethan clowns were called merry-andrews. In the 18th century, Harlequin (*q.v.*) and companions appeared in pantomimes with harlequinade and transformation scenes. Joseph ("Joey") Grimaldi (*q.v.*) displaced Harlequin as a clown and set the whiteface tradition. "Joey" influenced the circus clown, who first appeared at Philip Astley's riding school (afterward Astley's amphitheatre), as a comic on horseback and a talking clown.

In the 1860s a low-comedy buffoon appeared under the name of Auguste, who had a big nose, baggy clothes, large shoes and untidy manners. He worked with a whiteface clown, and always spoiled the latter's trick by appearing at the wrong time to mess things up. In Germany and Austria a stock figure, Hanswurst (*q.v.*), appeared in the 16th century and was popular through the 19th century. Other buffoons included the grimacing, musical, singing, rubber and vanishing clowns. With the three French Fratellini brothers, the Auguste-clown act became an art: François was the whiteface Pierrot (similar to Jean-Baptiste Gaspard Deburau, pantomimist, creator of lovesick, pale Pierrot) and Paul and Albert were the buffoons.

Grock (*q.v.*) (Adrien Wettach), the whiteface pantomimist, failed in everything he did. When he sat on a chair to play a concertina, the chair would collapse. He carried a tiny violin in a huge portmanteau. When a stool was too far from a piano, he shoved the piano to the stool. His sadness is comparable with that of Emmett Kelly, the U.S. vagabond clown. *See* also FOOL (JESTER).

See Marian Murray, *Circus! From Rome to Ringling* (1956); Joseph Kennard, *The Italian Theatre* (1932); Maurice Willson Disher, *Clowns and Pantomimes* (1925). (JN. H. M.)

CLOYNE (CLUAIN-UAMHA), a small market town of County Cork, Republic of Ireland, about 18 mi. E.S.E. of Cork by road. Pop. (1961) 612. Its Gaelic name signifies "the meadow of the cave," from the limestone caves of the vicinity. An ecclesiastical foundation of the 6th century, it has an ancient oratory and a cathedral (mainly 14th century) dedicated to St. Colman, disciple of St. Finbar of Cork. Opposite the cathedral is a fine round tower 100 ft. high. The town suffered from Scandinavian raids in the 9th century and was laid waste by Dermot O'Brian in 1071 and burned in 1137. In 1430 the bishopric was united to that of Cork, in 1638 it became independent, and in 1660 it was again united to Cork and Ross. It became independent once more in 1678 and so continued until its reunion with Cork in 1835. The *Pipe Roll of Cloyne* compiled by Bishop Swaffham in 1364 is a valuable record of medieval land tenure. It is now in the record office, Dublin, and was edited in 1859. The cathedral contains a memorial to Bishop George Berkeley (*q.v.*), the philosopher, who became bishop of Cloyne in 1734. The town gives its name to a Roman Catholic diocese with a cathedral at Cobh.

CLUB. The ancient Greek hetaeria and the Roman *sodalitas* may be regarded as early ancestors of the modern club, although they were in fact loose associations of like-minded companions rather than true clubs in the modern sense of that term. Among the Greeks, religious organizations that worshiped esoteric deities not recognized by the state religion were the most important, but political, commercial and athletic associations also flourished, together with dining clubs whose members met to eat together and exchange ideas.

In Rome, religious and trade clubs were common but, like their Greek predecessors, they were nearer to sects or trade guilds. The Roman political clubs were more like modern clubs in aim and organization but they tended to degenerate into unruly cabals and were suppressed by Julius Caesar as dangerous to public order. Burial clubs existed among poorer people to help them provide their dead with the expensive funeral rites then considered necessary. Cicero in *De Senectute* mentions symposia which, he says, he enjoyed as much for the conversation as for the well-cooked meals. Though some of these early societies elected committees and drew up definite rules, they had little in common with the modern club. Probably the true club spirit was most often found in the unorganized but more or less regular gatherings of friends at the Roman public baths.

BRITISH CLUBS

The Rise of English Clubs.—The earliest English club of which we have certain knowledge was Le Court de Bone Compagnie, described in a poem, *La Male Règle*, by Thomas Hoccleve, who was a member. It flourished in Henry IV's reign and was evidently a dining club, meeting in a house near the Middle Temple, London. The Elizabethan Friday Street, or Bread Street, club was also a dining association; it met in the famous Mermaid tavern, and is said to have been founded by Sir Walter Raleigh. About 1616 Ben Jonson founded the Apollo club in the Devil tavern by Temple Bar. Its many distinguished members included Lucius Cary, Sir John Suckling, Robert Herrick and Lord Herbert of Cherbury. Though purely masculine in membership, it adopted the modern-seeming practice of admitting ladies on special nights.

With the rise of coffeehouses in the mid-17th century, clubs acquired more or less settled homes and began to take on distinctive characters. The landlord of a coffeehouse usually allotted a special room to the club's use. For this he made no charge, relying for his profit on the food and drink consumed by the members and the distinction conferred upon his house by the presence of notable men. At this period the term "club," in its modern sense, first came into common use. "We now," says John Aubrey, "use the word clubbe for a sodality in a taverne." In 1660 Samuel Pepys mentions Woods' tavern in Pall Mall where he and his friends went "for clubbing."

Among the most notable political clubs of the 17th century was the Rota, founded by James Harrington in 1659. It was strongly republican in sentiment and included among its members Lord Algernon Sidney and Lord William Russell (both of whom were subsequently executed for their supposed parts in the Rye House plot), Sir William Petty and Andrew Marvell, the poet. Pepys calls it the Coffee club, perhaps because it met in Miles' coffeehouse in Westminster. The Sealed Knot was a royalist association, while the Green Ribbon club (sometimes called the King's Head club from the Chancery lane tavern in which it met) was an organization of influential malcontents under the leadership of Lord Shaftesbury. In 1693, White's, which in the 18th century was to become a prominent Tory stronghold, began its long career in the chocolate house owned by Francis White. In its beginnings it was social rather than political and derived its clublike characteristics from White's determination to keep his clientele select and from the strict rules he enforced. The original chocolate house stood in St. James's street, on the present site of Boodle's. In 1697 the business was transferred to the opposite side of the road where it was later carried on by John Arthur, the founder in 1765 of the club known as Arthur's. In 1736 White's became a private club, and 19 years later it moved to its present site in St. James's street.

Of nonpolitical Stuart clubs, two of the best known are the Royal Navy (1674), prototype of the 19th-century service clubs, and the Wednesday, founded by William Paterson in the Dog and Whistle tavern, Friday street. Paterson was the financial genius of his era and at his weekly meetings the project that resulted in the creation of the Bank of England was first evolved.

The 18th-Century Clubs.—The number and variety of clubs increased very rapidly. Many were comparatively short-lived associations, reflecting the more violent phases of contemporary political feeling, or the extravagant and often lawless fancies of idle young men. Among these was the Calves Head club (established shortly after the execution of Charles I) whose chief meeting was held on the anniversary of the execution, when the dishes served included a calf's head, representing the defeated king, and a pike, representing tyranny. Others were the various Mug House clubs, most of which were eventually suppressed for their disorderly conduct; the notorious Hell Fire club at Medmenham; and the Mohocks', whose unruly members terrorized law-abiding Londoners. Other societies with odd, and sometimes unedifying, aims are mentioned in the pages of the *Spectator*, and in Ned Ward's two books on club life (see *Bibliography*).

Of the more serious clubs, many were political, or partly so. The October was founded in 1710 or 1711 by a band of Tories dissatisfied with Robert Harley's administration. The Cocoa Tree began as a Jacobite association and became a private club in 1746. Jonathan Swift was a leading member of both and also of the Saturday (founded by Henry St. John in 1711), the Brothers, and the Jacobite Mourning Bush, afterward called the Fountain. Other clubs that were mainly political were the Hanover, for the more ardent supporters of the new dynasty; the Rumpsteak or Liberty (1734); the Board, mentioned by Horace Walpole in a letter dated 1743; White's, which became definitely Tory under William Pitt's influence in 1783; and its Whig opposite number, Brooks's. The last-named was founded in 1764 as a social and gaming establishment by William Macall, who bought a house in Pall Mall and, transposing the letters of his name, called it Almack's. This club (not to be confused with the more famous Almack's assembly rooms in King street, also run by Macall) was bought by Brooks in 1774. Four years later it was transferred to the present clubhouse in St. James's street and thereafter was always known as Brooks's. Renowned for its high stakes in play and its social brilliance, it was also famous as a leading Whig stronghold and the favourite haunt of Charles James Fox and his associates.

Important and influential as the political clubs were, the literary, artistic and social associations were most characteristic of the period. Many clubs combined these attributes. The members of Brooks's assumed the role of arbiters of literary taste; those of the Blue-stocking moved with equal ease in the learned and aristocratic worlds. The Scriblerus club, founded by Swift in 1714, included men of fashion like the earl of Oxford and Viscount Bolingbroke, and poets like Alexander Pope and John Gay. The Society of Dilettanti (1743) was a gathering of amateur art collectors, whose fine collection of pictures by Sir Joshua Reynolds and Francis Knapton is housed in the St. James's club, Piccadilly, where the Dilettanti hold their dinners. The famous Kit-Cat club, founded at the beginning of the century by Joseph Jacob Tonson, a bookseller, began as a literary association but soon became renowned for its distinguished membership, its toasts and the portraits of members by Sir Godfrey Kneller. The name was derived from Christopher Cat, in whose eating house the first literary reunions were held. In 1749 Dr. Johnson who, like Swift, was an ardent clubman, founded the Ivy Lane club at the King's Head tavern. Fifteen years later he and Sir Joshua Reynolds organized the more celebrated Literary club, usually known simply as "The Club." The original membership was limited to 12 and gradually increased to 40, after which a resolution was passed in 1780 that it should never exceed that number. Oliver Goldsmith, Edmund Burke, David Garrick, James Boswell and Sir John Hawkins were among the earliest members and during the next two centuries many outstanding men joined it. In 1783, not long before his death, Johnson founded yet another club, called the Essex Head, after the tavern near the Strand in which it met.

Boodle's (1763) which, like White's and Brooks's, still occupies its 18th-century home, was one of the more famous social institutions. Originally called the Sçavoir Vivre, it was later named for William Boodle, who became its manager about 1774. This club was renowned for its cuisine. Its beautiful clubhouse in St. James's street is said to have been designed by the Adam brothers. Another fine building is Coventry house, Piccadilly, once the home of the Coventry House club which settled there in 1769, and later occupied by the social and diplomatic St. James's club (1857).

During the 18th century, clubs of the English pattern sprang up in French and German taverns. In 1749, literary Monday club was founded in Berlin and the first purely social club in Germany was inaugurated in 1752. It was followed by a variety of political clubs, many of which were suppressed in 1848 during the revolutionary disturbances. In France small political coteries abounded in the years immediately preceding the French Revolution and contributed largely to the unrest of the time.

Clubs of the 19th and 20th Centuries.—In the 19th century many clubs began to follow the lead of White's and Brooks's in acquiring permanent headquarters, often in the form of imposing houses built for them by well-known architects. They also tended to become more specialized and clubs for those of different professions and interests became usual. This differentiation first appeared in the service clubs. Many officers returning to London at the end of the Napoleonic Wars needed meeting places where they could share meals and reminiscences. The Guards Club was formed in 1813, the United Service in 1815. In 1827 the Junior United Service was founded and, ten years later, the Army and Navy club. These pioneers were followed by the Naval and Military (1862), the Cavalry club (1890), the Junior Army and Navy (1911) and the Royal Air Force (1917). The soldiers and officials of the East India company congregated chiefly at the Oriental (1824) and the East India United Service (1850).

Among civilian specialized clubs, the City of London (1832) and Gresham's (1843) were, and remained, mainly for merchants and bankers as the Farmers' club (1842) was for agriculturists. Membership of the City Livery (1914) is confined to Liverymen of the City. The Garrick (1831) was one of the earlier theatrical foundations. A still earlier example was the Thespian, which flourished in the second half of the 18th century. It was followed by the Green Room (1877), the Rehearsal (1892), the O-P club (1900) and the Vaudeville (1901), to name only a few. Other specialized clubs are the Caledonian (1898) whose members must be of Scottish birth or be regular officers in a Scottish regiment; the Royal Societies (1894), a social club for members of learned societies; and the Travellers' (1819) which is restricted to those who have traveled outside the British Isles for a distance of 500 mi. in a direct line from London.

Of the many literary and artistic clubs founded in the 19th century, the most important was the Athenaeum, inaugurated in 1823 by John Wilson Croker at John Murray's house in Albemarle street. This famous club, to which Sir Walter Scott, Tom Moore and most of the leading writers of that and later days belonged, was first known as the Society. In 1830 it moved to the present clubhouse in Pall Mall, designed for it by Decimus Burton.

Almost as well known are the Savile (1868), once called the New club and generally regarded as a waiting place for the Athenaeum, and the Savage (1857), noted for its early bohemianism. The Arts club came into being in 1863, the Authors' in 1891 and the original centre of the P.E.N. club, an international association of writers and editors, in 1921. The principal university clubs were also formed during the 19th century, the United University and the New University in 1822, the Oxford and Cambridge in 1830, the New Oxford and Cambridge in 1883 and the City University in 1885.

The two outstanding political clubs founded in the 19th century are the Carlton club (Conservative, 1831) and the Reform club (Liberal, 1834). Both occupy houses of considerable architectural importance, that of the Reform club being usually considered the most impressive of its kind in London. They were followed by numerous others: the Conservative (1840); the Junior Carlton (1864); the Cobden (1866); St. Stephen's (1870); the Eighty (1880); the National Liberal (1882); the Constitutional (1883); and the United (1890). These were all West End clubs, the City having its own political organizations, such as the

City Carlton (1868), the City Liberal and various others.

The passion for gambling that marked the latter half of the 18th century continued during the first years of the 19th in most of the older social clubs and in some new ones. In 1806 Watier's club was founded in Bolton street and rapidly became the foremost gambling club in London. "Beau Brummell" (George Bryan Brummell), was one of its prominent members. After a feverish existence of little more than 12 years it perished and what remained of it was then acquired by William Crockford who, in 1828, opened the gambling club named after him. Crockford's was housed in a magnificent building in St. James's street, designed by James Wyatt, which became the home of the Devonshire club (1875). Hazard, whist and card games of all sorts were its principal attractions, but it was also renowned for its excellent meals and for cockfights held in a small cockpit in the basement. Like Watier's, it was short-lived and broke up soon after its founder's death in 1844.

Besides the clubs that had their own premises, there were various dining clubs to do honour to some great man, such as Dr. Johnson, Pepys, Samuel Butler or Charles Dickens, or to provide regular meetings for collectors or persons interested in particular ideas. Grillion's, to which so many illustrious men belonged, was founded in 1813 by Sir Thomas Acland as a centre for men of all shades of political feeling and the Cosmopolitan (1852) and the Breakfast club (1866) were similar nonparty institutions. There were also the Boz, the Erewhon and the Titmarsh for Dickens, Butler and Thackeray enthusiasts; the Roxburghe, the First Edition and the Sette of Odde Volumes for book collectors; the Hardwicke with legal interests, the Urban and many others.

Women's Clubs.—The last years of the Victorian era also saw the rise of women's clubs. An organization known as the Ladies club and referred to by Walpole as "the female Almack's" existed in the 18th century. There were also associations of working women at this period, such as the Mantua-makers' club in St. Martin's lane, and the Milliners' club near the Royal Exchange. In general, however, clubs were exclusively masculine institutions until 1883, when the Alexandria was founded. No man was allowed to enter its premises; on one occasion even the prince of Wales (afterward Edward VII) was refused admittance when he called for the princess. The University Women's club was formed in 1887, the Pioneer in 1892. Three years later the American Women's club for Americans visiting London came into being, and in 1897 the Empress was founded.

Once the idea of such associations was accepted, women's clubs developed with great rapidity. The Ladies' Empire was established in 1902, the London Lyceum in 1904, the Ladies' Carlton in 1906. Thereafter every sort of social, literary, artistic, sporting and political interest had its women's clubs in London and the provinces. There are also many institutions, like the Pilot club (1949), the Lansdowne (1935) and the International Sportsmen's (1929) and others, with both male and female members, and some that admit women as associate members.

Sports clubs have been in existence since the days of the Tudors, when young men gathered in companies with such grandiloquent titles as Prince Arthur's Knights. Among 18th-century clubs of this type may be mentioned the Sons of the Thames, predecessor of the Thames Rowing club (1860) and the London Rowing club (1856); the Royal Thames Yacht club, founded in 1775; the Royal Toxophilite (1781) which has been open to women as well as men since 1920; the Four-in-Hand coaching club; and the famous Hambledon club, started about the middle of the century, whose members laid the foundations of modern cricket. The last-named was dissolved in 1791 but its place was taken by the Marylebone Cricket club (1787), the famous "M.C.C."

About 1750 a number of men interested in horse racing began meeting at the Star and Garter coffeehouse in Pall Mall and there founded the Jockey club to regulate racing and eliminate abuses at Newmarket. The influence of this club soon spread from Newmarket to other courses, and it became the ruling authority in English racing throughout the country. Other clubs connected with the same sport are the Turf, which developed from the Arlington in 1868, the Victoria (Wellington st.) in 1860 and various other clubs connected with particular racecourses.

As well as general clubs like the Sports club (1893), the United Sports (1903) and the Bath club, specialized clubs representing every branch of sport have been established in London and the provinces since the beginning of the 19th century. Some of the more famous specialized clubs are the National Sporting club, devoted to boxing; the hunting clubs, Badminton and Beaufort; the Golfers' and the Lady Golfers'; the Flyfishers' (1884); the London Fencing club (1848) and the Sword (1905); the Alpine (1857), the Ladies' Alpine (1907) and the Ski Club of Great Britain (1903); and the Kennel club (1873). Yachting organizations range from the Royal Yacht squadron at Cowes (1815) and the Royal Ocean Racing club (1925), to the model yacht racing clubs associated with the Round pond in Kensington Gardens. The newer forms of sport are represented by such clubs as the Royal Automobile (1897) and the Royal Aero club, established in 1901.

Rural Clubs.—Rural benefit clubs formed an important part of village life from the late 18th century until the introduction of national insurance in 1912. The members paid a monthly contribution of 2*s.* or more, received sickness and unemployment benefit and a fixed sum, varying in the different clubs, paid to the survivor on the death of a member or his wife. Meetings were held in a room set apart in the local inn and each summer there was a club day with processions, a service in the parish church, sports, dancing and a dinner at the inn. In some parishes there were more than one benefit club, and in some there was also a female club which had its own funds and was quite independent of that of the men. In their early days these rural clubs were purely local institutions but with the growth of the great friendly societies (*q.v.*) they often became branches of such societies, while still retaining their local character. When national insurance was introduced, most village clubs were given up, but a few continued to flourish and to carry on their work. The Greyhound club at Marsh Gibbon, founded in 1788, is one that still pays benefits to its members. Another of the women's clubs which has long outlived its male counterpart is at Much Marcle in Herefordshire.

Club Organization.—The internal economy of clubs varies as much as do their aims or the architecture of their clubhouses. In some the committee has the power of electing or refusing members; in others this is done by a ballot of members. Some, like the Athenaeum, have the right to elect annually a certain number of members on account of their eminence, services to the state, literature, art, science and so forth. The committee is, of course, the responsible body, but in most cases the actual running of the club is largely in the hands of the secretary, control by members being exercised through the annual general meeting.

Clubs are also subject to certain legal restrictions and duties. Since the Licensing act of 1902 (passed primarily to prevent the formation of clubs for the sale of liquor), every club has to provide the clerk to the justices of the petty sessions area in which it is situated with yearly information concerning its membership, subscription and general conduct. The details of the laws covering club management may be studied in *Daly's Club Law* edited by C. J. Collinge (5th ed., 1954) and *Wertheimer's Law Relating to Clubs* edited by A. W. Chester (4th ed., 1935). *See* also WORKING MEN'S CLUBS; SERVICE CLUB.

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UNITED STATES

The number and variety of clubs in the United States demonstrate the prevalence of "joining" among the American people. As distinguished from many other expressions of this voluntary associationalism, clubs usually place greater stress upon sociability and are more apt to be local in nature than chapters of national organizations.

Although U.S. clubs derived from English prototypes of the late 17th and early 18th centuries, their appearance was understandably belated. The colonial period lacked both the city life and the leisure necessary for their development. Nevertheless, as early as the mid-18th century the success of Benjamin Franklin's Junto in Philadelphia, Pa., and the spread of Masonic lodges suggested that associational activity would presently become a prominent part of American life. Urban growth in the late 19th century not only made clubs possible by assembling groups large enough for specialized interests of nearly every sort but also made clubs essential to provide adequate social outlets in the impersonal metropolis.

The most direct imitations of English clubs (see *British Clubs* above) are the socially exclusive gentlemen's clubs existing in most large cities, such as the Somerset club of Boston, Mass., and the Pacific Union club of San Francisco, Calif. Admitting only those of high social and financial standing, they usually have fine buildings with eating, drinking, reading and athletic facilities. Other clubs, while highly selective, make some form of literary, artistic or intellectual interest the basis for affiliation rather than wealth or social background. In differing ways the Lambs and Players clubs of New York city, the Cosmos club of Washington, D.C., and the Bohemian club of San Francisco could be placed in this category. Slightly different are the large number of luncheon and dinner clubs, usually composed of business and professional men, which may or may not have their own buildings. Although the social element also predominates in these, they are often basically discussion groups which do little more than meet periodically for that purpose.

All the clubs mentioned tend to be highly restrictive in membership, but there are also many organizations open to all individuals sharing a mutual interest. Ever since the rise of "Democratic societies" among the opponents of the Federalist administration in the 1790s, political clubs have been prominent examples of this type. A vast network of such groups now forms the basis of U.S. political parties, at the same time affording considerable social opportunities for their members. In the late 19th century, when ward clubs in large cities became identified in some minds with corrupt political machines, good government advocates began founding the modern city clubs and commonwealth clubs, which are largely devoted to the study of public affairs and the improvement of government. In addition to these groups, which also often have their own buildings, innumerable less pretentious civic clubs developed in smaller communities or even neighbourhoods throughout the country. The average businessman, however, has preferred to join one of the service clubs such as the Rotary, Exchange, Kiwanis or Lions clubs. Good fellowship is one of their main attractions, and they sponsor many worthwhile programs to serve community welfare.

With the steady decline of working hours in the 20th century, came the existence and even the problem of far more leisure time for large numbers of people. Not surprisingly organizations have appeared catering to recreational interests of almost every description. In particular, because of the restrictions of urban life, a wide variety of athletic clubs arose. Golf clubs, for example, appeared in or near every metropolitan area. In the form of elaborate country clubs, many furnished additional facilities that enabled them to serve the entire family unit. With their restaurants, bars and Saturday night dances, they increasingly became the social centres for well-to-do suburban residents; thus the term "country club set" became part of the American vocabulary.

In addition to clubs in which the emphasis is on social exclusiveness, civic activity or avocational interests, many neighbourhood clubs have been formed along national or religious lines. There are still many survivals of the social clubs formed by various immigrant groups, and nearly every large American religious denomination has affiliated clubs that are important in the social as well as religious lives of their adherents.

The form of club life most characteristic of the United States, however, is the women's club, a striking demonstration of the leisure that has become available, at least to the urban middle-class woman. Organizations like the Chilton club, in Boston, the Colony club in New York city, and the Acorn club in Philadelphia parallel the exclusive men's groups, but far more significant are the numerous women's clubs of general membership which, beginning with the New England Women's club of Boston and the Sorosis of New York (both founded in 1868), spread so rapidly that by 1889 the General Federation of Women's Clubs was formed (*see* WOMEN'S CLUBS, GENERAL FEDERATION OF). At first concentrating on subjects such as literature, art and gardening, they extended their interests to include social problems and public affairs until the American clubwoman became a far more representative figure than the clubman.

There are, of course, numerous organized clubs for children in the United States, such as the Boy Scouts, Girl Scouts and, in rural areas, the 4-H clubs *(qq.v.)*. (WE. E. D.)

CLUBFOOT, the popular name for a medical condition characterized by abnormal position and shape of the foot and caused by a congenital deformity of the foot and ankle. In the more severe examples three distinct components of the deformity may be recognized, but in milder cases one or another of these may be lacking. The most constant component is plantar flexion of the foot at the ankle so that the foot points downward. Next most common is inversion of the foot, which is a rolling in of the sole of the foot so that the soles of the feet face each other. The third component is adduction of the forefoot, which is an extreme pigeon-toe deformity. All of these deformities are rigidly maintained so that the foot may not be returned to normal position. Each of the deformities may be present in varying degrees from mild to severe. At an early age these deformities result from abnormal pull of tendons and contracture of the ligaments, but over a period of years and particularly after weight bearing, bony deformity may appear and prevent correction of the deformities. In approximately half of the patients, both feet are involved.

The cause of clubfoot is essentially unknown. Many theories have been advocated, but none has been proved. The most popular theories involve pressure or faulty position in the uterus and hereditary influences. None of these theories has any foundation in experimental evidence. In observations on animals, typical clubfoot deformities in the offspring have been produced by excessive exposure to X-rays of a pregnant animal or by vitamin-deficient diets given a pregnant animal.

Treatment of the clubfoot depends upon the severity and multiplicity of the deformities. The treatment should begin early in infancy when the tissues are more pliable than later in life and before bony deformity occurs. In the extremely mild deformity, whether of plantar flexion, inversion or adduction of the forefoot, simple manipulation by the physician or the parent may suffice. In the more severe deformities, splints, plaster of Paris casts or special shoes may be necessary. Numerous methods for applying the splints and casts have been devised, but all depend upon the reversal of the deformities at an early age so that the muscles, tendons and bones may grow normally.

More severe or untreated deformities may require surgery upon tendons or bones or both. Treatment must be continued until all component deformities are corrected. Following adequate and complete correction, observation of the person must be continued until growth ceases. This is necessary because of the tendency toward recurrence of these deformities when the child is passing through a period of rapid growth. If adequate treatment is started early in infancy, the patient should be able to lead a normal life with normal activity. Frequently, similar deformities of the feet follow poliomyelitis or other diseases. In these instances, braces and surgery may be required because of muscle weakness or fixed deformity.

Abnormalities opposite to those of clubfoot frequently occur. These include increased dorsiflexion of the foot so that the foot points upward rather than downward, and eversion of the foot so that the sole faces outward. These deformities are usually more flexible than those of clubfoot and are more amenable to simple methods of treatment.

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CLUB MOSS, the common name for plants of the genus *Lycopodium* (*q.v.*), but often extended to cover all the Lycopodiales, an order of the class Lycopsida, which includes chiefly extinct relatives of club mosses. *See* Paleobotany.

CLUBROOT (Finger-and-Toe or Anbury), a destructive plant disease caused by a relatively simple fungus parasite—one of the phylum Myxomycophyta—known as *Plasmodiophora brassicae*, which attacks cabbages, turnips, radishes and other cultivated and wild members of the mustard family (Cruciferae; *q.v.*). The disease is recognizable by the presence of nodules or warty outgrowths on the roots, which usually become greatly swollen and ultimately rot, emitting unpleasant odours. The disease is contracted from minute round spores present in the soil which germinate in the spring, forming motile biflagellate cells which infect the young roots of the host plant. The parasite develops within the living cells of the plant, forming more motile cells in sporangia (spore sacs) and finally a mass of living material known as the plasmodium, the shape of which alters from time to time. The infected cells are stimulated to enlarge enormously in size (hypertrophy), and the parasite spreads from cell to cell. Ultimately the plasmodium cleaves into numerous minute spores which are set free in the soil as the host roots decay. The disease is more frequent in acid soils, and lime in various forms is used to control it. A dressing of 1,500–2,000 lb. per acre of hydrated lime will give fair commercial control. Diseased plants should be either burned or thoroughly boiled before feeding to animals in order to prevent transmission of the living parasite into the manure. More details on control practices are found in J. S. Karling's *The Plasmodiophorales*, pp. 104–120 (1942). (J. S. Kg.)

BY COURTESY OF DEPT OF PLANT PATHOLOGY, UNIVERSITY OF WISCONSIN

YOUNG CABBAGE PLANT INFECTED WITH CLUBROOT

CLUJ (Ger. Klausenburg; Hung. Kolozsvár), a town of Rumania, the historic capital of Transylvania (*q.v.*), is located 200 mi. (322 km.) N.W. of Bucharest in the Someşul-Mic river valley. Pop. (1960 est.) 161,931. It is the administrative centre of the Cluj region and the second largest town in Rumania. Cluj stands on the site of an ancient Dacian settlement which under the Romans became the Napoca municipium and an important military post. In the middle ages it was a thriving commercial and cultural centre, and in 1405 Sigismund of Luxembourg, king of Hungary, declared it a free town. Among its historic monuments are the house in which Matthias I Corvinus, king of Hungary, was born (1440); the ruins of the Mînăştur church, built in 1061; the ruins of the walls of the Cluj citadel; and the Gothic church of St. Michael, begun in 1321 and completed in 1444.

Cluj is important industrially, with machine-building, metalworking, chemical, textile, clothing, leather and footwear, timber, glass, ceramics and food-processing plants. Among its cultural institutions are a branch of the Academy of the Rumanian People's Republic, the Bolyai university, the Ion Andreescu Institute of Fine Arts, a polytechnic institute, a school of music and a number of research institutes. The Ethnographical Museum of Transylvania has a section on the world's primitive peoples. The Cluj botanical gardens are the richest in Rumania.

Cluj Administrative and Economic Region is situated in the northwestern part of Rumania. Area 16,820 sq.km. (6,494 sq.mi.). Pop. (1960 est.) 1,199,842. It is divided into 14 administrative districts. The relief is hilly and the region is surrounded by high mountains. The climate is continental and temperate. Chief rivers are the Someşul-Mare, Someşul-Mic, Almaş, Mureş, Crişul-Repede and the Arieş.

The mineral resources of Cluj include methane gas deposits, salt, brown coal, silver, gold, copper, limestone, clay, gypsum, dolomite and building stone. There are mineral springs at Sîngeorz. The region's important metallurgical industry developed on the basis of its mineral wealth. In addition to the many industries in the town of Cluj, there are chemical plants at Ocna-Mureşului and Turda, building materials, glass and ceramics factories at Turda, leatherwork at Bistrița and Turda and food-processing plants at Bistrița, Dej and Cherla. Agricultural products include grains (maize, wheat, barley and rye), potatoes, sunflower, hemp, colza, fruits and grapes for wine. Animal husbandry is practised.

CLUNY, a town of east central France, in the *département* of Saône-et-Loire, on the left bank of the Grosne, 14 mi. N.W. of Mâcon. Pop. (1962) 3,293. The interest of the town lies in the association with it of the monastic order of Cluny, a body of Benedictines (*q.v.*), and in its specimens of medieval architecture, which include, besides the celebrated abbey, the Gothic church of Nôtre-Dame, the church of St. Marcel with its Romanesque spire, portions of the ancient fortifications and a number of old houses. Cluny gradually increased in importance with the founding of the abbey (910) and the development of the religious fraternity, and in 1090 received a communal charter from the abbot St. Hugh. In 1471 the town was taken by the troops of Louis XI. In 1529 the abbey was given *in commendam* (in trust) to the family of Guise. The town and abbey suffered during the religious wars of the 16th century, and the abbey was closed in 1790.

The chief remains of the abbey are the ruins of the basilica of St. Peter and the abbot's palace. The church, built between 1090 and 1131, was a Romanesque building, and until the erection of St. Peter's at Rome was the largest in the world. It was in great part demolished under the first empire, but the south transept, a high octagonal tower, the chapel of Bourbon (15th century) and the ruins of the apse remain. The abbot's palace (15th century) serves as *hôtel de ville* (town hall), library and museum, containing fine sculptures from the church and paintings by Pierre Paul Prud'hon, a native of Cluny. There are local quarries of limestone. (Ar. E. S.)

CLUSIUM (modern Chiusi in the *regione* of Tuscany, Italy), the Roman name for an ancient Etruscan town, founded in the 8th century b.c., on the site of a prehistoric Umbrian town. The Etruscan form of the name was perhaps Clevsia; its pre-Etruscan name was Camars and the early inhabitants might have been connected with the Umbrian tribe of Camertes. In Roman times however its inhabitants belonged to the tribe Arnenses. In the early 6th century b.c. it entered in alliance with Arretium (Arezzo), Volaterrae, Rusellae and Vetulonia against Tarquinius Priscus of Rome. At the end of the 6th century it featured under the leadership of Lars Porsena in an attempt to restore the power of the Tarquins in Rome. By 391 b.c. it was allied with Rome against the invading Gauls and in 205 supplied the Roman army which was fighting Hannibal. Under Sulla it was refounded as a military colony. In imperial times it seems to have been rather isolated although according to Columella its agricultural land was highly productive.

Excavation of the cemeteries of Clusium, from the early 19th century onward, has shown it as an important centre of Etruscan art as well as importation of Greek pottery. The cemeteries are on a series of hills around Chiusi: Poggio Renzo and Poggio Gaiella to the north and northeast, Dolciano, Chianciano and Montepulciano to the northwest, and at Città della Pieve and Sarteano to the southeast and southwest. Material from these tombs is housed in the museums of Chiusi, Florence, Palermo (Cassuccini collection) and Rome (Villa Giulia).

Long after the coastal towns of Etruria had adopted inhumation, the inhabitants of Clusium retained the practice of cremation, begun in their early Villanovan culture, down to Roman times (*see* ETRUSCANS). Characteristic of the earliest cremations was the placing of the ashes in earthenware jars whose large "canopic" lids (*see* CANOPUS) were molded in the form of human heads. These and the series of pottery human figures, many with distinctive traits of portraiture, were placed in pit tombs dated by the presence of proto-Corinthian and locally copied pottery to the late 8th and 7th centuries B.C. From these anthropomorphic jars and effigies, often placed in the tombs on elaborate thrones, the later custom of portraying the deceased on sarcophagi may have evolved: they certainly had a formative effect on early Etruscan sculptures. In the 6th and 5th centuries, the figures, often of man and wife, are reclined upon the lid of the funerary box or sarcophagus. The sides of these boxes are often adorned with scenes in low relief of dances and funeral games and, from the 5th century, mythological scenes. In addition to their artistic merits, these sarcophagi are a major source of inscriptions in the Etruscan language. The sarcophagi were themselves placed in large chambered tombs, some of which, the Tomba della Scimmia, del Colle, del Granduca, di Tassinaia, have important painted frescoes. One such built chambered tomb, crowned with pyramids and bells, was famous in antiquity and is described by Pliny the Elder as the tomb of Lars Porsena. It is perhaps to be identified with a tomb on the Poggio Gaiella.

There are also remains at Clusium of catacombs of the Christian era and it was the seat of a bishopric in the 4th century A.D.

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CLUTCH, a coupling by means of which rotating parts may be connected or disconnected. A clutch may be used to connect two shafts end to end, or to connect a free-riding hub to the shaft on which it rotates. Clutches may be designed for automatic application, one-way drive, controlled slip to vary the relative speeds of the driving and driven members, and for slippage at predetermined torque.

Positive-drive clutches consist of cylinders with mating jaws attached to each rotating member; the jaws are engaged at low relative speeds. The jaws may consist of sections such as those in fig. 1, or teeth on the periphery of the cylinders, as in gear clutches. For heavy loads the jaw clutch may have two or three teeth, but for quicker engagement considerably more teeth must be used. To facilitate engagement, light spring-loaded cone clutches (fig. 2) may be used to bring the speed of the slower member up to that of the faster one, as is done in selective geared (synchromesh) automobile transmissions.

Clutches built into internal-combustion engines to permit load engagement after operating speed is obtained are known as power take-offs; clutches used to couple a driving motor to a shaft are known as cutoff couplings. Friction in some form is used to absorb energy by slippage during engagement and is sufficient to maintain constant speed during normal operating conditions. Contact may be made on the faces of disks, the inside or outside peripheries of drums, the surfaces of cones or wedge-shaped grooves, or combinations of these.

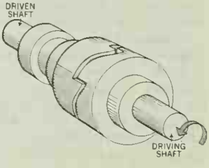
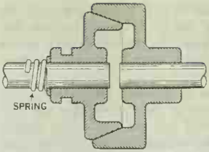


FIG. 1.—SPIRAL CLAW, OR RATCHET, CLUTCH (*See* TEXT)

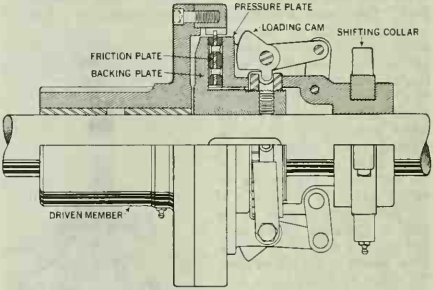


ADAPTED FROM V. M FAIRES, "DESIGN OF MACHINE ELEMENTS," 3RD ED., REPRODUCED BY PERMISSION OF THE MACMILLAN COMPANY

FIG. 2.—SPRING-LOADED CONE CLUTCH

Axial-Force Clutches.—The cone clutch (fig. 2) has had extensive use because the normal force between the contact surfaces is much greater than the axial force needed to engage the two cones. The contact may be metal-to-metal, or a lining of leather, cork or special friction fabric may be attached to the male cone. The female cone ordinarily is unlined, contact being made on the finished surface of the cast iron. The torque transmitted is equal to the product of the normal force, the coefficient of friction, and the mean radius of the cone.

The cone clutch is relatively heavy and it is often limited in capacity because suitably large cone diameters cannot be accommodated in restricted machine spaces; therefore, it becomes unsuitable if large torques must be transmitted at high speeds. Also, the inertia of the heavy cone causes it to continue rotating for a time after disengagement, a feature that may be undesirable.



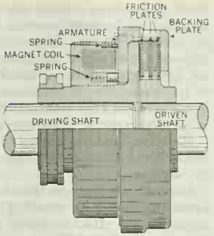
BY COURTESY OF LINK-BELT COMPANY

FIG. 3.—INDUSTRIAL DISK CLUTCH

The disk clutch is a compact type of clutch actuated by axial force. The industrial clutch coupling shown in fig. 3 illustrates such an application for controlling the rotation of a driven shaft. The sleeve to which that shaft is attached rides freely on a bearing. An extension of the hub carries the friction plate, restraining it from relative rotation but allowing axial movement. The friction plate is between a backing plate and a pressure plate connected to the hub and keyed to the driving shaft. When the shifting collar is moved to the left, the linkage forces the pressure plate against the friction plate, which is stopped by the backing plate. Both surfaces of the friction plate are subjected to the full axial force and resist slippage. The friction plate is made of flexible steel covered with a friction material and runs dry (without lubricant). When gradual engagement is desired, as in power take-off clutches, the friction plate may be divided into sectors by radial cuts and warped slightly. Upon engagement the edges contact first and deflect gradually until the whole plate is in contact. The same effect may be achieved by putting springy spots on the surface of the plate.

It can be seen that a series of plates, alternately connected to the driving and driven hubs, would increase the clutch capacity in direct proportion to the number of pairs of contacting surfaces. This type of clutch is called a multiple-disk clutch. A multiple-disk magnetic clutch is shown in fig. 4.

Multiple-disk clutches with plates alternately of bronze and steel operating in oil are used extensively on machine tools. Two



FROM "INDUSTRIAL POWER CLUTCHES" (FEB. 1948); REPRODUCED BY PERMISSION OF "POWER" MAGAZINE

FIG. 4.—MULTIPLE-DISK MAGNETIC CLUTCH (*See* TEXT)

clutches arranged back to back and operated by a single shift collar permit quick reversal of a shaft. Such clutches are called duplex-disk clutches and can be engaged and disengaged in fractions of a second.

Power take-off clutches are held in engagement by springs, except when disengaged by overcoming the force of the pressure springs. Single disks, faced with woven or molded asbestos surfaces and operated dry, are satisfactory for automobile use. Heavier vehicles use multiple-disk clutches, usually dry.

Rim-force clutches utilize the force applied to either the inside or outside circumference of a drum by wooden blocks, lined shoes, an expanding internal ring, a contracting external band or combinations of these. Many variations of the rim clutch have been devised. Great force may be exerted against an internal rim by blocks forced outward by toggle action. Wedges are also used to expand the blocks radially. Split-ring clutches may be operated by cams that force apart the split ends of the ring.

In external-band clutches the band is fixed at one end and a force is applied at the other end to wrap the band around the drum.

Coil clutches utilize a coil spring of rectangular cross section. One end of the spring is fastened to the driving plate and the other end can be actuated, through a leverage system, to force the spring to wrap snugly around a drum fastened to the driven shaft. Coil clutches may be designed for high-capacity applications.

Air Clutches.—Clutches may be classified also according to the means used to actuate them. Instead of being controlled by mechanical linkages, which in large sizes may be sluggish to operate, the clutch action may be controlled by the pressure of air or of a hydraulic fluid. Here the use of a piston, valve and tubing simplifies the clutch but requires an external source of pressure.

An air clutch consists of a tube, similar to an automobile pneumatic tire, that can be expanded by air under pressure, forcing the outer surface of the tube, covered with a friction material, against the inner surface of a drum. This clutch may be used for heavy-duty applications as a power take-off, clutch coupling or slip clutch.

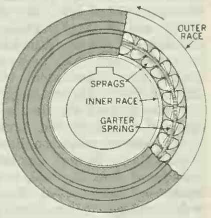
Magnetic Clutches.—Magnetic clutches are friction-disk clutches engaged by energizing a magnet coil which attracts a steel disk with the necessary axial force to resist slipping. When the energizing current is discontinued the plates are free to turn separately.

The magnetic fluid clutch uses a mixture of magnetic particles (powdered iron) in oil within the annular space between concentric drums, either of which may contain an electromagnetic coil. As the coil is energized, the magnetic particles form chains, and the viscosity of the mixture increases practically to that of a solid when the coil is fully energized. Controlled by a small current, the load may be engaged smoothly, without the "chatter" or wear typical of mechanical clutches. There is no slippage when the magnetic fluid clutch is transmitting the torque for which it is designed.

Automatic Clutches.—Automatic clutches are designed to allow the driving shaft to attain a preselected speed before engagement takes place. Such action is desirable where motors are used to drive equipment which has high inertia and friction when starting. Rim friction clutches are modified so that the shoes or bands are applied by the centrifugal force of a weight in the rotating system or by the weight of the shoes themselves. Another design consists of paddles on a hub which rotate inside a drum. The inner surface of the drum is serrated, and the enclosed space is partially filled with steel shot which is thrown outward by the paddles as they accelerate. At a certain speed the shot accumulates on the rim ahead of the paddles and transmits the force necessary to drive the drum. A similar clutch uses the centrifugal force of a heavy fluid, such as mercury, to create the force necessary to engage friction surfaces. The fluid is confined in a flexible container.

Single-revolution clutches, used on punch presses, make one revolution after engagement and are then released automatically by a tripping mechanism. One-direction, or free-wheeling, clutches are designed to drive in one direction only and permit free movement when the speed of the driven element exceeds that of the driver. A positive-drive ratchet engaging a toothed wheel will drive in one direction only. Similar effects can be obtained by rollers moving outward along ramps on a member rotating inside a drum. Force is transmitted by the jamming action of the rollers against the drum. Rotation in the opposite sense causes the rollers to move to the bottom of the ramp, out of contact with the drum. A comparable effect may be obtained with negligible backlash by inclined blocks, or sprags, tilted between the surfaces of concentric drums.

Fig. 5 shows rounded blocks retained in position by garter spring.



FROM "INDUSTRIAL POWER CLUTCHES" (FEB 1948); REPRODUCED BY PERMISSION OF "POWER" MAGAZINE

FIG. 5.—FREE-WHEELING CLUTCH (*See* TEXT)

Coupling-Type Clutches.—Electric or magnetic couplings are frequently classified as clutches, although there is a slip of about 3% between driving member and driven member at full load. The magnetic type has an outer member with a laminated core and squirrel-cage winding and an inner member with a field pole construction like that in a synchronous motor, but without the damping winding. When direct current flows through the field coils, there is generated in the squirrel-cage winding a current that transmits torque in proportion to the field excitation.

The eddy-current clutch uses an eddy-current ring instead of the laminated core and squirrel-cage winding, and a single-coil magnet. The ring is made of special magnetic steel and its periphery is slotted to carry the flux across the ring face and also to radiate the heat generated. In the larger eddy-current clutches, water cooling is necessary.

Hydraulic couplings have found extensive application as power take-offs for internal-combustion engines. The hydraulic unit consists of a vaned impeller attached to the driver, which faces a similarly vaned runner attached to the driven shaft, both enclosed in a casing with oil. At rest the oil is in the bottom of the casing, and thus the impeller starts with very small resistance. As the speed of the impeller increases, the oil is propelled to the vanes at the outer periphery and the oil drives the runner with increasing speed. When the impeller circuit is completely filled with oil, the speed of the runner is about 3% less than that of the impeller. The speed ratio may be controlled by limiting the quantity of oil in circulation. Various elaborations of design result in an effective torque converter.

Having no mechanical connections, the electric and hydraulic couplings do not transmit shock; they will slip when overloaded, and hence will not stall the driving engine.

See also AUTOMOBILE; POWER TRANSMISSION. (E. S. A.)

CLÜVER (CLUWER, CLUVERIUS), **PHILIPP** (1580–1622), German geographer, the founder of historical geography, was born at Danzig. He was sent to study law at Leiden, but turned to ancient history and geography. After a period as a soldier and of traveling in most of Europe, he settled in Leiden in 1615, where in 1616 he was appointed *geographus academicus*, with an annual stipend. He died prematurely and in poverty on Dec. 31, 1622. His principal works are *Germaniae antiquae libri III* (1616, 1631, 1663), *Sicilia antiqua cum . . . Sardinia et Corsica* (1619, 1624, 1659), *Italia antiqua*, two volumes (1624), his main work, posthumously published and *Introductionis in universam geographiam*

. . . *libri VI* (1624, 1652; in French, 1639; in German, 1678).

See J. Partsch, "Philip Clüver der Begründer der historischen Länderkunde," *Geogr. Abh.*, v (1891). (K. A. S.)

CLWYD, the principal river of northeast Wales, draining parts of Denbighshire and Flintshire. It rises at a height of 1,200 ft., about 7 mi. S.W. of Ruthin, its total length is 35 mi. and it reaches the sea by the town of Rhyl. In parts of its upper course the river flows in a deeply cut valley, but 2 mi. S. of Ruthin it breaks through a ridge of limestone to enter the Vale of Clwyd. This is a broad lowland floored with relatively soft Triassic sandstone, and flanked by the Clwydian hills on the east and the Denbighshire uplands on the west. From these uplands, the Clwyd receives the Wheeler on the right bank and the Clywedog, Ystrad and Elwy on the left. The chief settlements of the Vale of Clwyd are Ruthin, Denbigh, St. Asaph and Rhyl (*qq.v.*). (C. Em.)

CLYDE, COLIN CAMPBELL, Baron (1792–1863), British soldier who was commander in chief in India during the Indian mutiny (*q.v.*), was born in Glasgow on Oct. 20, 1792, and entered the army in 1807. He lacked social influence and his promotion was slow; he took 30 years to rise from captain to colonel and 40 to get clear of debt. He served in the Walcheren expedition (1809) and in the Peninsular campaigns, when he was twice wounded and distinguished by his gallantry (at San Sebastián and the Bidassoa). He took part in the War of 1812, in quelling the Demerara insurrection (1823) and in the Opium War with China in 1842. He was knighted for his notable service in the Sikh War of 1848–49. In the Crimean War he commanded the Highland brigade at the Alma and won fame for the repulse of the Russian attack on Balaklava. On the outbreak of the Indian mutiny he was appointed commander in chief, arriving in India on Aug. 13, 1857, and controlling operations until the mutiny had been quelled. For these last services he was raised to the peerage in 1858 as Baron Clyde, was thanked by both houses of parliament and was granted a pension of £2,000 a year—a splendid, prosperous end to the career of a self-styled "soldier of fortune." He died at Chatham, Kent, on Aug. 14, 1863.

Nicknamed "Old Khabardar" (Old Careful) in India, his care was for his men, not for himself. He paid great attention to the troops' health, fighting drunkenness, providing shelter in the Crimea, sun helmets in India. He believed in field exercises, the use of ground and open formations, and in the sappers and artillery rather than the bayonet. He expected his officers to set an example of sober economy in the mess and to share in the duties of their men. He was ready to pass over senior officers sent out from England when he felt that their juniors with Indian experience were fitter for command. Though criticized for overcaution during the mutiny, notably at Lucknow, his successes were very cheaply won and his campaigns thorough.

See Sir Owen Tudor Burne, *Clyde and Strathnairn* (1891); L. Shadwell, *Life of Colin Campbell, Lord Clyde* (1881). (J. B. Ha.)

CLYDE, the most important of Scottish rivers (the Clota of Tacitus and Ptolemy), also the name of the estuary which forms the largest firth on the west coast of Scotland.

The River.—The Clyde has a total length of about 106 mi. from its source, perhaps best taken as lying on the north side of Queensberry hill (2,286 ft.) in Dumfriesshire, to "Tail o' the Bank" opposite Greenock where the firth begins. Its catchment area is estimated at 1,481 sq.mi. Its main headstreams are the Daer water and Potrail water which unite 3½ mi. S. of Elvanfoot.

From this point the name Clyde is given to the river, though a minor right-bank tributary entering below the junction is known as the Little Clyde burn. The river follows a generally northward course for 30 mi. to the neighbourhood of Biggar. Throughout this section it occupies a well-developed mature valley bordered by gravel terraces. At Coulter station the river abandons this valley and turns abruptly northwestward, though the wide valley continues eastward where it is drained by the insignificant Biggar water to the Tweed. It is clear that the upper Clyde was, at one period, tributary to the Tweed.

In the second section of its course, as far as its junction with the Douglas water, the Clyde is a winding stream flowing over deposits of glacial drift and falling less than 100 ft. in 15 mi. South of Carstairs it turns southwestward and then, about 4 mi. from Lanark, northwestward, a direction it maintains for the rest of its way to the sea. In a stretch just exceeding 4 mi. occur the Falls of Clyde where the river level drops nearly 250 ft. over the Bonnington, Corra, Dundaff and Stonebyres linns as it cuts its way through a red sandstone gorge. Water power from these falls was used by the cotton mills of New Lanark in the early days of factory industry. Hydroelectric power stations at Bonnington (10,000 kw.) and Stonebyres (5,680 kw.) were constructed after World War I, but their output is variable as well as low by modern standards.

The valley widens as the river emerges from the gorge near Crossford, though its bounding slopes remain steep until Glasgow is approached. Its flat alluvial floor is liable to flood. As far as Hamilton the Vale of Clyde or Clydesdale is intensively farmed, with orchards on the slopes and strawberry fields and extensive greenhouses on the lower ground. Comparable conditions occur nowhere else in Scotland. It is noted for a leading draft breed of horse, the Clydesdale (*see* Horse). Coal mining and heavy industry crowd in on the river from Hamilton to the heart of Glasgow.

As late as the mid-18th century the river was fordable at several places to 12 mi. below Glasgow bridge. Whiteinch road tunnel under the river was completed in 1962. A channel giving a depth of 26 ft. at low tide was dredged and blasted in the mainly glacial clay deposits of the river bed from the city to the entrance from the firth. Clydeside shipyards, long among the best equipped in the world, border the river for 20 mi. below Glasgow. Hills close in upon the river as it nears its mouth, and the towns on its banks (*e.g.*, Dumbarton on the north bank and Greenock on the south) are crowded on narrow raised beaches. The Forth and Clyde canal (completed 1790) links Bowling on the Clyde with Kirkintilloch, Falkirk and Grangemouth on the Forth, a distance of about 40 mi., but now carries little traffic.

The Firth.—From Dumbarton, where the firth is commonly considered to begin, to Ailsa Craig, where it ends, the fairway measures 64 mi. Its width varies from 1 mi. at Dumbarton to 37 mi. from Girvan to the Mull of Kintyre. Depths of more than 600 ft. are found in a narrow trench reaching up Bute sound into Loch Fyne and in Kilbrennan sound; over a submerged ridge from Kintyre through Ailsa Craig to Girvan they are less than 150 ft. The Cumbraes, Bute and Arran (*qq.v.*) are the principal islands in its waters. The sea lochs comprise Gare loch, Loch Long, Loch Goil, Holy loch, Loch Striven, Loch Riddon and Loch Fyne.

The only rivers of any importance entering the firth are the Ayrshire streams, of which the chief are the Garnock, Irvine, Ayr, Doon and Girvan. The chief ports are Glasgow, Port Glasgow, Greenock, Ardrossan, Irvine, Troon, Ayr and Campbeltown (*qq.v.*). There are lighthouses on Ailsa Craig, Sanda, Davaar, Pladda, Holy Island and Little Cumbrae, and at Turnberry point, Cloch point and Toward point. There is a network of passenger steamer services, curtailed in winter, connecting the various piers. (T. Her.; A. T. A. L.)

CLYDEBANK, a large burgh of Dunbartonshire, Scot., on the right bank of the Clyde, 6 mi. N.W. of Glasgow. Pop. (1961) 49,654. In the 1870s the district was almost entirely rural, but many industries have since been established, including the manufacture of sewing machines and asbestos cement. Most important are the shipyards, where the "Queen Mary" and the "Queen Elizabeth" were built.

Large areas of Clydebank were severely damaged by air raids in 1941, and the local authority had to replan the whole town. Many new districts were added after World War II. The Clydebank Burgh Order Confirmation act of 1949 extended the boundaries of the burgh for housing and other purposes.

CLYNES, JOHN ROBERT (1869–1949), British statesman, was a member of the original parliamentary Labour party, served in the first two Labour governments and became one of the party's most respected leaders. He was born at Oldham, Lancashire, on March 27, 1869, the son of an Irish labourer, and himself worked in a cotton mill from the age of ten until he became a full-time trades union official in 1889. He always maintained a close trades union connection and was later president of the National Union of General and Municipal Workers (1912–37); widening his activities, he entered parliament in 1906 as Labour member for Manchester Northeast. With a break from 1931 to 1935, he sat for the same constituency (renamed the Platting division in 1918) until 1945. During World War I he gave his support to the Lloyd George coalition and was parliamentary secretary to the ministry of food in 1917–18, becoming minister for a short time in 1918. Clynes became deputy leader of the Labour party in 1919 and leader in 1921. After the 1922 election, however, James Ramsay MacDonald returned to parliament and took over the leadership, and Clynes again became deputy. He was lord privy seal and deputy leader of the house of commons in the first Labour government (1924), and home secretary in the second Labour government (1929–31). When MacDonald formed his National government in 1931 Clynes unhesitatingly went into opposition with the majority of the Labour party. He was never again in office and he died in London on Oct. 23, 1949. He was a loyal, moderate, self-effacing man who made few enemies but whose career was often overshadowed by more flamboyant and less predictable colleagues. His *Memoirs*, two volumes, were published in 1937. (R. J.)

CNIDUS, an ancient Greek city on the Carian coast, the site of which is on the Resadiye peninsula in the Mugla *il*, at the southwestern extremity of Turkey. Recent research has shown that the early site was on the south coast of the peninsula near Resadiye (Datca) (nearly 20 mi. E. of Cape Krio). About 330 B.C. the city was transferred to Cape Krio, where a small island was joined up (probably artificially) to the mainland and thus provided shelter for two harbours (joined by a canal). The harbour on the northwest of the isthmus was for warships, the other gave ample accommodation for merchant ships. The new city at Cape Krio was chiefly on the mainland, but continued over to the former island; and the whole was enclosed in a fortified circuit which is still well preserved.

The ancient city was nearly a mile in length. Extensive excavations were carried out by C. T. Newton aided by British sailors during 1857–59, and the axial plan of the city appears clearly, with a large theatre on the slope, an odeum, a number of temples and other public buildings. The world-famous "Aphrodite" of Praxiteles (a statue rejected by the people of Cos on account of its nudity, and purchased by the Cnidians) has perished and is known only from later copies; but in a sanctuary on the south slope of the city Newton found a fine marble statue of the seated Demeter (perhaps by the sculptor Leochares), which now adorns the British museum.

The Cnidians claimed to be of Spartan origin. In conjunction with Halicarnassus, Cos and the cities of Rhodes, Cnidus celebrated regular festivals with games at Triopion (perhaps the modern Kumyer, 6 mi. E. of Cape Krio). It planted colonies on Lipari and at Black Corcyra (Curzola) in the Adriatic, and settled the adjacent Carian Chersonese. After a vain attempt to separate their peninsula from Asia by a canal the Cnidians submitted to the Persians (soon after 546 B.C.); they joined the Delian league after the battle of Mycale (479 B.C.) and revolted from Athens in 412. In the 4th century B.C. the narrow and despotic oligarchical government was replaced by a democracy. In the 3rd century B.C. Cnidus was under Ptolemaic control (and perhaps was subsequently subject for a short time to Rhodes). In the Roman province of Asia it ranked as a free city. The site at Cape Krio seems to have become desolate in early Byzantine times, perhaps as a result of Arab sea raids.

The new city at the cape was an important commercial station. It exported the full-bodied wine of the peninsula in great quantity and was reputed for the production of canes, onions, and medicinal herbs and seeds. Cnidus had a famous school of medicine. Among its illustrious citizens were Ctesias and Eudoxus (*qq.v.*) and Sostratus who built the Pharos lighthouse at Alexandria.

See also references under "Cnidus" in the Index volume.

See C. T. Newton and R. P. Pullan, *A History of the Discoveries at Halicarnassus, Cnidus and Branchidae*, 2 vol. (1862–63); G. E. Bean and J. M. Cook, "The Cnidia," *The Annual of the British School at Athens*, vol. xlvii (1952). (Jo. M. Co.)

COACH: *see* CARRIAGE.

COAHUILA, a northern frontier state of Mexico, bounded north and northeast by Texas, east by Nuevo León, south by San Luis Potosí and Zacatecas, and west by Durango and Chihuahua. Pop. (1960) 896,509; area 58,067 sq.mi. Its surface is a roughly broken plateau, traversed by several ranges of mountains. The western part of the state was barren desert until irrigation projects made the soil productive. In general the rainfall is light and the rivers are small. The climate is hot and dry, and generally healthful. Stock raising was for a time the principal industry, but agriculture has been developed in several localities. The chief products are cotton, Indian corn, wheat, beans, sugar and grapes. The Parras district in the southern part of the state has long been celebrated for its wines and brandies. The mineral products include silver, lead, coal, copper and iron. The mining operations are chiefly centred in the Sierra Mojada, Sierra del Carmen and in the Santa Rosa valley. The modern industrial development of the state is due to the railway communications developed during the last quarter of the 19th century, and to the investment of foreign capital in local enterprises. The first Spanish settlement in the region was at Saltillo in 1575, when it formed part of the province of Nueva Viscaya. Coahuila and Texas formed a single state in 1824. The dissatisfied American settlers in Texas declared their independence in 1836.

In 1857 Coahuila was combined with Nuevo León, but in 1868 it became a separate state. The capital of the state is Saltillo (*q.v.*). Among the more important towns are Parras (pop. [1950] 18,546), 98 mi. N.W. of Saltillo, one of the largest railway centres in the country, and Piedras Negras (*q.v.*), formerly Ciudad Porfirio Díaz, on the Rio Grande. Torreón (pop. [1950] 128,976), founded in 1887, is one of Mexico's most modern cities. The state has excellent air and rail connections, and a superhighway between Piedras Negras and Mexico City. (J. A. Cw.)

COAL AND COAL MINING. Coal mining is one of the world's basic industries and also one of the most complex. Like other enterprises engaged in the extraction of mineral products, it differs from manufacturing industries in that an increased mine capacity must inevitably result in a shortened mine life: doubling the output must halve the life, whether it be that of a single mine or of a national industry. The immense expansion of industry that began in the 18th century and transformed the western world was initiated by the development by the two Abraham Darbys and others of methods of using coal (coke) instead of charcoal in blast furnaces and forges by the coal-burning steam engine developed by James Watt. Ample workable deposits of coal became the growth of the industrial strength of Europe and the United States (*see* INDUSTRIAL REVOLUTION, THE). By the start of the 20th century the United States had displaced Great Britain as the world's major coal producer and, because of its favourable mining conditions, developed complex machinery which raised coal mining from a pick-and-shovel technique to an assembly-line operation by the second half of the 20th century.

In the following pages, the discussion of coal and coal mining will be divided as follows:

I. Origin of Coal
II. Types of Coal
III. Early Uses and History of Coal
IV. Mining and Miners
    A. Early History of Working Conditions
    B. Miners' Unions
V. Types and Methods of Mining
    A. Underground Mining
    B. Surface or Strip Mining
    C. Auger Mining
    D. Coal Mining in Great Britain
    E. Coal Mining in Other Countries
    F. Automation in Mining
VI. Hazards of Mining
    A. Falls of Ground
    B. Haulage and Transport
    C. Mine Ventilation and Gases, Explosions and Fires
    D. Other Hazards
VII. Preparation and Uses of Coal
    A. Preparing Coal for the Market
    B. Transportation and Marketing
    C. By-products of Coal

- VIII. World Production and Resources
  - A. World Production
  - B. Productivity and Labour
  - C. World Coal Reserves

I. ORIGIN OF COAL

Coals are not true minerals, but are organic compounds of many types formed from the remains of living trees, shrubs and plants that flourished millions of years ago during periods of uniformly mild and moist climate. Coal is a fossilized plant material whose exact nature is dependent upon that of the original plant debris, upon the decay and weathering which this undergoes prior to its burial and consolidation (diagenesis) and upon the effects of pressure, temperature, time and other subsequent geological conditions. Although coal is not a true mineral, its formation processes are similar to those of sedimentary rocks. Various coal seams can be studied and related geologically to the sedimentary rocks with which they are associated.

Coal consists of varying amounts of carbon and volatile material and of impurities such as sulfur, phosphorus, incombustible rock materials and moisture. The carbon in the plants which later became coal was manufactured in the cells through the action of the colouring material (chlorophyll) of their leaves. This carbon originated in the carbon dioxide and water content of the air, and the energy necessary for the transformation originated in the sun.

Although some coals were deposited 400,000,000 years ago during the Silurian period, most were formed during the Mississippian and Pennsylvanian geological epochs (Lower and Upper Carboniferous) about 250,000,000 years ago. A warm and humid climate favoured the growth of huge tropical seed ferns (Pteridospermae) and giant nonflowering trees, and created the vast swamp areas which comprise the coal beds of today. (*See* also CARBONIFEROUS SYSTEM AND PERIOD.)

As the plants died and fell into the boggy waters, which excluded oxygen and killed bacteria, they partially decomposed, but did not rot away. The vegetation was changed into a slimy material called peat. Some peat was brown and spongy, some black and compact, depending on the degree of decomposition.

The sea advanced over such deposits and new sediments were laid down. Under pressure the peat dried and hardened to become low-grade coal or lignite. Further pressure and time created bituminous coal, a thickness of about 20 ft. of the original plant material compressing to 1 ft. of coal. Even more extreme pressures, resulting from the folding of the earth's surface into great mountain ranges, produced the highest-grade coal, anthracite.

II. TYPES OF COAL

The degree of coalification (rank) of coals is determined by chemical methods called proximate analysis (*see* FUELS: *Coal and Related Fuels*). Proximate analysis determines how much moisture, volatile matter (material turned into gases as a result of heat) and fixed carbon the coal contains. Heating value, caking and weathering properties classify the lower ranking coals. Coal rank increases with the amount of fixed carbon and decreases with moisture and volatile-matter content (*see* Table I).

Lignite.—This is a low-rank, brown-to-black coal containing 30% to 40% of moisture. It disintegrates rapidly in air and is liable to spontaneous combustion. Although there are thousands of square miles of lignite deposits in the United States, little is mined because of these facts and because of its relatively small heat value.

Subbituminous Coal is black and contains from 15% to 30% moisture when mined. It weathers and is subject to spontaneous combustion to a lesser degree than lignite. It is mined commercially for local use in some areas.

Bituminous Coal is the most abundant variety, varying from medium to high rank. It is a black, usually banded coal. It weathers only slightly and may be kept in open piles with little danger of spontaneous combustion if properly stored. Medium- to low-volatile bituminous coals may be of coking quality. This property is independent of rank classification and depends on the ability of the coal to produce a coke when heated in a coke oven.

TABLE I.—*Classification of Coals by Rank**

Class	Group	Limits of fixed carbon or B.T.U., mineral-matter-free basis	Requisite physical properties
Anthracitic	1. Meta-anthracite	Dry F.C., 98% or more (dry V.M., 2% or less)	
	2. Anthracite	Dry F.C., 92% or more and less than 98% (dry V.M., 8% or less and more than 2%)	
	3. Semianthracite	Dry F.C., 86% or more and less than 92% (dry V.M., 14% or less and more than 8%)	Nonagglomerating†
Bituminous§	1. Low-volatile bituminous coal	Dry F.C., 78% or more and less than 86% (dry V.M., 22% or less and more than 14%)	
	2. Medium-volatile bituminous coal	Dry F.C., 69% or more and less than 78% (dry V.M., 31% or less and more than 22%)	
	3. High-volatile A bituminous coal	Dry F.C., less than 69% (dry V.M., more than 31%); and moist‡ B.T.U., 14,000‖ or more	
	4. High-volatile B bituminous coal	Moist‡ B.T.U., 13,000 or more and less than 14,000‖	
	5. High-volatile C bituminous coal	Moist B.T.U., 11,000 or more and less than 13,000‖	Either agglomerating or nonweathering¶
Subbituminous	1. Subbituminous A coal	Moist B.T.U., 11,000 or more and less than 13,000‖	Both weathering and nonagglomerating
	2. Subbituminous B coal	Moist B.T.U., 9,500 or more and less than 11,000‖	
	3. Subbituminous C coal	Moist B.T.U., 8,300 or more and less than 9,500‖	
Lignitic	1. Lignite	Moist B.T.U., less than 8,300	Consolidated
	2. Brown coal	Moist B.T.U., less than 8,300	Unconsolidated

(F.C.=fixed carbon; V.M.=volatile matter; B.T.U.=British thermal units)

*This classification does not include a few coals that have unusual physical and chemical properties and that come within the limits of fixed carbon or B.T.U. of the high-volatile bituminous and subbituminous ranks. All these coals either contain less than 48% dry, mineral-matter-free fixed carbon or have more than 15,500 moist, mineral-matter-free B.T.U.

†If agglomerating, classify in low-volatile group of the bituminous class.

‡Moist B.T.U. refers to coal containing its natural bed moisture but not including visible water on the surface of the coal.

§It is recognized that there may be noncaking varieties in each group of the bituminous class.

‖Coals having 69% or more fixed carbon on the dry, mineral-matter-free basis shall be classified according to fixed carbon, regardless of B.T.U.

¶There are three varieties of coal in the high-volatile C bituminous coal group: variety 1, agglomerating and nonweathering; variety 2, agglomerating and weathering; variety 3, nonagglomerating and nonweathering.

Source: American Society for Testing Materials.

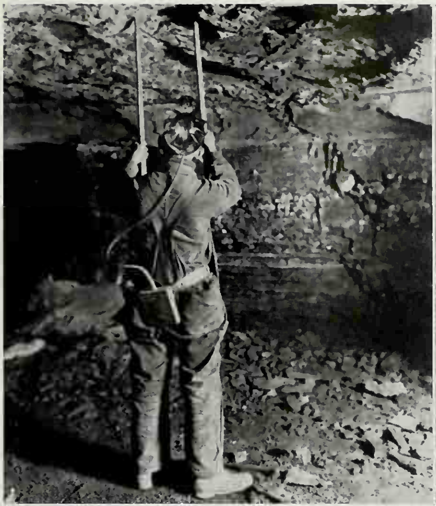
A coking, or caking, coal softens, swells and runs together when heated almost to its burning temperature. When it is further heated in a closed oven, either without oxygen or with only a little, the volatile matter is driven off in the form of gas, water vapour, light oil and tar. The gray porous matter remaining consists largely of fixed carbon and is called coke. Coke is used extensively in blast furnaces for the smelting of iron ore.

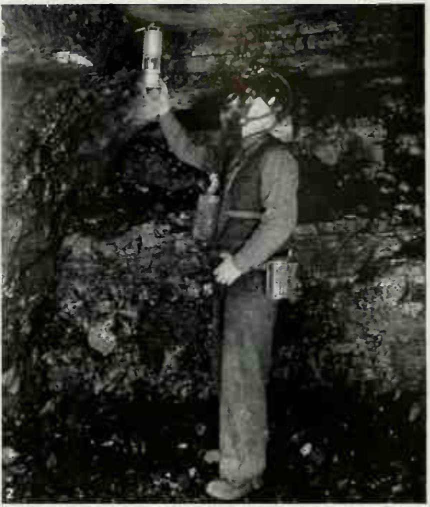
Noncoking coals resemble the coking types in appearance, but burn freely without pronounced swelling. Residue from combustion is a char or powder rather than coke. Such coals are preferred for the manufacture of cement because of their high-volatile content.

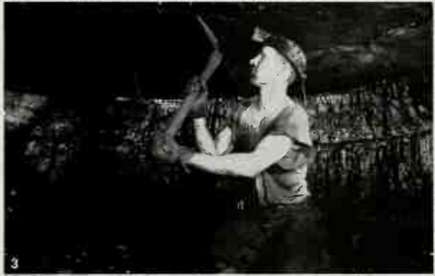
Anthracite, or "hard" coal, has a brilliant lustre. It can be rubbed without leaving a stain on the finger. It can even be polished and made into costume jewelry. Anthracite burns slowly with a pale blue flame and requires a minimum of attention. It is used primarily as a domestic fuel, although it can sometimes be blended with bituminous grades of coal to produce a mixture with improved coking qualities.

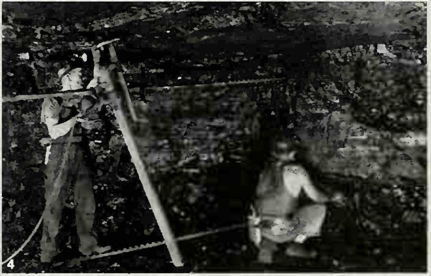
III. EARLY USES AND HISTORY OF COAL

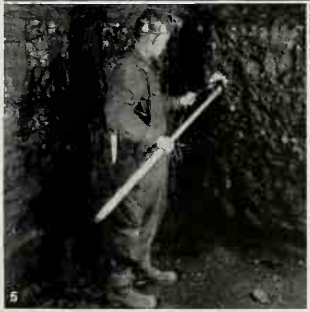
The Chinese are said to have used coal as long ago as 1000 B.C.,

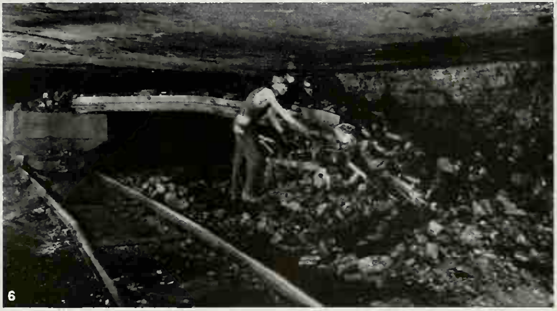










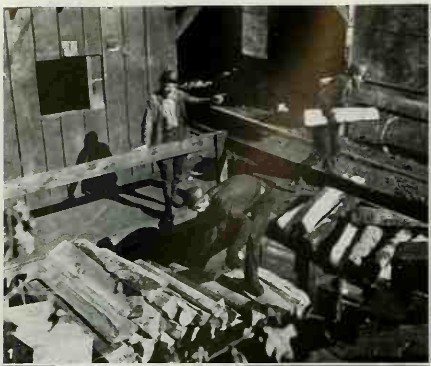


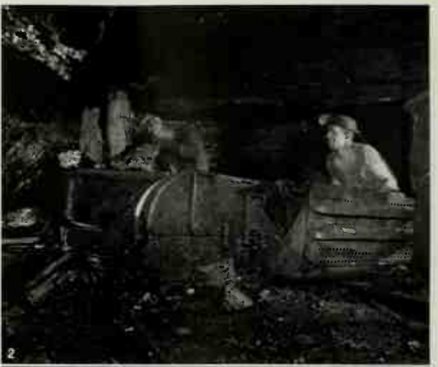
BY COURTESY OF (1, 2, 4-6) BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR, PHOTOGRAPH, (3) PICTORIAL PUBLISHING CO.

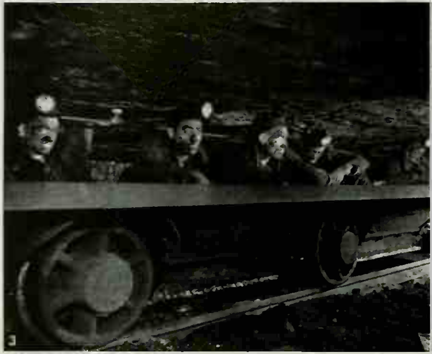
OPERATIONS IN COAL MINING

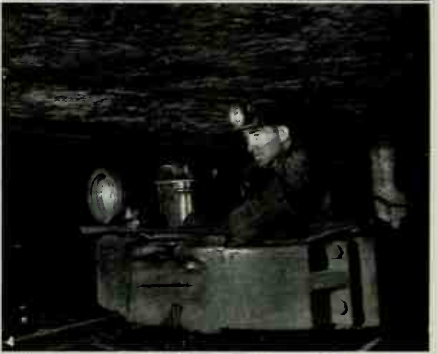
1. Workman testing the roof of a seam
2. Miner equipped with gas mask, testing for explosive gas and for oxygen deficiency
3. Working a low seam with ordinary pick
4. Electric post drill in operation
5. Charging a hole with explosive, using a wood tamping stick
6. Loading machine in operation at a mine face

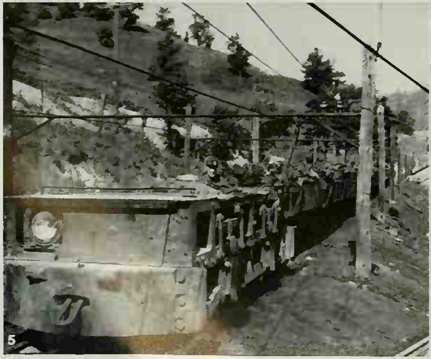
COAL AND COAL MINING

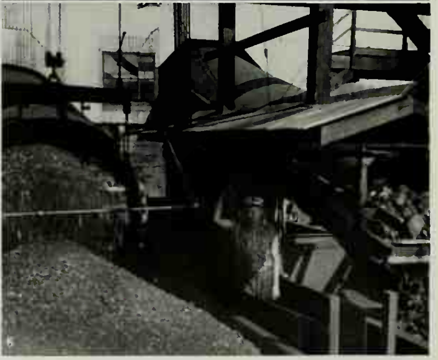












PHOTOGRAPHS, (1-4) HEYER FROM PICTORIAL PUBLISHING CO., (5, 6) HOBART FROM MONKMEYER

MINING AND TRANSPORTING COAL

1. Assembling timber posts at the tipple of a mine, for use in supporting the mine roof at regular intervals
2. Miner setting a timber post to hold up the roof while a machine cutter waits to operate a giant saw
3. Loaded "man-trip" train taking a shift of miners out of a low-seam mine
4. Motorman of a coal train emerging from a low-seam mine
5. Coal train outside the mine
6. Loading coal into railroad cars

but there is no concrete evidence that other ancient peoples were aware of the properties of this fuel. Marco Polo, in his wanderings through Cathay toward the end of the 13th century A.D., recorded the long-established practice of the natives, who dug out of the mountain a black stone which they burned for fuel. There was a widespread belief that coal was used on a small scale in the Greco-Roman world. This belief was largely based on the writings of Theophrastus, the Greek philosopher and disciple of Aristotle who, in his "Treatise on Stones," made reference to a black stone which smiths occasionally burned instead of charcoal. Theophrastus said that this fuel originated in Liguria in northern Italy and the province of Elis in Greece.

Further evidence in support of the theory that the Romans used coal was given by archaeological excavations in England, which revealed the presence of coal ashes amid Roman remains. There are many legends suggesting that coal was worked on the continent of Europe in Roman times, but scholars have failed to find any foundation for them in fact.

The first documented proof that coal was mined in Europe occurs in the chronicle of the monk Reinier, of the priory of St. Jacques at Liège, who wrote of "black earth very similar to charcoal" in use by metalworkers. This chronicle was written about the year 1200, and provides the first authentic documented proof of European coal mining as such. It is, however, known that even by this time *charbon de roche*, or sea coal, was being exported from England to Bruges in appreciable quantities.

But the gathering of sea coal cannot be considered as truly representative of actual mining operations, and it is not until the first decades of the 13th century that definite references to coal mining are to be widely found. Scores of authentic records show that in this century coal was being worked in many of the coal fields of England and Scotland and in a number of fields on the European continent. The pits were generally very shallow excavations widening out at the base and resembling in shape a bell or inverted funnel; each employed at the most a dozen workmen.

Early prejudice against coal as a fuel was caused by its inefficient use. It emitted noxious fumes, which so aggravated the populace that it is recorded that during the reign of Edward I (1239–1307) the death penalty was imposed on those found guilty of burning coal. With abundant supplies of timber available in Europe and discriminations against the use of coal, it is not surprising that this fuel was not recognized as an important national asset until the 16th century.

Although by this time coal mining operations were in evidence in many European countries, the industry was of no great consequence to national life or economy. Except in isolated cases, coal was produced by small groups of men for use largely within the immediate vicinity of the mine. However, the increased use of coal-fired brick kilns in the 15th and 16th centuries led to a wider demand for coal. Not only was coal required for the firing of the kilns themselves, but the bricks made could be used to build improved domestic fireplaces and chimneys, and thus coal could be burned on the hearth without the inconvenience formerly experienced. By the mid-16th century the estimated annual coal production of the principal mining districts in Britain was almost 220,000 tons. This period marked the start of large-scale mining activity, and thus the effective birth of the industry.

During the 17th century the ironmaster Dud Dudley (1599–1684) established in Staffordshire iron smelting works, and early in the 18th century innovations by the Darbys and others opened up a vast potential market for coal, so that the foundations for widespread industrial expansion were laid and assured markets for British coal were provided. Successive metallurgical and engineering developments engendered a well-nigh insatiable demand for coal. Although coal production on the European continent also significantly increased, Britain had, by the beginning of the 18th century, established a commanding supremacy as the world's greatest coal producer.

It was just at this period (1701) that the earliest recorded coal mining operations in the United States were commenced, in Virginia, on the James river near Richmond; but it was not until 1745 that coal was mined on a commercial scale. Coal was discovered in Ohio in 1755, and in 1770 George Washington commented on a coal mine he had seen near the Ohio riverbank.

Deposits of anthracite were known to have existed near the headwaters of the Schuylkill river and Swatara creek in Pennsylvania as early as 1770. Up to the time of the American Revolution, however, most coal used in the American colonies came from England or Nova Scotia. Spurred on by wartime shortages, the indigenous infant industry expanded considerably, particularly to serve the needs of the munitions manufacturers. The government requisitioned coal in amounts of from 6 to 1,000 bu. from Philadelphia citizens for use in "casting cannon." The state of Maryland authorized the purchase of 6,000 bu. to help the war effort, guaranteeing to pay for boat and cargo if captured by the enemy. After the American Revolution, coal came to be used more and more in the United States and countless small companies were organized to mine it.

In 1742 when Peter Salley named the Coal river in western Virginia (later West Virginia) he had no idea how correct the name would be. It is recorded that in 1852 private owners built a canal system of eight locks and dams extending 35 mi. up Big Coal river to ship coal from the region. The American Civil War interrupted this little-known operation, and high waters destroyed the system. No more coal was shipped from the area until 1910 when the railroad arrived.

The first exploitation of the famous Appalachian bituminous coal field, the largest in the U.S. with a length of more than 900 mi. and an area of almost 63,000 sq.mi., is indicated on the Fry and Jefferson map of Virginia (1751). There the words "Coal Mine" appear near the site of Georges creek in Maryland. During the ensuing three decades little reference to coal in this region can be found, but it can be assumed that outcropping seams were mined for local use. In 1810 an unusually violent freshet unearthed a large area of a huge seam—probably the Pittsburgh—near Barton. The discovery caused great excitement, and people came for miles to see it. The coal was hauled by wagon as far east as Romney and even Winchester, where it was used for smithing. Later it was hauled to Westernport and floated to Washington on flatboats and rafts. The United States geological survey records that coal was first discovered near Frostburg, Md., in 1804. Coal from the Sheetz mine was hauled to Cumberland, where it is known to have been used for the manufacture of glass as early as 1816. In 1814, during construction of the turnpike from Cumberland to Wheeling, coal was found at Eckhart Mines, in the general vicinity of the Sheetz mine, and hauled by wagon to Cumberland and Baltimore. During 1842, 1,708 gross tons are known to have been produced by the Cumberland region.

In 1852 or 1853, the first commercial shipments of coal were made from a mine operating in the Pittsburgh seam and located near the centre of the present city of Fairmont. One of the first known commercial operations in the great low-volatile Pocahontas field was opened by a blacksmith named Jordan Nelson shortly before the year 1870. This mine was located near Pocahontas, Va., and operated in the Pocahontas no. 3 seam, which was 13 ft. in height in the immediate area. Nelson sold his coal for a penny a bushel, and mountaineers carried it home on muleback. Blacksmith Nelson's mine, abandoned in 1955 after the removal of more than 44,000,000 tons of coal, was a direct cause of the westward expansion of the Norfolk and Western railway.

By the early 1830s many small mining companies were in existence along the Ohio, Illinois and Mississippi rivers and in the Appalachian regions. In the 1840s the U.S. coal industry mined its first 1,000,000 tons, and from then on growth was steady.

As in European countries, the advent of the steam locomotive gave a tremendous impetus to the coal industry; the problem of land transportation was solved and immense new markets opened. The 40-year period 1865 to 1905 showed an increase in total world production from 182,000,000 tons to 928,000,000 tons, representing a rise in output of rather more than 500%. Despite continued increases in world production after that time, this accelerated rise in output was not maintained, and by 1935 world output stood at 1,181,000,000 tons; it remained at about that level until the second half of the 20th century when marked increases in previously underdeveloped areas, especially the U.S.S.R. and China, pushed world production to more than 2,500,000,000 tons.

IV. MINING AND MINERS

To appreciate the rise of the coal miner from his former position at the very foot of the social scale to his status as one of the highest-paid industrial workers, it is advantageous to consider the history of working conditions in the industry. Much of this early history was enacted in Great Britain, as, until the 20th century, the United Kingdom was the world's leading coal producer.

A. Early History of Working Conditions

When mining was nothing more than an indiscriminate nibbling at coal deposits, operations were more or less wholly dependent upon the will of the reigning monarch or of the owner of the land beneath which the coal was found, who promulgated such rules and regulations as he thought fit. These formed the basis of a primitive mining code, much akin to other customs regulating human vassalage. Even until well into the 19th century it was common for European miners to be bound in law to work continuously at one particular colliery for a specified period—usually 12 months.

By its very nature, work in coal mines involved hard manual labour performed under conditions of great personal risk and discomfort. These features fostered a spirit of comradeship and interdependence among miners and there are many records of the banding together of coal miners of the 17th and 18th centuries in an effort to ameliorate their conditions. In Britain, as long ago as 1662, 2,000 miners of the northern coal field put their marks to a petition to the king, Charles II, praying for redress of their grievances, chief among which was the danger to which they were exposed by inadequate ventilation. As with many other appeals, there was no response from the state. Following the adaptation of the steam engine to operate mine pumps in the early 1700s, pits became deeper and workings much more extensive, and the toll of human life and suffering increased proportionately. Isolated rebellions and strikes broke out throughout Britain as the miners were provoked beyond endurance. Such expressions of disquiet did not have the sympathy of the general public, and in the absence of an effective organization these localized strikes were totally ineffective.

Until after the repeal of the Combination law (*q.v.*) in 1824, the men held together without any formal constitution, which, under these laws, would have exposed them to prosecution and imprisonment.

As the Industrial Revolution gathered impetus the condition of the miners deteriorated and, even judging by the poor over-all standard of living of industrial workers of the period, the lot of the coal miner was unenviable. As degradation breeds decadence it is not surprising that the miners sank lower and lower and that they entered the 19th century virtually as outcasts. By this time Britain had reached unquestioned industrial supremacy, built upon the annual 10,000,000 tons of coal won at a cost of great human suffering. Working conditions were appalling and exploitation of child and female labour was rampant. Such was the condition of the industry that an eminent judge was moved publicly to criticize, in 1815, the then practice of dispensing with a coroner's inquest if the corpse "was only that of a collier."

Into such a community there came between 1820 and 1850 two inspiring influences, religion and trade unionism. Religion was carried into the mining villages by unschooled, poverty-stricken men, themselves earning a precarious living as manual workers, yet finding time and means to preach the gospel of salvation of the Methodist Church. It would be difficult to overestimate the profoundly beneficial effect of these "ranters" on the lives of miners of the period, many of whom completely changed their mode of living. The early trade unions, which were soon to follow this religious crusade, benefited considerably in that an astonishingly large proportion of their leaders was recruited from the ranks of the converts.

B. Miners' Unions

Almost immediately after the repeal of the Combination act in 1824, local unions came into being in many of the coal fields. However, lack of funds and experience and determined opposition from the coal owners resulted in the premature collapse of most of them. Not until 1841 did Martin Jude succeed in forming the Miners' Association of Great Britain, which quickly gathered 100,000 members. Although this union also eventually succumbed, it is to this national association that the miners owe the first enunciation of what afterward became their characteristic policy. This was, broadly, not to rely mainly on strikes but to secure as many as possible of their demands by act of parliament, and to insist on continuous negotiation with the employers, preferably on a national basis. Although the mining trade union movement suffered many vicissitudes before emerging as a definite force in the industry, a start had been made. The influence of these primitive organizations, even though unimpressive by current standards, nonetheless made itself felt both in collective bargaining with employers and in the activities of national governments. The early mining associations were in part responsible for state intervention in the regulation of working conditions, prohibition of child and female labour underground, enforcement of safety regulations, etc. Indeed, the histories of safety legislation and of miners' unions are so interwoven the world over that it would be difficult to consider them separately.

Meanwhile, during the embryonic struggles of the early unions in Britain, public opinion had been aroused by a series of colliery disasters. Successive commissions set up in the second and third decades of the 19th century had revealed a state of affairs which profoundly shocked the nonmining community. Probably the most significant of these investigations was that carried out by the royal commission of 1840 which, two years after its appointment, reported to parliament on the employment of children and women underground. Their report revealed that children of both sexes—some as young as five and six years of age—were habitually employed in the mines. Girls of 16 and 17 were working at the coal face with naked colliers; children were kept underground for as much as 16 hours a day dragging loaded tubs along roadways 30 in. in height.

Public conscience was finally stirred, and in Aug. 1842 an act was passed—albeit against opposition in the house of lords—prohibiting the employment underground of females of all ages and of boys under ten. This act also provided for the appointment of mines inspectors, although it was not until 1850 that statutory legislation demanded the appointment of expert mining engineers as government inspectors of mines and compulsory notification to the state of all fatal mining accidents.

Despite being the world's greatest producer, Britain had lagged behind other European coal countries in appreciation by the government of the moral and social responsibilities of the state toward the mining community. France, Germany and Belgium had all instituted a system of mine inspection before 1850, although adult female labour was still employed underground in Belgium until toward the end of the 19th century. Illogically, the prohibition of women underground had almost invariably met with opposition from the miners themselves. This proved as true in India, when the government banned underground female labour in 1937, as in Europe a century before.

In the United States, the latter half of the 19th century was a period of tremendous activity in the industry, and output of coal and anthracite rose from just over 1,000,000 tons in the fourth decade to almost 250,000,000 tons by the turn of the century. Not unnaturally such a phenomenal development was accompanied by severe growing pains. There was considerable labour unrest, chiefly manifested in spontaneous localized strikes. As many of the workers came from established European coal fields, they brought with them a miscellany of traditions and usages. Small local unions were soon in existence, but there was no significant workers' association until the late 1890s, when an organization came into being which embraced the entire state of Illinois (*see* Strikes and Lockouts: *United States*). Within a few years, an effective labour organization was functioning in Indiana, Ohio, Michigan and parts of Pennsylvania. The southern sector of the Appalachian region remained largely nonunion until 1933, but since that time, with few exceptions, all the mineworkers in the United States have been members of a common organization, the United Mine Workers of America.

Mining legislation in the United States was introduced on a state basis rather than on a national basis as in Europe. In 1870, Pennsylvania became the first state to institute compulsory inspection of mines. Since that time, every state in which coal is mined has promulgated mining laws and instituted an inspection department. Research was instituted by the federal government following a succession of disastrous mine explosions in 1907 causing the deaths of 1,148 miners. In 1910 this work was transferred to the newly created bureau of mines. Despite the strenuous efforts of this organization, the first four decades of the 20th century gave the U.S. an unenviable record for mine safety. Standards in some mines were woefully low and state safety laws varied widely in scope and adequacy.

Alarmed at the rising toll of dead and injured, the 77th congress enacted the Federal Coal Mine Inspection act in May 1941. By this legislation the secretary of the interior, acting through the federal bureau of mines, was empowered to make inspections and investigations of health and safety conditions. Somewhat illogically, no authority was given to enforce the recommendations of the federal inspectors until 1946, when a federal mine safety code was issued after consultation between representatives of the U.S. bureau of mines, the United Mine Workers and mine operators. Since then an intensive safety drive has been maintained, with considerable success.

Complementary to the various national organizations already discussed, there are several international bodies concerned with the well-being of the coal miner. Even during the 19th century there had been a growing feeling that something should be done on an international basis to protect industrial workers in general. In 1919 the International Labour organization came into being with, at first, 41 member countries pledged to improve working and living standards within their boundaries. In 1945 a Coal Mining Industrial committee was inaugurated within the I.L.O.; on this were represented workers, employers and governments of all the major coal producing countries. This committee dealt with such topics as safety in mines, hours of work, labour problems, wages and productivity, etc. Although purely advisory, the work of this and similar organizations contributed materially to the rise in the working and living standards of coal miners in many parts of the world. Thus mining has become possibly the most closely controlled and organized of the major industries. Although the miner's social status and working conditions have changed tremendously over the years, he has still much in common with his predecessors. Most miners still live in the relatively compact communities well away from the cities, with the mine the hub around which life revolves. Workers in these closely knit communities, sharing common heritage, hazards and interests, display a solidarity seldom evinced elsewhere, a solidarity fostered by the father-to-son tradition still strong in mining. Men raised in such an environment rapidly develop strong convictions, and the coal fields have produced many strong, even turbulent, characters who have achieved eminence in other walks of life.

V. TYPES AND METHODS OF MINING

Coal mining operations can be considered under three main headings:

Underground, or Deep Mining.—Coal is extracted from the seam without removal of overlying strata.

Strip, or Opencast Mining.—The strata overlying the coal seam (overburden) are removed and coal is extracted from the exposed seam.

Auger Mining.—Coal is extracted by means of large diameter augers boring horizontally into the outcropping seam.

The type of mining employed depends upon the area of coal available, the thickness and inclination of the seam and overlying strata, the value of surface land and other economic factors. In the United States approximately 70% of the bituminous coal output is mined by underground methods, almost 30% by strip mining and about 1% by augering.

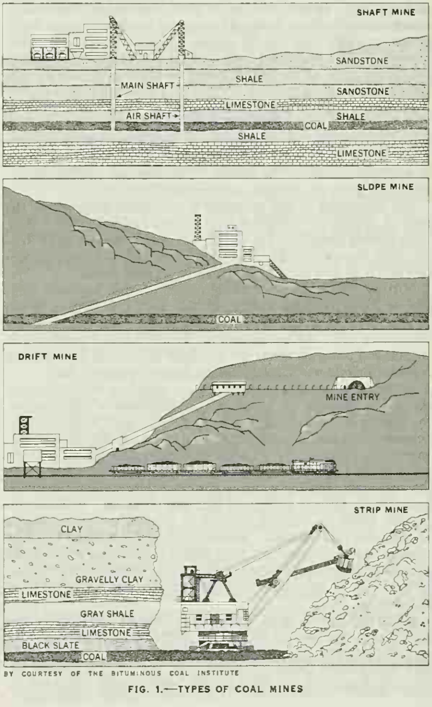
A. UNDERGROUND MINING

Access to underground mines is by shaft, slope or drift openings (*see* fig. 1). Many mines employ a combination of these, and all mines have a minimum of two access openings to facilitate circulation of air through the mine and to provide alternative means of escape in case of emergency.

A shaft is a vertical opening driven through the rock from the surface to the coal seam. It is the shortest and frequently the most economical method of reaching the coal. However, coal from shaft mines must be hoisted to the surface in buckets, cages or skips. Complex machinery and controls and skilled labour are required, and less coal or machinery and fewer men can be transported.

In a slope mine, coal is removed through an opening driven from the surface through the rock to the coal level at an angle of between 15° and 25° from the horizontal. Such slopes vary in length from a few hundred feet to more than one mile, depending on the depth of the seam and on the inclination of the tunnel. Their advantage lies in the ease and economy with which the coal can be brought to the surface on conveyers and in the fact that men and machines can be taken in and out of the mine with greater ease than through a vertical opening.

A drift mine is one from which the coal is removed through a horizontal opening driven from the surface directly into the coal seam. This method is only possible where the coal seam is exposed at surface elevation (outcrop) or has been exposed by stripping away the rock above the coal. In such mines coal may be brought out of the mine on belt conveyers or in cars pulled by locomotives or winches.



BY COURTESY OF THE BITUMINOUS COAL INSTITUTE

FIG. 1.—TYPES OF COAL MINES

The type of access opening is not dependent on the physical size or production capacity of the mine. Any of the three types may cover a land area equivalent to an entire county. Daily production depends upon the thickness of the seam, the mining conditions and the type and size of equipment employed.

The thickness and quality of coal seams vary greatly. China is said to have the world's thickest coal bed—400 ft. in thickness. Two seams in Wyoming measure 90 ft. or more in thickness. The average thickness of coal seams in the United States suitable for mining—because of their quality, proximity to the surface and the ease with which the coal can be extracted—is from 2 to 10 ft.

The anthracite beds in Pennsylvania are more variable in thickness and have been subjected to greater geological upheavals than the bituminous ones, and whereas the latter are often relatively level, anthracite frequently must be mined from measures lying more than 80° from the horizontal. A single minable anthracite seam can vary in depth from surface outcrop to almost two miles beneath the surface of the earth.

Underground Mining Methods.—Room and pillar mining is the most usual method adopted in U.S. mines. Rooms are large tunnels driven in the solid coal and the intervening pillars of coal may be either permanently left or extracted later. The percentage of coal recovered from a minable seam depends on several factors. In the United States, where coal reserves are very large, the percentage to be extracted is primarily decided by consideration of the number and size of protective pillars of coal thought necessary to support the roof safely. In general, the less coal is extracted the less is the need for costly roof supports. The necessity to protect valuable surface land also has a bearing on the amount of coal mined. In some sections of West Virginia and other states, where the surface land is owned by the coal producer, almost 100% of the available coal can be mined. In such states as Illinois, however, where farm and industrial land is extremely valuable, only about 50% of the coal is mined to prevent surface damage from subsidence.

In certain heavily industrialized areas in Great Britain and in western Europe the need to mine every possible ton of coal overrides consideration for the surface. In such cases special methods of working the deposits are employed and every care is taken to minimize damage to the surface. Nevertheless, total extraction inevitably gives rise to some surface subsidence.

The percentage of coal extracted is sometimes governed by the need to protect the workings from inundations of water. Thus, when mining operations are carried out below the sea, as in Britain, only narrow working places are permitted, and large protective pillars of coal are left permanently between them.

Mining Operations.—Although much of what follows is common to all coal mining operations, this section is written in the context of U.S. mining practice. Techniques and practices developed to meet the special mining conditions and problems in Britain and other countries are discussed below (see *Coal Mining in Great Britain* and *Coal Mining in Other Countries*, below).

In the room and pillar method, coal is mined by driving a series of tunnels through the seam in two directions at right angles, so dividing it into a number of blocks. The daily output of coal depends upon the amount extracted from each tunnel, and this varies according to the physical conditions and the height and width of the tunnel. The height is fixed by the actual thickness of the coal seam, and the width is normally the maximum that can be removed without collapsing the rock overhead. Contrary to popular belief, no attempt is made to support the entire weight of overlying rock material. Mines are designed to leave sufficient blocks of coal to support the total weight of overlying rock. Roof support underground is only for the purpose of supporting the few vertical feet of immediate rock left unsupported by the driving of tunnels.

After the tunnels have been driven through the coal to the limit of the area planned for mining, pillars between adjacent tunnels may be removed. After removal of such blocks of coal, the rock strata above generally collapse and the earth gradually settles, creating cracks and breaks in the surface land. Removal of coal from blocks and pillars is known as retreat mining. Underground areas in which final or retreat mining has been done are known as gob areas and thereafter are impossible, or at least unsafe, to enter. The width of the original tunnels driven largely depends on the cost of supporting the rock strata immediately overhead (see *Hazards of Mining*, below). In general the larger the cross sectional area of the tunnel the lower is the cost of mining per ton.

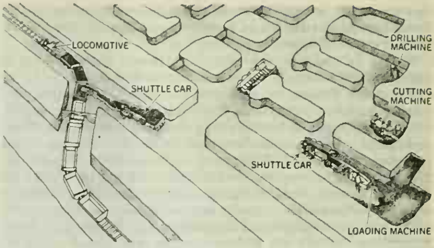


FIG. 2.—ROOM AND PILLAR MINING (CYCLIC)

Mechanization.—Two principal methods of underground mechanized mining are employed in the United States. They are known as "conventional" or "cyclic" mining and "continuous" mining. Conventional mechanized mining involves the following sequence of operations: supporting the roof, cutting, drilling, blasting and loading (*see* fig. 2). After the roof above the seam has been made safe by timbering or rock bolting, one or more slots—a few inches wide and extending for several feet into the solid coal—are cut along the length of the coal face by a large, mobile cutting machine. (This is essentially a multiton version of the portable power saw used to fell trees.) The cut, or slot, provides a free face and facilitates the breaking up of the coal subsequently blasted by explosives from the seam. The holes in which the explosive charges are placed are drilled by power drills. Special explosives are used to break down the coal. These are known as "permissible" explosives and when detonated liberate less heat and unpleasant fumes than ordinary high explosives (*see* EXPLOSIVES).

Other methods of breaking down the coal consist of placing in the blast holes steel cartridges several feet in length, filled with air compressed to pressures as great as 20,000 lb. per square inch, or with liquid carbon dioxide. The gases, when suddenly released in the small hole, expand and break the coal with an effect similar to that of explosives. (*See* also BLASTING.) After breakage, the coal is loaded directly into track-mounted mine cars or into rubber-tired electric trucks known as shuttle cars. Sometimes it is loaded directly onto chain or belt conveyers. The self-propelled loading machines are mounted on tracks, crawlers or rubber tires and are capable of loading up to 20 tons of coal a minute.

The operations of supporting the roof, cutting, drilling, blasting, loading and moving the coal out of the working place are performed by a group of from 10 to 20 men, known as a section crew. An experienced crew may mine more than 1,000 tons of coal in a single seven-hour shift.

Continuous Mining.—This is a method introduced during the late 1940s, which began to replace the sequential and cyclic operations of cutting, drilling, blasting and loading coal. A single machine, the continuous miner, was developed to break off the coal from the seam and to transfer it back to the haulage system (*see* fig. 3). Many such machines were installed underground, some having a productive capacity in excess of 5 tons per minute. Their use eliminated cyclic operations and reduced the number of men required in a section crew. Secondary advantages lay in the elimination of explosive costs and of machines for cutting and drilling the coal. The weak link in the chain of operations extending from the coal face back to the main haulage system was often the secondary transport system immediately behind the continuous miner. Such was the high rate of advance and loading of the continuous miner that normal secondary haulage systems were inadequate, so that mobile extensible belt conveyers were introduced. These high-capacity conveyers have self-propelled drive and tail sections and sufficient belt storage to permit advances of up to 100 ft. without stopping the conveyer. Cornering devices were also developed to carry coal around a series of right angle turns without its having to be transferred to another conveyer.

Underground Haulage.—After the coal is loaded into shuttle cars or conveyers in the production area, it is transferred to the main haulage system. In the United States more than 500 mi. of belt conveyers are used, most of them automatically controlled so as to stop the flow of coal in the event of any unforeseen condition. Many of these belts are adapted to carry men and equipment in and out of the mine. Approximately 4,000 mi. of railroad were in use in underground coal mines in the second half of the 20th century, with track equal in quality to that of many surface railroads. Trains carrying up to 25 tons of coal in each car were hauled by 35- to 50-ton locomotives, either completely out of the mine or as far as the shaft or slope foot where the coal was transferred to the shaft hoist or slope conveyer. It was estimated that 8,000 underground locomotives were in use.

B. Surface or Strip Mining

Coal was first discovered on the surface of the earth in exposed ledges or outcroppings. In time this supply was exhausted and man scratched back the earth to lay bare the coal seams. That was the way in which strip, opencut, or surface mining began. It became increasingly difficult, however, to remove the masses of overlying earth and rocks, and eventually mining operations went underground. The early miners rapidly realized that coal lying too close to the surface could not be safely mined underground. Unless there was a solid roof above them which could be propped up, the tops of the shallow tunnels would collapse. Large reserves of coal were therefore left, too deeply buried to be exploited by the primitive equipment then available and yet too shallow to be safely won from underground workings. As improved earth-moving equipment became available, strip or opencut mining developed. It consists of the removal of the soil and rock (overburden) above a coal seam and subsequent loading of the exposed coal. The method is used to best advantage where the seam outcrops or is not deeply buried, although many modern strip mines employ equipment capable of removing overburden more than 200 ft. in thickness. Power shovels used for this purpose in the second half of the 20th century were as tall as 12-story buildings and could remove up to 115 cu.yd. of earth in a single bite; wheel excavators rated up to 3,500 cu.yd. per hour were of virtually equivalent capacity.

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FIG. 3.—CONTINUOUS MINING MACHINE

By the second half of the 20th century more than one-fourth of all bituminous coal production and one-third of anthracite production in the United States came from surface mines. In Europe the large brown coal deposits were extensively worked by this means, and about 5% of British coal production was by opencast methods.

Strip Mining Method.—Although certain coal deposits can be strip mined without the use of explosives, usually some means of breaking the overburden is required. Large drills place either vertical or horizontal blast holes up to 14 in. in diameter in the overburden, and explosive charges are detonated to break the rock into fragments for easy loading. A power shovel or dragline then removes the broken rock overlying the coal and piles it in an area from which the coal has already been removed. Power shovels are located at the coal level, while draglines operate at the earth's surface level adjacent to the pit. The almost vertical solid rock wall above the coal seam that faces the direction of mining advance is called the high wall. The pile of broken rock moved to the opposite side of the pit is known as "spoil." Many states require that the spoil piles left following strip mining be leveled and restored to conditions of future productivity.

The horizontal surface of the coal seam is cleaned of small remaining amounts of dirt and rock with bulldozers or self-propelled power brooms. Smaller power shovels then load the coal into trucks or large semitrailers which move it to a preparation plant for washing and sizing.

C. Auger Mining

Auger mining as a method of recovering coal developed in the period following World War II. Because of the low initial cost of equipment and economy in mining, the growth of this method has been rapid in areas where it can be used. Auger mining consists of boring a series of parallel horizontal holes into the coal seam which has been exposed by outcropping or by strip-mining methods. Augering is frequently used in open-pit mines where the thickness of overburden over the coal at the high wall has become too great for further economic strip mining.

The augering machines, powered by diesel or gasoline engines, drill holes between 2 ft. and 5 ft. in diameter to depths of up to 300 ft. in the coal seam. The coal so removed is discharged to an elevating conveyer and loaded into waiting trucks. No drilling to place charges of explosives, blasting, roof support or overburden removal is required. With a production crew of three men, an auger mine is capable of producing up to 100,000 tons of coal annually, although additional men and equipment are required to transport the coal and prepare it for market. Augers have been adapted for use in underground mines.

D. Coal Mining in Great Britain

Large-scale coal mining operations have been carried on in Great Britain for many centuries, and most of the easily accessible and high-quality seams have been depleted; reserves of certain particularly high-grade coal are almost completely exhausted. Seams of such low thickness are worked at such great depths as would be considered impracticable and uneconomical in the United States. In Durham a seam has been worked which is frequently only 12 in. thick, and some collieries in Lancashire and Staffordshire are mining more than 4,000 ft. below the surface. The average depth of British mines is about 1,100 ft.

Workable seams in Britain range in thickness from 1 ft. to 40 ft., although the average thickness of seams being mined in 1960 was approximately 4 ft. The coal measures of England are fairly flat and relatively free from major geological disturbances but in certain areas of Scotland and south Wales the seams are highly inclined and faulted. Appreciable deposits of coal have been proved to underlie the sea bed off the northeast and northwest coasts; and many mines are working a mile or more out to sea. In the 1950s exploratory borings were made from offshore drilling towers

BRIAN SEED

FIG. 4.—OFFSHORE DRILLING TOWER, FIRTH OF FORTH, SCOTLAND

(fig. 4) to locate seams that could be mined through tunnels from the shore under the sea. In most British coal fields seam density is high. This is the ratio of cumulative coal seam thickness to over-all coal measure strata thickness, and a high density indicates seams in close proximity. Special techniques have been evolved to allow full extraction of seams adjacent to one another. Many British coal fields are situated in heavily industrialized areas, and it is often necessary to "solid stow"; *i.e.*, to fill completely with rubble the void created by the extraction of the coal. Power stowing machines have been developed which throw debris into the void at a rate of 30 to 40 cu.yd. per hour. Although solid stowing minimizes surface subsidence, the extraction of many seams in close proximity inevitably gives rise to damage. Provision for payment of compensation to owners of property damaged by subsidence amounted to approximately between £3,000,000 and £6,500,000 annually after World War II. Mining conditions are generally more difficult in Britain than in the United States, and although several British coal mines use U.S. mining equipment and the techniques associated with it, natural conditions militate against large-scale application of room and pillar mining as practised in North America. Room and pillar mining (variously known in Britain as bord and pillar, pillar and stall, stoop and room) accounts for less than one-tenth of output. It finds its widest application in the working of seams where safety considerations preclude the adoption of the much more favoured longwall system of mining.

Advancing Longwall Mining Methods.—This is by far the most important method of mining coal in Britain and accounts for about 92% of total annual production. With this system the whole of the seam within a specified area (panel) is extracted in one continuous operation by taking successive slices over the entire length of a long working face. The length of this face is normally between 80 yd. and 150 yd. In the simplest case a modern longwall face is developed and worked as follows (*see* fig. 5):

Assuming that consideration of required daily output has shown that a 100-yd. longwall face is necessary, two parallel tunnels are driven, starting from the main haulage road, at points 100 yd. apart. These parallel tunnels are termed gate roads and they are often at right angles to the main haulage road. As they are ultimately intended for use as transport roads for men, mineral and supplies, they are made fairly large. In the case of thin seams, part of the roof has to be blasted down in order to provide headroom. After some distance has been advanced, a longwall face is opened up by driving a further tunnel, the height of the seam, between the remote ends of the gate roads. The roof along this 100-yd. longwall face is then supported. In conventional longwall mining the coal face is usually undercut by a specially developed cutting machine which makes a slot about five inches wide and five feet deep into the seam. Blast holes are then drilled into the coal face and explosives are used to bring down the coal for hand shoveling onto a conveyer belt which runs the length of the face. This belt carries the coal to a gate road. Installed in this road—called the mother gate or main gate—is a second conveyer which delivers the coal to the principal transport system in the main haulage road.

After the entire slice of coal has been removed, the face conveyer and the face supports are moved forward a distance equal to the depth of the undercut. Then the mother-gate conveyer is extended by a like amount and permanent supports are erected in the now lengthened gate roads. The full cycle is now complete and begins again. Normally the three principal operations, cutting, filling and advancing equipment, are carried out in consecutive shifts, so giving a 24-hour production cycle. As one cubic yard of coal weighs about 0.95 long tons it can readily be calculated that in a 4-ft.-thick seam, a 100-yd. longwall face having a 5-ft. undercut will produce 210 tons of coal each day. Many British coal mines have a dozen or more such production areas, each requiring a total of about 60 miners to complete the whole cycle.

The waste area (known also as gob or goaf) left behind as the longwall face advances can be partially or wholly filled (solid stowed) with rock. The former process is known as strip packing, and involves the building of wide rock walls at intervals along the face. These walls or packs run parallel to the gate roads. Choice of method depends on the competence of the strata adjacent to the seam and the urgency of the need to reduce surface subsidence. On many longwall faces the roof behind the face is induced to break up and cave into the goaf. This is termed longwall caving, and with this system the only supports left in the waste area are protective stone packs which are built alongside the gate road and are continually extended as the face advances.

On occasion the longwall method is adapted to retreat mining. In such cases the gate roads leading from the main haulage road are driven to the boundary of the panel of coal to be extracted. At the boundary, a longwall face is developed as before, and is then worked back toward the main haulage road in the same general manner as previously described.

Both longwall systems can be successfully used in a wide variety of mining conditions. In Britain, seams varying in thickness between 1 ft. and 40 ft. have been mined by longwall methods and the system has been adapted to use in seams having inclinations

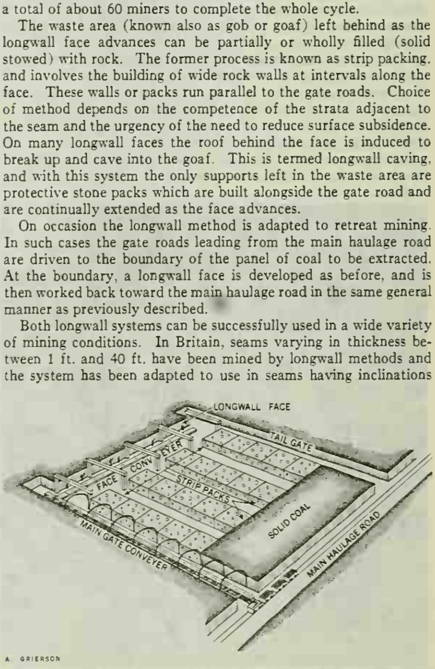

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FIG. 5.—MINING AT ADVANCING LONGWALL FACE WITH ROOF SUPPORT BY STRIP PACKS (*See* TEXT)

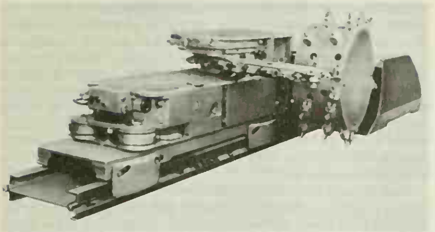

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FIG. 6.—LONGWALL CUTTER AND LOADING MACHINE

in excess of 45°. Another important feature is that longwall mining can be carried out at depths so great that pillars might break under the weight of the overburden if the room and pillar system were used. It is because of this versatility in application and the high percentage extraction which it permits that longwall mining has found universal favour in Britain.

Mechanized Mining.—The necessity for close support systems on longwall faces is an impediment to mechanization, and progress in developing power-loading machinery has been limited by the extreme variations in mining conditions. Such variations militate against standardization, and many machines have been designed for a specific set of operating conditions. Power-loading machinery in Britain can be divided broadly into two main groups: those machines which mechanically load coal that has previously been blasted, and cutter-loading machines which eliminate the need for any prior preparation of the coal (*see* fig. 6). Many of these machines utilize high speed revolving chains fitted with hard metal teeth which tear the coal from the face. Although the machines are capable of producing many hundreds of tons of coal each shift, the severe working action of some of them so degrades the coal that its selling value is often reduced. With the end of the 1950s came a slackening in the demand for coal and a corresponding greater discrimination in the choice of mechanized mining equipment.

Nationalization.—As in most European countries, the coal industry in Britain is under state control. Public ownership of the coal industry was initiated by the Coal act of 1938, whereby the state acquired all the unworked coal then privately owned at a cost of £66,450,000. This act was followed in 1946 by the Coal Industry Nationalization act, which brought the entire industry under public control at a further cost to the state of £164,600,000.

In accordance with the provisions of this act the responsibility of running the industry was transferred on Jan. 1, 1947, to the national coal board, whose members are appointed by the minister of power. Since the inception of nationalization various changes have been made in the structure of the board and in the organization of the industry. In 1959 Britain was divided into nine major producing zones or divisions, each having a divisional coal board with considerable autonomy. These divisions were in turn subdivided into a total of 51 areas, each controlled by a general manager responsible for about 15 to 20 coal mines. Although each higher management level has considerable independence there is a clearly defined line of command, and all major capital expenditure must be sanctioned by the national board. The national coal board itself is subject to directions of a general character from the minister of power, on matters which affect the national interest.

E. Coal Mining in Other Countries

Western Europe.—In Europe the coal seams are generally numerous, highly inclined and at appreciable depth. These geological features have led to the widespread use of a special mining technique known as "horizon mining." This is analogous in concept to metalliferous mining practice in that the main haulage and ventilation tunnels are not driven in the seam or mineral vein being worked but in the adjacent strata. Thus the principal tunnels are not constrained to follow the undulations and vagaries of the coal seams but can instead be driven in a predetermined direction at an arbitrary uniform inclination. In Europe it is usual for horizon roads to be driven at an inclination of about 1:500, as this gradient is ideally suited to locomotive haulage. The various seams are reached via small shafts driven upward from the horizon roads, and the actual mining of the coal is usually by one or other of the longwall mining methods. The coal is generally less hard than in Britain and the United States and, in consequence, much of the output is won by pneumatic picks. The use of compressed-air picks eliminates the need for machine undercutting and explosives. In an endeavour to increase productivity, special machinery and techniques have been developed for use in these soft coal seams. Much of western Europe's power-loaded output is won with the use of coal plows (*see* fig. 7). In their simplest form these are hardened steel or alloy blades, fitted to a plow frame, which shear off a strip of coal a few inches thick as the plow is slowly hauled across a longwall face by means of a wire rope coiling onto a powerful winch in the gate road. The coal sheared from the face is deflected by a ramp onto a specially designed armoured chain conveyer. The plow is capable of shearing coal in both directions, and auxiliary plows at each end of the machine clear in advance any loose coal lying in its track. The armoured conveyer has articulated joints and is capable of being continuously snaked forward toward the solid coal face. Specially developed support systems complete the face mechanization equipment and permit full continuous mining to be done. Power-activated plow blades have been developed for use with harder coals.

Eastern Europe.—Many of the eastern European countries are major coal producers, and in every country the coal industry has been highly developed since the end of World War II. In no country has more progress been made than in the U.S.S.R., and output of coal and lignite increased from an estimated 161,000,000 tons in 1946 to about 500,000,000 by 1960. The U.S.S.R. has huge reserves of coal at less than 1,200 ft. depth and much of the annual output is mined from shallow seams. In the interests of rapid expansion in output numerous slope mines have been developed, many with daily outputs of less than 500 tons. Longwall mining is the most common method of working and accounts for about three-quarters of total output, including coal which has been strip mined. The U.S.S.R. has developed a wide range of power-loading equipment, and in the flatter seams about one-half of the output is loaded by mechanical means. In such widely scattered coal fields as in the U.S.S.R. a great variation in mining conditions is inevitable, and in the Kuzbas field (Kuznetsk basin) alone the thickness of seams worked varies between 2 ft. 6 in. and 50 ft., the average being 6 ft. 9 in. Almost one-third of deep-mined output comes from seams inclined at more than 25° to the horizontal.

Hydraulic mining has been introduced at several slope mines. This system involves the removal of coal from the face by high-pressure water jets and its transportation entirely by hydraulic means to the surface. The water pressure in the hydraulic nozzle ranges from 300–1,000 lb. per square inch, depending on whether the coal is first loosened by a special blasting technique or is sliced off the solid coal face. It is claimed that the productivity in hydromines is about 2½ times that in comparable mines worked by conventional methods.

Asia.—The Chinese coal industry is undergoing a period of intensive expansion, and one of the most important developments has been the large-scale introduction of hydraulic mining. Immense coal reserves are available under conditions which vary widely. The availability of ample manpower has in the past militated against intensive mechanization although it is probable that the

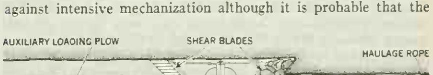

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FIG. 7.—TOP VIEW OF SIMPLE COAL PLOW

phenomenal rise in production recorded after the mid-1950s must in substantial part be due to machine mining.

India has appreciable reserves, but if over-all industrial development in the second half of the 20th century were not to be retarded, it would be necessary to reorganize almost the entire coal industry. Seams of 40 to 50 ft. in thickness are worked by bord and pillar mining, with very little mechanization. One of the principal problems facing the industry in India is that of maintaining an adequate labour force: many miners are also farmers, and this results in high seasonal absenteeism.

Australasia.—Coal mining is one of Australia's oldest industries. Most of the bituminous coal output comes from New South Wales, where mechanized mining methods have been widely introduced. This field has an area of about 5,000 sq.mi. and by the early 1960s over 80% of underground production was mechanically cut and loaded. The brown coal deposits in Victoria are of extraordinary thickness—there are single seams up to 265 ft. thick—and are worked by opencast mining methods. Small amounts of coal are mined in Queensland, New Zealand and Tasmania.

F. Automation in Mining

The remote or automatic control of mining operations, which comprises a large number of small, scattered working units, poses a very different problem from that existing in a compact manufacturing plant where both the product and the processes have reasonable uniformity. This diversification has militated against its widespread application to mining machines and methods. Although mechanization underground has contributed significantly to the increased efficiency of mining operations, automatic control has been first applied to straightforward materials handling operations such as haulage and hoisting. Here progress has been fairly rapid. Many mines have automatic hoisting equipment, sometimes supplemented with closed circuit television, which loads the mineral into the shaft conveyances, operates the hoist and discharges the mineral at the surface without requiring the attention of the miner. Automatic traffic direction units, complemented by computers, have been installed underground to control intricate locomotive haulage systems and automatic control of conveyer systems has long been standard practice. Many of the processes within the surface plant lend themselves to automation.

The extension of control to operations on the coal face was being actively considered. In Britain, hydraulic-powered roof supports, which only require manual operation of a control valve to carry out the operations of release of support, advance and reset of support for the roof, are extensively used. Research was undertaken to operate these powered supports remotely and monitor their performance. Successful experiments have been made underground using a nucleonic probe to give an indication of the thickness of coal beneath the cutter-loading machine to the miner controlling it by hand, thus facilitating coal mining within the seam without excursions into roof or floor. Work was under way to make this operation fully automatic. Similar work was proceeding in the U.S.S.R. The carbide miner, a combination of carbide-tipped, multiple rotating cutters with a unitized conveying system, operated by remote control from an outcrop portal, has been in use in the United States for several years.

VI. HAZARDS OF MINING

Although comprehensive mining legislation, improved mining techniques and intensive safety propaganda directed at the workers have considerably reduced accidents in coal mines throughout the world, mining remains an inherently dangerous occupation. For example, the death rates per 100,000 underground man shifts in western European and United States coal mines for the ten-year period following World War II ranged, in Great Britain, from a high of 0.44 in 1947 to a low of 0.24 in 1954; in Belgium from 0.66 (1953) to 0.32 (1955); in the Netherlands from 0.53 (1946) to 0.15 (1955); in France from 0.48 (1948) to 0.34 (1955); in the Federal Republic of Germany from 0.77 (1948) to 0.61 (1955); and in the United States, for anthracite, from 1.54 (1955) to 0.75 (1950), and for bituminous from 1.22 (1947) to 0.84 (1952). When considering the significance of these figures it must be borne in mind that they bear very favourable comparison with those obtained in other coal fields. The expression of accident frequency in terms of man shifts worked is common in western countries as it is more reliable than systems based on output. These often permit high productivity to mask high accident rates. A general downward trend, by and large, has been maintained since 1935 as a result of successive improvements in legislation and in mining techniques. That there are no grounds for complacency is illustrated by the fact that even the relatively low fatality rate of 0.22 recorded in Britain in 1956 represented 289 deaths. Death rates in auger mines are low.

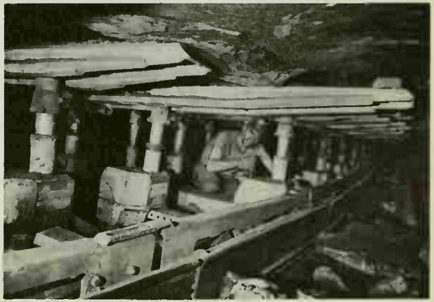
Underground accidents may be classified under three main headings: (1) falls of ground; (2) haulage and transport; (3) ventilation and mine gases, explosions and fires. In addition, other health hazards must be noted. A study of accident statistics reveals a fundamental similarity in the general percentage classification of casualties in the major coal-producing countries. Falls of ground account for just over half the total killed or seriously injured each year in coal mines. A further 20% of the annual casualties are attributable to haulage and transport accidents, and the remainder are accounted for by gases, explosions and fires, and by electrical mishaps and the like. Major disasters such as mine fires and explosions—grievous though these may be in local effect—do not account for the greatest number of underground deaths and injuries.

A. Falls of Ground

Accidents caused by falls of the mine roof and sides do not usually involve more than one or two men, although on occasion single incidents result in many deaths. This is particularly the case in mines liable to rock bursts. In certain circumstances the sudden release of elastic strain energy in stressed strata results in violent disintegration of the rock itself. Such rock bursts can be on a very large scale and accompanied by air-pressure waves of sufficient violence to disrupt the mine ventilation circuit. Although much has been learned of this phenomenon, and safety measures have been introduced, rock bursts still constitute a major hazard in many coal fields, particularly in North America.

The relatively small falls of rock, however, account for most deaths, occurring as they do with terrible regularity. Prevention of this type of accident depends upon adequate support of the roof and sides of the mine. Normal support systems may be supplemented by protective pillars of coal which are left unmined. Since 1945 a technique known as rock bolting has been widely employed, particularly in United States coal mines. This involves drilling holes in the strata and inserting steel rods which are subsequently anchored in position. These rods, several feet in length and an inch or so in diameter, either bolt the immediate roof or sidewall to a stronger stratum or, alternatively, bolt together several individually weak layers to form in effect one thick, compound beam.

In Europe, hydraulically powered supports have been extensively used to give improved roof conditions and to reduce the



BY COURTESY OF DOWTY MINING EQUIPMENT LIMITED

FIG. 8.—SELF-ADVANCING HYDRAULIC SUPPORTS ON A LONGWALL FACE

number of men employed on the coal face on support operations (*see* fig. 8).

B. Haulage and Transport

Mine haulage systems are often large even by surface standards, and it is not unusual for a coal mine to require large numbers of haulage workers. Haulage accidents, like falls of ground, tend to be limited in individual effect but to be all too frequent in occurrence. Apart from the obvious dangers associated with the large-scale movement of men and material, mine haulage is made more dangerous by lack of working space and by a standard of lighting much below that on the surface.

C. Mine Ventilation and Gases, Explosions and Fires

Ventilation.—Provision of adequate ventilation is one of the most essential safety features of underground coal mining. In Europe, the average weight of air passing daily through the coal mines is about six times the total daily weight of coal produced, and many mines require the circulation of more than 500,000 cu.ft. of air per minute. Obviously not all of this vast quantity of air is required to enable the miners to work in comfort. Most of it is necessary in order adequately to dilute the harmful gases produced during mining operations. Such gases are frequently termed "damps," (from the Middle German *dampf*, literal meaning, "vapour").

Firedamp.—The gas which occurs naturally in the coal measures is nearly always methane, CH_4. This gas is highly inflammable and explosive when present in the air in a proportion of 5% to 14%. Several gas explosions are recorded each year in the United States. In Great Britain methane is frequently called marsh gas or firedamp, although more correctly the latter term should be confined to an inflammable mixture of methane and air. Methane is occluded in the coal and the associated strata and is liberated when these are disturbed, although the amount generated in some mines is insignificant. It is usually given off gradually, and in the course of mining some seams yield up to 5,000 cu.ft. of methane for each ton of coal. In order to render this gas harmless it is necessary to circulate large volumes of air to reduce the percentage of methane to below a prescribed figure. (The permissible maximum methane content varies from country to country but is of the order of 1% or 2%.) Methane may also be given off in the form of outbursts. These are sudden, violent discharges of short duration, usually accompanied by the displacement of large quantities of broken strata and dust. In the earlier years of the 20th century, at Morissey colliery in British Columbia, about 2,000 tons of coal were displaced during an outburst of an estimated 3,000,000 cu.ft. of methane. Although such serious outbursts are fortunately rare, firedamp, however formed, is a major hazard and, despite improvements in detection and ventilation techniques, dangerous accumulations still occur. In a five-year period in the 1950s, 157 ignitions of firedamp occurred in Britain alone, causing 69 deaths and 214 injuries.

To reduce the danger from inflammable gas underground, long boreholes may be drilled in the strata ahead of the working face and the methane drawn out of the workings and piped to the surface. This technique is known as methane drainage and is common in Europe. The extracted gas is frequently utilized on the surface, pure methane having a calorific value of 1,012 B.T.U. per cu.ft. Although many instruments have been specifically designed to detect the presence of firedamp underground, the principles of the flame safety lamp (*q.v.*) devised by Sir Humphry Davy in 1815 still form the basis of many detectors.

Methane air mixtures can be ignited by a naked flame or by frictional sparking, which has accounted for many serious underground explosions, and it has been found that firedamp can be readily ignited by electrical energies in the region of one millijoule. Accordingly, only specially designed electrical equipment may be used in mines where methane constitutes a possible hazard. In some mines only compressed-air-powered machinery is permitted.

Whitedamp: CO.—Carbon monoxide is a particularly harmful gas, and as little as 1% in the air inhaled very rapidly causes death. It is the product of the incomplete combustion of carbon and is formed in coal mines chiefly by oxidation of coal, particularly in those mines where spontaneous combustion occurs. It is often found after explosions and it occurs in the gases evolved by explosives. The exhaust gases of diesel engines used underground also contain up to 0.05% carbon monoxide by volume, and this emission may necessitate the circulation underground of up to 200 cu.ft. per minute of diluting air for every brake horsepower (b.h.p.) of the engine. The term "whitedamp" is obsolescent.

Blackdamp.—This is an atmosphere in which a flame lamp will not burn, usually because of an excess of carbon dioxide in the air or because of a deficiency of oxygen. Blackdamp, chokedamp or stythe as it is variously called, is found chiefly in old workings or badly ventilated headings. The actual percentage composition of blackdamp depends upon its source, and its physiological effect on the miner varies with its composition. Many countries prescribe the minimum oxygen content and the maximum carbon dioxide content permissible in the atmosphere in which miners are to work. However, numerous fatalities have resulted from men's inadvertent entering of old or badly ventilated workings.

Stinkdamp: H_2S.—This is the name given by the miner to hydrogen sulfide, because of its characteristic smell of rotten eggs. It is one of the first gases to be expelled when coal is heated out of contact with air; hence it is frequently found in the gases resulting from gob or goaf fires. It occasionally occurs in small quantities along with the methane given off by outbursts and is sometimes present in the fumes resulting from blasting. Stinkdamp is an extremely poisonous gas and concentrations in excess of 0.1% can cause serious disability or death.

Afterdamp.—This is the term applied to the mixture of gases found in a mine after an explosion or fire. Its actual composition varies with the nature and amount of the materials consumed by the fire or with the extent to which firedamp or coal was involved in the explosion. Afterdamp is very deficient in oxygen and among other dangerous characteristics has a high carbon monoxide content. By far the greater proportion of deaths in coal mine explosions and fires are due to the effects of afterdamp.

Explosions and Fires.—The menace of firedamp explosions in coal mines was widely recognized early in the 19th century and appropriate steps were taken to prevent them. The danger of coal dust in mines was not, however, appreciated until the 20th century. Few people heeded Michael Faraday's thesis in 1845 that the ignition and explosion of firedamp would raise and then kindle coal dust. Eventually it was realized that coal dust presents a far greater danger than methane, in that coal dust explosions are far more violent in character and widespread in effect than simple firedamp explosions. These latter are usually fairly localized in their effect and their principal danger lies in the fact that a relatively minor firedamp explosion may initiate a far more serious coal dust explosion. Some of the worst disasters of the 20th century, all coal dust explosions, are shown in Table II. Precautions taken against the occurrence of coal dust explosions include the deposition of incombustible rock dust in the mine roadways to suppress propagation of the explosion.

Fires are particularly dangerous in coal mines as, apart from the fact that a naked flame may initiate an explosion, there is the added complication that the coal itself provides a virtually inexhaustible supply of fuel. Much of the equipment used underground is capable of initiating or sustaining a fire. Inflammable conveyer belting was responsible for the death of 80 miners at Creswell colliery in England in 1950. To prevent a repetition of this disaster the British national coal board replaced all underground rubber belting by noninflammable polyvinyl chloride belting.

TABLE II.—*Coal Dust Explosions* (*More Than 300 Killed*)

Year	Place	Fatalities
1906 . . .	Courrières, France	1,099
1907 . . .	Monongah, W.Va.	362
1908 . . .	Radbod, Federal Republic of Germany	360
1910 . . .	Pretoria, South Africa	344
1913 . . .	Senghenydd, Wales	439
1942 . . .	Honkeiko, Manchuria	1,572
1946 . . .	Grimberg Monopol, Federal Republic of Germany	439

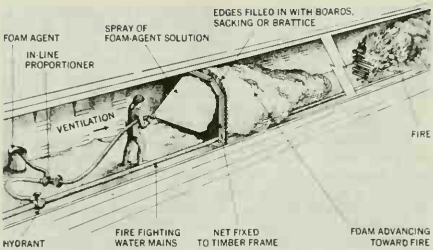

EDGES FILLED IN WITH BOARDS, SACKING OR BRATTICE
SPRAY OF FOAM-AGENT SOLUTION
FOAM AGENT
IN-LINE PROPORTIONER
VENTILATION
FIRE
HYDRANT
FIRE FIGHTING WATER MAINS
NET FIXED TO TIMBER FRAME
FOAM ADVANCING TOWARD FIRE

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FIG. 9.—FIGHTING A MINE FIRE BY THE FOAM-PLUG METHOD (*See* TEXT)

A development in the field of underground fire fighting is the "foam plug" technique. Tens of thousands of cubic feet per minute of air-water foam are generated on the upwind side of the fire. This foam completely fills the roadway and is pushed by the normal air stream into the fire zone, and so blankets the fire (*see* fig. 9). Large-scale trials of this technique have taken place in Great Britain, the United States, Poland and the U.S.S.R.

D. Other Hazards

It is now universally recognized that continued inhalation of certain dusts is detrimental to health and may lead to reticulation of the lungs and eventually to fatal diseases included under the general term pneumoconiosis. Coal and silica dusts are particularly harmful when the particle size is below five microns and, unfortunately, much of the dust produced during mining operations is below this size. Methods adopted to combat the dust hazard include the infusion of water under pressure into the coal before it is broken down; the spraying of water at all points where dust is likely to be formed; the installation of dust extraction units at strategic points; and the wearing of masks by miners operating drilling, cutting and loading machinery. Despite these precautions, in Great Britain almost 3,000 men per year are certified as having contracted lung diseases.

Miners' Nystagmus.—This is an occupational disease which usually manifests itself after 20 or 30 years' work in coal mines. Initially it is a defect of vision, but if it is not checked nervous disorders may develop culminating in total disability. The concensus is that the primary cause of miners' nystagmus is to be found in the low brightness levels characteristic of working faces in coal mines. Illumination underground has improved considerably during the 20th century and the replacement of oil-flame safety lamps by more efficient sources of lighting has resulted in a significant drop in the incidence of this disease. In the mines of the United States, where electric cap lamps have long been used in preference to other forms of portable lamps, the disease became virtually unknown. In Europe, the change-over to electric lamps came about later and, as the disease takes very many years to develop, some cases of miners' nystagmus were still being diagnosed in the 1960s.

VII. PREPARATION AND USES OF COAL

A. Preparing Coal for the Market

Coal preparation embraces all the handling and treatment of the coal from the time that it reaches the mine outlet until it is finally taken over by the surface haulage system for dispatch to the market.

In earlier days, coal was dispatched from the mine and sold much as it came from the ground. Some effort was made to remove rock and impurities when the coal was loaded into the mine car underground, because payment to the miner was generally withheld if his cars contained visual impurities. When coal was hewn and loaded by hand, the miner could sort out much of the large-sized dirt and leave it in the waste area. At the beginning of the 20th century small coal was not easy to sell, as the principal consumers, power stations and the coking and gas industries, were very small by modern standards. In the absence of a market for a small-sized product, coal was often loaded underground with a fork rather than with a shovel. This left behind the small coal, which tended also to be the dirtiest. This primitive form of selective mining disappeared early in the century, and gradually rudimentary coal-sorting plants came into general use. In the United States bituminous mines these were called tipples, after the tippling operation which transferred the coal from the mine cars onto picking or sorting screens and belts. Here a group of men picked out the visible impurities. Tipples also segregated the run-of-mine coal into size groups, and as the larger sizes could be more carefully hand-cleaned and were burned with greater ease and cleanliness in fireplaces and hand-stoked furnaces, size became associated with quality in the public mind.

With the onset of mechanical mining, and in some countries the economic necessity to mine dirtier seams, run-of-mine coal became smaller and dirtier. In many mines more than a quarter of the coal brought to the surface was rejected as waste, and thus grew the mountainous heaps of rock which disfigure coal mining areas. With improved efficiency in the many coal-cleaning processes used, the tonnage of rejected waste material increased yearly. In several countries—particularly in Europe—much of this rock was taken back underground and used as stowing material. Attempts were made to improve the unsightly appearance of waste heaps by seeding them with special grasses and by planting shrubs.

Coal-Cleaning Processes.—Methods employed for the removal of impurities from coal depend upon the physical differences between the impurity and the coal; particularly the differences in their specific gravities. The specific gravity of coal depends in some degree upon its intrinsic impurities, and ranges between 1.2 and 1.5, a generally accepted average value being about 1.25. Most of the extraneous impurities mined with coal are much heavier than the coal itself, and separation can be effected by immersing the run-of-mine coal in a fluid having a specific gravity greater than that of the coal but less than that of the impurity. This allows the pure coal to float and the heavy waste material to sink, and arrangements are made to collect the two products separately. There are, however, all kinds of associations of coal and rock ranging in an unbroken series from pure coal through coal with an increasingly higher proportion of inorganic impurities, continuing through rocks having a more or less carbonaceous content and finishing with pure rock. Accordingly, the specific gravities of these bodies form an unbroken series between the two extremes represented by pure coal and pure rock. Thus in practice the problem is often to separate impure coal from more or less carbonaceous rock, and the arbitrary demarcation line is frequently dependent on economic considerations; *i.e.*, the balance of the cost of improved cleaning of the coal against the increase in sales resulting from such improvement.

One of the most widely adopted heavy-medium cleaning proc-

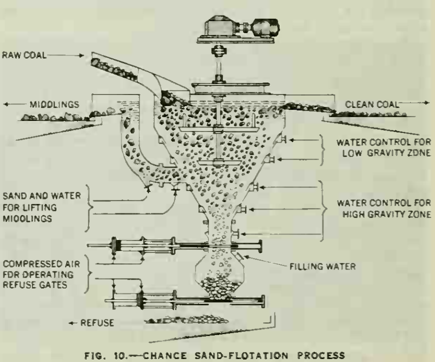

RAW COAL
MIDDLINGS
CLEAN COAL
WATER CONTROL FOR LOW GRAVITY ZONE
SAND AND WATER FOR LIFTING MIDDLINGS
WATER CONTROL FOR HIGH GRAVITY ZONE
COMPRESSED AIR FOR OPERATING REFUSE GATES
FILLING WATER
REFUSE

FIG. 10.—CHANCE SAND-FLOTATION PROCESS

esses is illustrated in fig. 10. The plant consists of a large inverted conical vessel in which sand is maintained in suspension in an upward current of water. The density of the fluid can be varied by increasing or decreasing the amount of sand held in suspension. The process can be arranged so as to give an intermediate product between the pure coal and the pure rock. This is achieved by adjusting the speed of the upward water current through control of the volumes of water admitted at the several levels. Some heavy-medium flotation plants use finely crushed barium sulfate or magnetite in suspension in water. In some processes, termed dry, or pneumatic, cleaning, air is used as the separating medium. This system originated in the United States and is considered cheaper than wet washing, but it is less catholic in application.

Very small sizes of run-of-mine coal can be cleaned by froth flotation methods. Coals to which much dirt adheres may be crushed to less than $\frac{1}{50}$ in. in size and fed into a bath containing an oil and water emulsion through which air is bubbled. The oil spreads as a film over the surface of the coal particles, which then attach themselves to the entrained air bubbles and are carried to the surface of the bath. The rock particles, however, are preferentially wetted by water and not by oil and so sink to the bottom of the bath. The froth on the surface of the bath is then removed and broken down to release the clean coal.

Occasionally, especially for the anthracite market, coal must be broken to smaller sizes before sale. Coal preparation plants in the anthracite fields of the United States are therefore commonly known as "breakers." Even when dealing with the softer bituminous coals it is becoming a general practice to crush all coal above 6–8 in. in size. Thus hand-sorting confined to the larger-size ranges will eventually disappear. By mid-20th century, more than half of the coal mined in industrialized countries was mechanically cleaned and sorted.

B. TRANSPORTATION AND MARKETING

Almost three-fourths of the coal mined in western countries is transported to market by railroad, the remainder being shipped or trucked to its destination or used at the mine. There are many occasions when coal is transported by road, rail and water in its journey from mine to market. In the United States, tonnage handled on the inland waterway system increased significantly in the second half of the 20th century as waterways were improved and extended to serve more coal mining areas. By this time almost 200,000,000 tons of coal were moved each year by water—much of it in barges. In Europe, too, considerable tonnages were moved by water. Special 50-ton-capacity amphibious vehicles came into use in the 1950s to carry coal from the Ruhr to lower Saxony. The coal was loaded into the vehicles at the mine and these were then hauled by locomotives to the waterway, where the containers were transferred bodily from the railroad track to the water. This system reduced the cost of transferring the mineral from one transport medium to another.

In some mining areas near the coast the coal was taken by conveyers directly from the mine to the holds of large coastal vessels. In Britain, much of the coal from the northern coal fields is taken to London and the south in coastal cargo vessels called colliers. Almost 17% of British output was moved by sea in 1958. However, this was less than one-fourth of the tonnage moved by rail.

In both the United States and Britain, the coal industry and the railroads are closely linked historically and economically. Each was largely responsible for the development of the other, and traditionally they were each other's best customer. However, particularly in the United States, the balance of this reciprocal benefit has been upset by the rapidity of the change-over from coal-fired locomotives to diesel or electrically-powered ones. In the United States, class I railroads decreased their use of bituminous coal from a peak of 132,000,000 tons in 1944 to about 2,000,000 tons by 1960. In Britain the fall in demand was much less abrupt, and in the 1960s the railroads still provided a market for about 5% of total output. On the other hand coal traffic provided the nationalized British railways with 40% of the total freight receipts.

The late 1950s saw the introduction of higher-capacity road-haulage trucks than were formerly considered practicable. Large-scale truck haulage of coal is normally only economic over relatively short distances, but increased size of pay load makes for a wider field of application. In some strip mines giant trucks were introduced carrying up to 80 tons or more.

Another development was the erection of large chemical, industrial and power plants close to the mines to reduce fuel-haulage costs. The coal was carried directly to the plant or factory on conveyers. Electrical utilities were built fairly adjacent to mines, for it was much cheaper to transmit electrical power over long distances than to move the equivalent tonnage of coal. In 1957 a co-operative producer-consumer project was inaugurated using a coal pipeline 108 mi. long to carry a mixture of coal and water from a mine near Cadiz, O., to a power plant at Cleveland where the coal was separated from the water and fed into the boilers. Although this system of coal transportation was not new, it represented a major step forward in the field of long-distance hydraulic transport. Further installations were put into operation in Britain and elsewhere. It was held that pipeline transmission of coal was economic between the areas in which a large supply of coal was available and those specific markets where large tonnages of coal were used at a fairly uniform rate. Where consistently high tonnages were required, belt conveyers were widely used for medium-distance hauls. With the development of stronger belting and the introduction of conveyers in which the stress was taken by external steel cables, many of the former limitations of belt conveying were removed. Single flights up to many miles in length were installed, handling many hundreds of tons of coal an hour.

Great Britain and the United States differ considerably in their patterns of coal consumption, independently of the size of their respective coal industries. This is explained by the serious encroachment of oil and natural gas onto U.S. coal markets. Since the end of World War II, the contribution of bituminous coal to U.S. energy requirements in those spheres where coal can be used had fallen from 60% to less than half this figure by the 1960s. The market for domestic coal, traditionally a very profitable one, had, for example, plunged from 99,000,000 tons in 1947 to 33,000,000 tons by 1958. This drop was offset exactly by a corresponding rise in the electrical utilities market during this period and although, on balance, the amount of coal produced had not materially altered, the actual consumption pattern had been greatly changed. As Great Britain has no significant natural gas deposits, the demand for manufactured gas there provided a market for 25,000,000 tons in 1958, almost one-eighth of total inland consumption.

C. BY-PRODUCTS OF COAL

Although most of the coal mined throughout the world is burned in its natural state, a significant proportion is used to produce various processed fuels and coal chemicals. Of paramount importance is the manufacture of coke for the steel and kindred industries and, indeed, many coal chemicals are obtained as by-products from coal which in the first place has been carbonized to manufacture coke. (*See* also CARBONIZATION, LOW-TEMPERATURE; COKE, COKING AND HIGH-TEMPERATURE CARBONIZATION.)

In the basic coke manufacturing process, one short ton of coal produces about 1,500 lb. of coke, 11,000 cu.ft. of manufactured gas, 10 gal. of coal tar, 3.5 gal. of light oil and 28 lb. of chemicals. There are many processes in which the aim is to gasify the coal completely. The resultant gas may be used directly as a fuel or be further treated to produce fuel oils and various chemicals, as at Sasolburg in South Africa, where eight Lurgi pressure gasifiers each completely gasify 400 tons of coal per day, producing about 20,000,000 cu.ft. of raw gas. This gas is further treated to produce vast quantities of oils and related chemicals. The coal used in this plant comes from a nearby colliery, where mine production costs per ton are considered to be the lowest in the world. Coal is used in the manufacture of such common products as fertilizers, insecticides and disinfectants, food dyes, synthetic rubber, nylon and numerous plastics used in everyday life. The refrigerants in many refrigerators, *i.e.*, carbon dioxide and ammonia, are frequently coal derivatives. Tar and pitch for highways and roofs are important by-products of coal. Photographic sensitizing dyes are a few among the many thousands of dyes derived from coal.

VIII. WORLD PRODUCTION AND RESOURCES

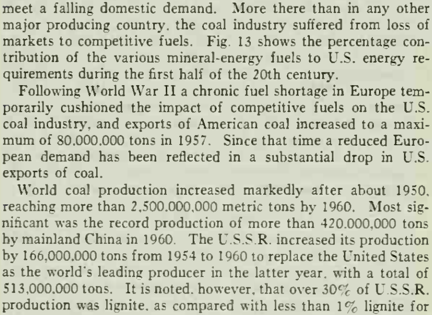
Industrial production and living standards depend decisively upon fuel and power, and although over-all dependence on coal as a primary source of energy has been proportionately reduced during the 20th century coal still supplies much of the world's energy needs. Fig. 11 shows the trends in the United States in the energy supplied by mineral fuels, water power and atomic energy in the 20th century.

A. World Production

Discounting occasional downward trends of short duration, world demand for coal has risen steadily during the 20th century despite the extremely rapid increase in the use of alternative fuels. For the most part this rise in demand has been attributable to a tremendous increase in industrial activity in the western world and, although this stimulus remains, it seems probable that further significant increases in coal production are coupled to the rising needs of the hitherto underdeveloped areas. Improved living standards for the vast populations in these areas require massive increases in indigenous coal production on a scale comparable with that evidenced in Europe and North America during the western Industrial Revolution. In China, for example, official coal production statistics suggest that output was more than doubled in a single 12-month period, rising from 130,730,000 tons in 1957 to 270,000,000 tons the following year. Fig. 12 shows total world production of coal and lignite from the beginning of the 20th century and indicates the falling off in the proportion contributed by the United States and Great Britain. This falling off was not due solely to increased activity in other coal mining countries—although this was the dominant factor—but also, in the case of the United States, to deliberate restriction of coal production to meet a falling domestic demand. More there than in any other major producing country, the coal industry suffered from loss of markets to competitive fuels. Fig. 13 shows the percentage contribution of the various mineral-energy fuels to U.S. energy requirements during the first half of the 20th century.

Following World War II a chronic fuel shortage in Europe temporarily cushioned the impact of competitive fuels on the U.S. coal industry, and exports of American coal increased to a maximum of 80,000,000 tons in 1957. Since that time a reduced European demand has been reflected in a substantial drop in U.S. exports of coal.

World coal production increased markedly after about 1950, reaching more than 2,500,000,000 metric tons by 1960. Most significant was the record production of more than 420,000,000 tons by mainland China in 1960. The U.S.S.R. increased its production by 166,000,000 tons from 1954 to 1960 to replace the United States as the world's leading producer in the latter year, with a total of 513,000,000 tons. It is noted, however, that over 30% of U.S.S.R. production was lignite, as compared with less than 1% lignite for the U.S. U.S. production (480,000,000 metric tons in 1956) totaled less than 400,000,000 in 1960, Canada's production was about 10,000,000 and the production of the United Kingdom was down to less than 200,000,000. Production of the Federal Republic of Germany had reached 240,000,000 metric tons; that of the German Democratic Republic 228,000,000. Other important world producers in 1960 included Poland (114,000,000 metric tons), Czechoslovakia (86,000,000) and Hungary (26,000,000) in eastern Europe; France (58,000,000), Belgium (22,000,000) and the Netherlands (12,000,000) in western Europe; Spain (16,000,000); and Yugoslavia (23,000,000). Production in India reached 53,000,000 tons, a figure almost matched by Japan, and both South Africa and Australia produced about 38,000,000 tons. (*See* also *World Coal Reserves*, below, and articles on individual countries.)

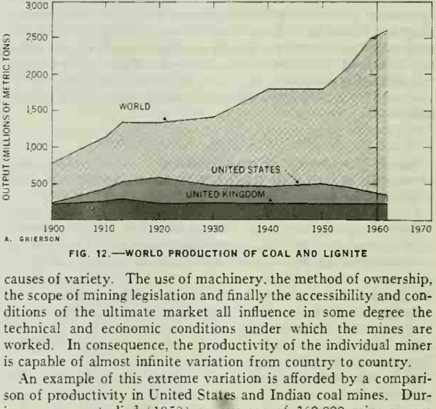


NATIONAL COAL ASSOCIATION, "BITUMINOUS COAL TRENDS" (1956)

FIG. 11.—ENERGY SUPPLIED BY MINERAL FUELS, WATER POWER AND ATOMIC ELECTRICITY IN THE UNITED STATES, PROJECTED THROUGH THE 1970S.

B. Productivity and Labour

The particular and rather complicated character of coal mining has led to a diversity of conditions of employment probably without parallel in any other major industry. This diversity is due primarily to the fact that mining is dependent on natural conditions to a far greater extent than are manufacturing industries. These conditions vary widely from coal field to coal field and even from colliery to colliery within the same field. Coal seams vary widely in thickness, cleavage, inclination and faulting. They are encountered at differing depths; the roofs and floors vary in competence and dryness; the working places vary in size, layout and distance from the mine outlet. Nor are such features the only causes of variety. The use of machinery, the method of ownership, the scope of mining legislation and finally the accessibility and conditions of the ultimate market all influence in some degree the technical and economic conditions under which the mines are worked. In consequence, the productivity of the individual miner is capable of almost infinite variation from country to country.



A. GRIERSON

FIG. 12.—WORLD PRODUCTION OF COAL AND LIGNITE

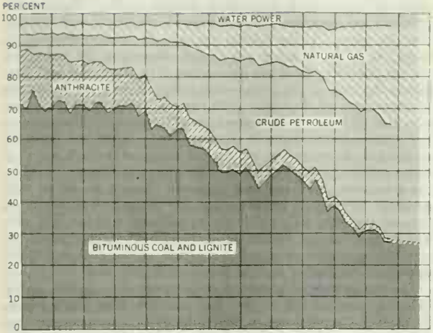
An example of this extreme variation is afforded by a comparison of productivity in United States and Indian coal mines. During one year studied (1958) an average of 360,000 miners were employed in India to produce about 46,000,000 tons of coal. With a labour force of little more than half that of India, the U.S. coal industry produced 392,000,000 tons in the same period.

The extraordinary rise in output of the U.S. coal miner has been due to large-scale introduction of loading machinery underground. By 1960, of the coal won from the underground bituminous mines, more than four-fifths was mechanically loaded; the comparable fraction in Indian mines was less than one-twentieth. In 20 years (1940–60) the productivity of U.S. miners more than doubled and employment declined more than 70%. The rising productivity per miner per day, together with a generally declining market, aggravated employment and other economic problems in coal producing communities, as, for example, in West Virginia.

In Europe, where mining conditions are less favourable than in the U.S., productivity is proportionately less. Although the rise in output per man shift in European coal mines has not been so marked as in North America, steady progress has been maintained chiefly because of increased use of power-loading machinery.

C. World Coal Reserves

Economic and political considerations together with differences in reporting criteria militate against reliable estimations of world



BY COURTESY OF BUREAU OF MINES, U. S. DEPARTMENT OF THE INTERIOR, "MINERALS YEARBOOK," VOL. II (1960)

FIG. 13.—PERCENTAGE OF TOTAL PRODUCTION OF BRITISH THERMAL UNITS (B.T.U.) EQUIVALENT OF MINERAL-ENERGY FUELS AND ENERGY FROM WATER POWER IN CONTINENTAL UNITED STATES

coal reserves. Even if official national figures purporting to give coal reserves could always be accepted as correct, the situation is often obscured by lack of relevant data. There is, for example, a significant difference between probable and proved total reserves. Again, all proved reserves cannot be considered recoverable. The total coal reserves of the United States are estimated at 1,660,000,000,000 short tons of which half are estimated to be recoverable.

In addition to these massive United States deposits, there are immense coal reserves in Canada, ranging in rank from anthracite to lignite. Total Canadian recoverable reserves are estimated at more than 40,000,000,000 metric tons.

Estimated recoverable bituminous and anthracite coal reserves in the United Kingdom total 48,700,000,000 metric tons. Estimated reserves on the European continent include, in France, 5,700,000,000 metric tons of bituminous and anthracite and 300,000,000 metric tons of other coals (lignites and higher grade lignites); Belgium, 2,800,000,000 tons of bituminous and anthracite; the Netherlands, 5,000,000,000 tons; and Italy, 500,000,000 tons and 800,000,000 tons of other coals. Austria's reserves are estimated at 200,000,000 tons of lignite and higher grade lignite. Turkey's reserves include 1,000,000,000 tons of bituminous and anthracite and 300,000,000 tons of other coals. Norway's bituminous and anthracite reserves amount to 2,500,000,000 tons and Sweden's to 100,000,000. Reserves of the Federal Republic of Germany amount to 70,000,000,000 metric tons of bituminous and anthracite and 63,000,000,000 of other coals, and those of the German Democratic Republic to 200,000,000 and 28,600,000,000 respectively. Yugoslavia has reserves of 12,100,000,000 tons of which 100,000,000 are bituminous and anthracite. Hungary has 1,600,000,000 tons of lignites and higher grade lignites; Rumania, 1,700,000,000 tons of bituminous and anthracite and 1,100,000,000 of other coals; Bulgaria, 100,000,000 and 1,400,000,000; Poland, 71,000,000,000 and 1,000,000,000; and Czechoslovakia, 100,000,000 and 12,000,000,000. The estimated reserves of the U.S.S.R., including all types, are 425,600,000,000 metric tons.

Other major coal deposits occur in Asia and Australasia, particularly in the former. The original estimate of the 12th International Geologic congress in 1913, estimating China's coal reserves at 995,587,000,000 tons, was challenged by geologists as an overestimate, and in 1926 the Chinese geological survey offered a conservative estimate of 217,626,000,000 tons. However, since the Communist regime, upward revisions have been made which suggest that Chinese coal resources are not far short of the figure given in the 12th International Geologic congress. Whatever the true figure, the fact remains that China must be considered as possessing a large fraction of the world's coal reserves. Other major Asiatic deposits are found in Japan, and are estimated to total 7,869,000,000 metric tons.

Although when the world's total coal reserves are considered as a whole it is seen that they are sufficient to maintain current output for very many centuries, distribution is nevertheless so inequable that already some major producing countries are experiencing a shortage of certain coals—particularly coals suitable for the manufacture of high-grade coke. *See* FUELS; *see* also references under "Coal and Coal Mining" in the Index.

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For production statistics *see* the *Britannica Book of the Year*.

(M. E. SE.; W. A. McC.; AL. GR.)

COALFISH (*Pollachius virens*), a fish of the cod family (Gadidae), with three dorsal and two anal fins, distinguished from the cods (*Gadus* species) by its blackish colour, prominent lower jaw and very small barbel. It ranges from the Arctic ocean to the Bay of Biscay and Chesapeake bay, and grows to a length of about three feet. It is sometimes called pollock. (C. HU.)

COAL GAS: *see* FUELS; GAS INDUSTRY.

COALITION, a combination of bodies or parts into one body or whole, from the Latin word *coalitio*, from *coalescere*, "to grow together." The word is used, especially in a political sense, of an alliance (*q.v.*) or temporary union for joint action of various powers or states, such as the coalition of the European powers against France during the wars of the French Revolution (*see* FRENCH REVOLUTIONARY WARS) and Napoleonic empire (*see* NAPOLEONIC WARS); the word is also used to describe the union in a single government of distinct parties or members of distinct parties.

Modern war demands that allies engage in a joint effort far more intimate than was called for by treaties of alliance in an earlier day. Anglo-French relations during World War I, strained by the difficulties of reaching agreement on a military strategy, a unified command or an equitable sharing of sacrifice, illustrate the problems of integrating the war effort of allies. Anglo-American relations during World War II were not uniformly smooth; but a series of conferences between Prime Minister Winston Churchill and Pres. Franklin D. Roosevelt (*see* WORLD WAR II CONFERENCES, ALLIED); the erection of a number of "combined" agencies for military and economic planning, and the appointment of inter-allied supreme commanders for each major theatre of the war made the coalition effort relatively harmonious.

In the second half of the 20th century, strategists believed that war could be fought successfully only if everything were in readiness on the first day of the war. Greater importance was attached in the era of thermonuclear weapons to a strategy of deterrence. It was felt that coalition diplomacy and coalition military planning must, therefore, as in the North Atlantic Treaty organization (*q.v.*), precede rather than follow the outbreak of war. In domestic politics, coalitions are normal in countries with multiparty political systems. In countries with two-party systems, coalitions are characteristic only of war or other grave emergency. *See* also WARSAW TREATY ORGANIZATION; AMERICAN STATES, ORGANIZATION OF; PAN-AMERICAN CONFERENCES.

(W. T. R. F.)

COAL TAR is the primary condensation product resulting from the carbonization of coal; *i.e.*, the heating of coal in the absence of air, at temperatures ranging from about 900° C. to about 1,200° C. It is a black, viscous, sticky fluid whose density is greater than that of water. A vast number of chemical compounds, many of which are of commercial importance, have been derived from coal tar. (Many of the coal-tar derivatives mentioned here are discussed in greater detail in separate articles.)

History.—J. J. Becher, a German professor of medicine, is credited with having discovered coal tar sometime prior to 1665. When the supply of American wood tar, used for treating ships' bottoms, was cut off during the Revolutionary War, coal tar was manufactured for this purpose in England.

The introduction of coal-gas lighting in England in 1792 created a large supply of coal tar as a by-product. Up to the middle of the 19th century the commercial applications of coal tar were few and on a small scale; and it became common practice to dump this "waste material" into streams in the neighbourhood of the gas works. The first of a series of minor industrial uses for coal-tar distillates was developed in 1820, when Charles Mackintosh used naphtha derived from them to produce a solution of rubber for waterproofing cloth. About five years later, coal-tar distillates were used as a preservative for railroad ties. (*See* CREOSOTE.) In 1842 coal-tar pitch, a residue of redistilled coal tar, was used for briquetting coal.

In 1843 A. W. von Hofmann, a professor at the Royal College of Chemistry in London, discovered that aniline was present in coal tar; in 1845 he succeeded in extracting benzene from coal-tar distillates. In 1856 W. H. Perkin—a former pupil of Hofmann and at age 18 his laboratory assistant—synthesized the first coal-tar dye, mauve, from aniline. In 1868 two German chemists, Carl Graebe and Carl Liebermann, experimenting with coal-tar anthracene, synthesized alizarin, or Turkey red, a widely used dye that previously had been obtained only from the roots of the madder plant. Coal tar, once a public nuisance, rapidly assumed an important place in world economy; 50,000 ac. in France, and at least five times that number in the rest of Europe and in Asia Minor that had been devoted to producing madder, were released for cultivation of food. In 1897 a synthetic indigo derived from coal tar was placed on the market in Germany, eventually releasing an additional 1,000,000 ac.

In its medical history, coal tar has played a double role. The discovery of the antiseptic properties of carbolic acid (phenol) by Joseph Lister in 1865 was the forerunner of many pharmaceutical uses for coal-tar derivatives. On the other hand, some coal-tar products are believed to contribute to cancer. (*See* CARCINOGENIC CHEMICALS.)

Coal tar was first used to surface roads in 1901. The new industrial field of coal-tar plastics was opened in 1907 when Leo Baekeland discovered the Bakelite resins; these are made from phenols and formaldehyde. Another major industry was created with the synthesizing of nylon and other artificial yarns from coal-tar constituents. Coal-tar pitch is an important raw material in the manufacture of aluminum (*see* below).

PRODUCTION PROCESS

The manufacture of coal tar and related products starts with the placing of coal in a chamber, and the heating of it out of contact with air. The coal is thereby decomposed into volatile products and into a nonvolatile residue, coke. The volatile products are composed of condensable materials and noncondensable gases. As the volatile products are formed they are removed from the chamber and cooled, whereupon the water and tar are liquefied; these two substances (*i.e.*, water and tar) constitute the bulk of the condensable materials evolved during the decomposition of the coal. With the condensation of the water, a portion of some of the gaseous constituents which are more or less soluble in the water is also removed. After the complete removal of the water and tar, the gas is passed through water, or dilute sulfuric acid, which absorbs the ammonia present. Finally, the relatively clean, cool gas is passed through an oil or over activated carbon to remove such low boiling constituents as benzene, toluene, etc., which go to make up coal-tar light oils. The temperature at which the carbonization is conducted, the type of equipment used and the nature of the coal carbonized determine the kind of tar and the quantity obtained.

The temperature of carbonization has more effect on the quality (kind) of coal tar and on the yield than any other single factor. So great is the influence of the carbonization temperature that coal tars are divided into high-temperature tars and low-temperature tars; those produced at carbonization temperatures from 900° C. to 1,200° C. are called high-temperature tars and those produced at carbonization temperatures from 450° C. to 700° C. are called low-temperature tars (*see* TARS, LOW-TEMPERATURE).

Low-Temperature Carbonization.—When coal is heated, in the absence of air, to a temperature of about 450° C., the coal begins to decompose and an evolution of gaseous products occurs. As these gases are liberated from the coal mass they come in contact with the walls of the carbonizing chamber before they escape and are condensed. If the walls of the carbonization chamber are at about 450° C., the gaseous products are not changed by coming in contact with them and the tar recovered from the gases is a true low-temperature tar, called a primary tar. If, however, as is the case in the commercial production of coal tar, the walls of the chamber are at a higher temperature, the gases evolved from the coal at 450° C. are altered when they come in contact with the hotter walls. The type of change which occurs at these hot walls, as well as the portion of the gases that undergoes change, depends upon the temperature of the walls and the length of time the gases are in contact with the hot walls.

Although it is customary to say that the coal is carbonized at a low temperature or at a high temperature, this is not strictly correct. The coal is not carbonized *at* a temperature but *to* a temperature. The initial decomposition of the coal takes place at about 450° C. As the carbonization progresses, the temperature of the decomposing coal rises. If the carbonization process is discontinued when the temperature of the decomposing coal mass reaches about 700° C., and if the gases do not come in contact with walls which are at a temperature above about 700° C., the tar recovered is a low-temperature tar. If the decomposing coal is heated to a higher temperature, 900° C.–1,200° C., further decomposition of the coal mass takes place; the gaseous products evolved at these higher temperatures are of a different nature from those evolved at the lower temperature.

High-Temperature Carbonization.—In commercial carbonization of coal, the heat needed is usually supplied through the walls of the retort. In high-temperature carbonization processes the temperature of the retort walls varies from about 900° C. to about 1,200° C. In such retorts the coal close to the hot walls is quickly heated to the temperature of the walls, and the gaseous products evolved come in contact with the hot walls before they escape; the tar thus produced is truly a product of high-temperature carbonization. However, the coal farther removed from the walls is heated more slowly, the gases are first evolved at low temperatures, and if all of these gases could be condensed without coming in contact with the hot walls (900° C.–1,200° C.) a low-temperature tar would be obtained, but most of these gases do come in contact with the hot walls and are thereby altered. As the carbonization proceeds the temperature toward the centre of the charge increases and slowly approaches that of the walls.

The higher temperature causes further decomposition of the coal. The type of products obtained by this later decomposition is different from that first obtained.

The tar recovered from commercial high-temperature carbonization is a mixture of products resulting from the high-temperature decomposition of the coal and of the products formed by the thermal decomposition of the low-temperature and intermediate-temperature tars evolved from the coal.

Chambers.—Two general classes of chambers are used for the production of coal tar: (1) gas retorts, which are relatively small chambers; and (2) by-product coke ovens, which are much larger. Most gas retorts are either horizontal or vertical. Horizontal retorts, the oldest form of gas retorts, vary from about 8 ft. to about 20 ft. in length; they have a shape which is approximately that of a half cylinder with the flat portion forming the floor of the retort. A group of these retorts is built up into banks or "benches"; around the outside of the retorts and through the benches there is a system of flues through which flow the hot gases which thus heat the walls of the retort. Horizontal retorts are heated to about 1,000° C. to 1,100° C. throughout their entire length. The tar liberated from the coal during carbonization in a horizontal retort is in contact with the hot retort walls for a long time before it escapes to the condensing equipment. This prolonged exposure to the high temperature alters a large portion of the tar. Although the walls of horizontal retorts are not much hotter than those of the by-product coke ovens, the ratio of wall surface to coal charge is high and therefore the tars obtained from horizontal retorts have undergone considerable decomposition after their liberation from the coal. Horizontal retort tars are high-temperature tars; they have high specific gravities, are viscous, have only a small amount of tar acids and are high in naphthalene content.

The vertical retorts are the most popular gas retorts in England. These retorts are vertical tubes having an elliptical or rectangular cross section. They are usually about 20–25 ft. long and measure 5–10 ft. by 8–18 in. in cross section. The retorts are grouped in settings. They are heated by means of hot gases passed through flues arranged between individual retorts. Vertical retorts are either of the intermittent or continuous type. In the operation of vertical retorts, coal is charged in at the top and the coke is discharged at the bottom. In the continuous vertical retort, as the coal moves downward it slowly passes through zones of increasing temperatures. The decomposition of the coal starts in the cooler upper regions of the retort and the tars formed there escape from the retort without much change; some of the tar formed in the lower portions of the retort is decomposed by coming in contact with the hot retort walls, but most of this tar passes up through the coal bed and escapes without being thermally decomposed. Hence, the tar which emerges from the vertical retort is a combination of tars, most of which have been subjected to only low-temperature conditions, some that have been exposed to medium temperatures and a small portion that has been exposed to high temperatures. Although vertical retorts are considered to be a type of high-temperature carbonizing equipment, the tars produced in these retorts have characteristics intermediate between those of low-temperature and high-temperature tars.

As was mentioned above, the other general type of equipment used to produce tar is the by-product coke oven. More than three-fourths of the tar produced in the United States is by-product coke-oven tar. The modern by-product coke oven is rectangular in shape, about 40 ft. long, 14 ft. high and 16 in. wide. The ovens are built in long rows, called "batteries." The two long walls of the oven are heated by flues in which gas is burned to furnish the heat. These ovens are operated in an intermittent manner. Coal is charged into the ovens through removable doors in the top. After the carbonization is complete, doors at both ends of the oven are opened and the red-hot coke is pushed out by means of a long steel ram. Then another charge of coal is introduced and the process repeated. Some of the gaseous products evolved from the coal during carbonization pass upward along the hot walls of the oven, some of them pass through the uncoked centre of the coal charge, but some of them pass through the coked and partly coked region of the charge; these gases are largely decomposed as they pass through the heated zones so that a high-temperature tar is formed.

Coal.—Commercially, coal tar is produced by the carbonization of bituminous coal of the common banded variety. The yield of tar obtained is dependent upon the amount of volatile matter in the coal. When coal is carbonized at high temperatures there seems to be little relationship between the properties of the tar produced and the nature of volatile matter originally present in the coal; the thermal decomposition of the primary tars equalizes their properties.

DISTILLATION OF COAL TAR

The raw tar is processed in various ways to produce a variety of products. The processing is carried out either at the plant which produced the tar or at conveniently located tar processing plants. The processor of coal tar has long been known as a tar distiller.

Usually the first step in processing coal tar is to give it a primary distillation to produce a number of fractions or cuts. The number of cuts made and the nature of the cuts vary somewhat at the different plants. In general, at least three cuts are made. These are frequently referred to as light oil, middle oil and heavy oil; the middle oil is also known as tar-acid oil and as crude naphthalene oil; the heavy oil is sometimes called anthracene oil. The material remaining after the removal of the oil distillates is usually either a pitch or a refined road tar base; occasionally, the distillation is carried on until the residue is pitch coke.

The primary distillation is made either in batch stills or in continuous stills. In the United States the commonly used batch still is a horizontal, cylindrical steel vessel; in England it usually is a vertical cylindrical vessel, known as a "pot still." Capacity of the batch stills varies from about 3,000 to about 8,000 gal.

In the continuous distillation of coal tar the most generally used equipment is a tube still, also called a pipe still. Essentially, the tube still consists of a furnace containing a tube several hundred feet long. The tube is either in the form of a spiral or more commonly in straight lengths connected in a continuous manner by means of return bends. The diameter of the tube varies in the different plants but is usually between one inch and five inches.

When tar is processed in a continuous manner in a tube still, it is pumped through the hot tube whereby it is heated to a predetermined temperature. After passing through the tube the hot tar is released either into one tall fractionating column or into several shorter columns which are connected in series. In the fractionating equipment the tar is separated into oil vapours and either a pitch or an intermediate product, as desired. The oil vapours are collected into such cuts as are wanted; the pitch is pumped to storage.

How far the tar is distilled depends upon the products to be manufactured. If the plant is interested primarily in the distillate oils, the tar is distilled to either a hard fuel pitch or even to pitch coke. On the other hand, if the plant is to make specific residual products, such as road tar, electrode pitch, briquetting pitch or roofing pitch, the distillation is stopped at an appropriate intermediate point. In some of the smaller tar distilling plants, the oils obtained by the distillation of coal tar are merely mixed together to make creosote oil. In the larger refineries various chemical compounds are removed from the distillate oils prior to blending them to produce creosote oil. Prior to about 1940 the main purpose of the tar distiller was to make creosote oil for the preservation of wood. The pitch obtained was of so little value that most of it was used as fuel. With the growth of the aluminum industry, the demand for pitch to make electrodes has increased tremendously. Today creosote is sometimes considered a secondary product, pitch being the main product of the tar distiller.

The coal-tar distillate oils are complex mixtures of hundreds of chemical compounds. Most of these compounds fall into one of three groups: hydrocarbons, acids or bases. Mainly, the hydrocarbons present in coal-tar distillates belong to the aromatic series; typical coal-tar hydrocarbons are benzene, naphthalene and anthracene. The acidic compounds occurring in coal-tar oils are chiefly phenolic compounds, such as phenol, cresols, xylenols (dimethylphenols) and naphthols (*see* NAPHTHALENE). Coal-tar bases are cyclic nitrogen compounds; they have the nitrogen either attached to the ring as in aniline or forming a member of the ring as in pyridine; in addition to aniline and pyridine, the picolines, quinoline and acridine are typical coal-tar bases. Coal-tar oils also contain nonacidic oxygen compounds such as coumarone and diphenylene oxide, nonbasic nitrogen compounds of which carbazole is the most important, and organic sulfur compounds such as the mercaptans and thiophenols. (For a list of compounds that have been identified in coal-tar oils, see *Constituents*, below.)

Tar Acids.—After the tar has been distilled and the desired cuts obtained, the next processing step in a coal-tar chemical plant is the extraction of the tar acids. These phenolic compounds react with caustic soda to form water-soluble salts. By means of this ability to form water-soluble salts they are separated from the other compounds present in the coal-tar distillates. The process used for the recovery of tar acids is essentially the same in all plants. The light-oil and the middle-oil fractions are washed separately with a dilute aqueous caustic soda solution by thoroughly mixing the two liquids. The mixture is then allowed to settle, whereupon it stratifies into two layers. The lower layer is the caustic soda solution of the tar acids, which solution is called "carbolate"; the upper layer consists of the oils which are not soluble in the caustic soda. The caustic soda solution is separated from the oil layer. Usually, the carbolates from the light-oil fraction and from the middle-oil fraction are combined for further purification; such purification comprises the removal of noncaustic soluble oils that were entrained in the carbolate and is usually accomplished by steaming. The tar acids are liberated or "sprung" from the purified carbolate by treating it with sulfuric acid or with carbon dioxide. The crude mixture of phenols thus obtained is subjected to fractional distillation, usually under vacuum, to obtain a number of products: phenol, orthocresol, cresylic acid and mixed xylenols; cresylic acid is a mixture of tar acids consisting largely of the three cresols (*o*-cresol, *m*-cresol and *p*-cresol) but also containing appreciable amounts of phenol and of the various xylenols. Years ago almost all phenol and cresol were derived from coal tar, but by the 1960s phenol was being produced synthetically in such large quantities that the amount obtained from coal tar was less than 10% of the annual production.

By special processing the cresylic acid and the mixed xylenols are separated into the individual cresols and the individual xylenols. The individual tar acids which are commercially available are shown in italics in the list at the end of this article. The tar acids present in the heavy-oil fraction are also recovered in some plants. These high-boiling tar acids are seldom fractionally distilled; they are usually used in the form of crude mixtures in the preparation of disinfectants possessing exceptionally high germicidal properties.

Tar Bases.—The more progressive coal-tar refineries recover the basic constituents present in the distillate oils. After the tar acids have been removed, the distillate oils are thoroughly mixed with a dilute aqueous solution of sulfuric acid. The sulfuric acid reacts with the coal-tar bases present to form water-soluble sulfates. Upon standing, the mixture stratifies into two layers: a lower aqueous sulfuric-acid layer containing the coal-tar base sulfates and an upper layer of neutral oil. The base sulfate solution, after being separated from the neutral oil, is purified to remove any entrained neutral oil. Then the bases are sprung by treating the solution with an excess of caustic soda or with a lime slurry. The crude mixture of bases is then subjected to fractional distillation to obtain various individual bases. The bases recovered from the light-oil fraction are pyridine, the picolines, the lutidines and some aniline bases. Frequently, a mixture of light bases is sold as "denaturing pyridine"; such mixtures were added to grain alcohol to make it unfit for human consumption; as the chemical uses for pyridine bases developed, the amount of bases sold as denaturing pyridine became small. From the middle-oil fraction are recovered quinoline, isoquinoline, methylquinolines and acridine. In a few plants the tar bases present in the heavy-oil fraction are recovered. The mixture of bases thus obtained is a valuable inhibitor in the pickling of steel; it prevents the acid from attacking the steel but does not interfere with the action of the acid in dissolving the scale that is to be removed.

Pyridine (which is also produced synthetically) is used in rubber, medicinals, textiles, fungicides and herbicides. The three picolines are also important commercial chemicals: alpha-picoline is used to make 2-vinyl-pyridine, a component of nylon tires; beta-picoline is oxidized to nicotinic acid, the antipellagra vitamin; and gamma-picoline yields isonicotinic acid hydrazide, a drug used in the treatment of tuberculosis.

Naphthalene.—After the tar acids and the tar bases have been extracted from the middle oil, the "washed" oil is fractionally distilled to produce a heavy coal-tar solvent naphtha and a naphthalene fraction. The naphthalene fraction, while it is hot, is run into shallow pans; there it cools and crystallizes. The solidified mass is broken into large pieces, which are transferred to a crusher. By being crushed into fairly small pieces the solid chunks are transformed into a thick slurry of crystalline naphthalene suspended in an oil. The naphthalene is separated from the oil either by means of a centrifuge or a hydraulic press. The resulting crude naphthalene is used without further purification for many purposes. For other uses a pure naphthalene is needed. The crude naphthalene is refined by first treating it with either sulfuric acid or metallic sodium, and then distilling it. The distilled liquid naphthalene is usually passed over water-cooled steel rolls whereby it is solidified in thin layers which are then scraped to give "chipped naphthalene"; sometimes the naphthalene is allowed to solidify in pans and then is crushed to give "crystalline naphthalene"; the purest naphthalene is made by sublimation. Naphthalene is also produced commercially by the dealkylation of naphthalene homologs.

Higher Coal-Tar Hydrocarbons.—For the recovery of such higher boiling coal-tar hydrocarbons as acenaphthene, fluorene, phenanthrene, anthracene, pyrene and chrysene, the heavy-oil cut is distilled to obtain fractions rich in the particular compound desired. Such fractions are then chilled to cause the compounds to crystallize. The crystalline substances are separated from the oil and are then purified, usually by recrystallization from solvents.

Light Oil.—The first fraction obtained in the distillation of coal tar is "light oil." It contains the lower-boiling constituents of coal tar; *i.e.*, benzene, toluene and the xylenes. Because of the low boiling point of these compounds only a small portion of them is condensed with the tar; most of them are recovered from the coke-oven gases in a separate step after the tar has been condensed. The quantity of light oil recovered from the coke-oven gases is so much greater than the quantity recoverable at the tar distillation plant that it is seldom profitable to refine light oil at a tar refinery. Practically all the processing of light oil is carried out at the tar producing plants.

After the tar and water have been condensed, and usually after the ammonia has been removed, the coke-oven gases are treated to recover the light oil. It is recovered from the gases by scrubbing them with high-boiling coal-tar or petroleum oils, or by absorption on activated carbon. In the oil-washing process the coke-oven gases are passed through a suitable high-boiling tar oil or petroleum oil, which dissolves the light-oil components. The light oil is recovered from the wash by steam distillation in a stripping column; the wash oil is used again to scrub more coke-oven gases. In the activated carbon process the coke-oven gases are passed through a bed of activated carbon which absorbs the light oil. The latter is recovered from the carbon by steaming it; the carbon is re-used.

The refining of coal-tar light oils is essentially a combination of fractional distillation and sulfuric-acid washing. A common practice is first to fractionate the light oil to obtain several crude cuts: forerunnings (the most volatile fraction), benzene, toluene, light-solvent naphtha and heavy-solvent naphtha. The further processing of the crude benzene depends upon the use to which it will be put; if it is to be used as a motor fuel, its further processing consists in the addition of an antioxidant; if, however, the benzene is to be used as a chemical or for industrial solvent purposes, it is washed with sulfuric acid and then distilled. The process for refining the crude toluene fraction and the crude light-solvent naphtha fraction is the same as that for the crude benzene. Petroleum refineries in the 1960s were producing more benzene and toluene than was made from coal carbonization.

The crude heavy-solvent naphtha is the main source of the coumarone-indene resins. In order to produce these resins the naphtha is subjected to a special processing. First it is washed with dilute sulfuric acid to remove the bases. Then the resin-forming constituents, the coumarones and the indenes, are polymerized (resinified) by vigorous agitation of the washed naphtha with small quantities of concentrated sulfuric acid. The polymerized product is separated from the unreacted oils, dried and polymerized further by heating.

Light Pyridine Bases.—Because of their widely different boiling points, and because of their solubility in water and in oils, the pyridine bases formed by the carbonization of coal are divided between the tar and the gases remaining after the tar has been condensed. In 1937 the demand for pyridine made it desirable to recover more bases from the coke-oven gas. As described above, after the water and the tar have been removed, the remaining gas is passed through dilute sulfuric acid to absorb the ammonia present; the sulfuric acid at the same time absorbs the pyridine bases. The separation of the pyridine bases from the ammonia liquor is accomplished in many ways, usually by neutralization and distillation.

Road Tar.—In the manufacture of road tar, the crude tar is distilled to obtain a "road tar base," which is a soft pitch. The road tar base is then cut back or thinned by the addition of a suitable flux oil; the flux oils most commonly used are water-gas tar distillates, coal-tar oils or a light water-gas tar. The extent to which the base is thinned is governed by the particular requirements in each case.

CONSTITUENTS

The chemical constituents identified in coal tar are listed below. The compounds are grouped by their chemical nature. In the various groups, they are listed in the order of increasing boiling points. Those hydrocarbons, phenols and bases which are printed in italics have been produced commercially.

Hydrocarbons.—*n*-pentane, isobutylacetylene, pentene-1, cyclopentadiene 41° C., 1,1-dimethylallene, valylene (1,4-pentadiene), 1-methylbutadiene, propylacetylene, methylethylacetylene, *n*-hexane, hexene, 2,3-dimethylbutadiene, diethylacetylene, butylacetylene, *benzene* 80° C., cyclohexane (hexahydrobenzene), cyclohexene (tetrahydrobenzene), dihydrobenzene, methylpropylacetylene (4-hexyne), heptene, *n*-heptane, *toluene* 110.8° C., *n*-octane, ethylbenzene, *m-xylene* 139.3° C., *p-xylene* 138.4° C., 1,2,4-trimethylcyclohexane, *o-xylene* 144° C., styrene, cumene (isopropylbenzene), decane, *n*-propylbenzene, *m*-ethyltoluene, *p*-ethyltoluene, mesitylene (1,3,5-trimethylbenzene), *o*-ethyltoluene, pseudocumene (1,2,4-trimethylbenzene), *dicyclopentadiene* 170° C., hemimellitene (1,2,3-trimethylbenzene), cymene (*p*-methylisopropylbenzene), hydrindene, *indene* 182° C., 1-ethyl-3,4-dimethylbenzene, *n*-undecane, durene (1,2,4,5-tetramethylbenzene), isodurene (1,2,3,5-tetramethylbenzene), 4-methylindene, *tetrahydronaphthalene*, *naphthalene* 218° C., dimethylindene, *2-methylnaphthalene* 241.1° C., *1-methylnaphthalene* 244.8° C., 1-ethylnaphthalene, 1-ethylnaphthalene, *diphenyl* 255.2° C., 2,6-dimethylnaphthalene, 2,7-dimethylnaphthalene, 1,7-dimethylnaphthalene, 1,6-dimethylnaphthalene, 1,5-dimethylnaphthalene, 2,3-dimethylnaphthalene, 1,2-dimethylnaphthalene, 3-methyldiphenyl, 4-methyldiphenyl, 1,3,7-trimethylnaphthalene, *acenaphthene* 280.7° C., 2,3,5-trimethylnaphthalene, 2,3,6-trimethylnaphthalene, 3,4′-dimethyldiphenyl, 4,4′-dimethyldiphenyl, γ-diphenylenemethane, 4,5-benzondane (1,2-cyclopentanonaphthalene), *fluorene* 298° C., paraffin (octadecane), heneicosane, 2-methylfluorene, 3-methylfluorene, tricosane, tetracosane, pentacosane, docosane, nonadecane, hexacosane, heptacosane, octacosane, *phenanthrene* 340° C., *anthracene* 342.3° C., 3-methylphenanthrene, 4,5-phenanthrylenemethane, 9-methylphenanthrene, 1-methylphenanthrene, 2-phenylnaphthalene, naphthacene, 2-methylanthracene, 2,7-dimethylanthracene, 1,2,3,4-tetrahydrofluoranthene, truxene, *fluoranthene* 384° C., *pyrene* 393° C., retene (8-methyl-2-isopropylphenanthrene), 1,2-benzofluorene (naphthofluorene), 2,3-benzofluorene (isonaphthofluorene), naphtho-2′,3′-1,2-anthracene, 1,2-benzonaphthacene, *chrysene* 448.5° C., triphenylene, crackene, benzerythrene, 1,2-benzanthracene, perylene, 4,5-benzopyrene, 1,2-benzopyrene, 3,4-benzopyrene, picene, 1,12-benzoperylene.

Phenols.—*phenol* 183° C., *o-cresol* 191° C., *p-cresol* 201° C., *m-cresol* 202° C., *1,3,4-xylenol* (2,4-dimethylphenol) 211° C., 1,3,2-xylenol (2,6-dimethylphenol), *1,4,2-xylenol* (2,5-dimethylphenol) 211.3° C., *m-ethylphenol* 219° C., *p-ethylphenol* 218° C., 1,2,3-xylenol (2,3-dimethylphenol), *1,3,5-xylenol* 220° C., *1,2,4-xylenol* (3,4-dimethylphenol) 226° C., pseudocumenol (2,4,5-trimethylphenol), *1,3,5-methylethylphenol* 236° C., isopseudocumenol (2,3,5-trimethylphenol), 7-hydroxycoumarone, 4-hydroxyhydrindene, 3,4,5-trimethylphenol, durenol (2,3,5,6-tetramethylphenol), 5-hydroxyhydrindene, *o-phenylphenol* 275° C., *α-naphthol* 280° C., *β-naphthol* 286° C., *p-phenylphenol* 319° C., tetramethylbiphenol, 2-hydroxydiphenyleneoxide, 2-hydroxyfluorene, hydroxyanthracene, 2-hydroxyphenanthrene (2-phenanthrol).

Nitrogen Bases.—*pyridine* 115° C., *α-picoline* (2-methylpyridine) 129° C., *2,6-lutidine* (2,6-dimethylpyridine) 143.8° C., *β-picoline* (3-methylpyridine) 144° C., *γ-picoline* (4-methylpyridine) 145.4° C., *2,5-lutidine* 156° C., *2,4-lutidine* 157° C., 2,3-lutidine, 3,4-lutidine, 4-ethylpyridine, 2,4,5-trimethylpyridine, 2,3,4-trimethylpyridine, 3,5-lutidine, symmetrical collidine (2,4,6-trimethylpyridine), 2,3,6-trimethylpyridine, *aniline* 184° C., *p-toluidine*, 200.4° C., *o-toluidine* 200.7° C., *m-toluidine* 203.3° C., 2,4-xylidine, 2,5-xylidine, 3,5-xylidine, 2,3-xylidine, 2,3,4,5-tetramethylpyridine, *quinoline* 238° C., *isoquinoline* 243.2° C., *quinaldine* (2-methylquinoline) 247.6° C., 8-methylquinoline, *3-methylisoquinoline* 252.2° C., *1-methylisoquinoline* 255.2° C., 2,8-dimethylquinoline, 7-methylquinoline, 6-methylquinoline, 3-methylquinoline, 5-methylquinoline, *lepidine* (4-methylquinoline) 264.2° C., 5,8-dimethylquinoline, 2,4,6-trimethylquinoline, hydroacridine, *α-naphthylamine* 301° C., *β-naphthylamine* 306° C., *acridine* 346° C., phenanthridine, phenanthridone.

Sulfur Compounds.—ethylmercaptan, dimethylsulfide, carbon disulfide, ammonium sulfide, thiophene, diethylsulfide, 2-methylthiophene, 3-methylthiophene, trimethylthiophene, thiophenol, ammonium thiocyanate, *o*-thiocresol, thionaphthene, methylthionaphthene, diphenylene sulfide, dibenzothionaphthene.

Nonphenolic Oxygen Compounds.—acetone, ethyl alcohol, methylethylketone, acetic acid, propionic acid, coumarone, 6-methylcoumarone, 3- or 5-methylcoumarone, 4-methylcoumarone, acetophenone, 3,6-dimethylcoumarone, 4,5-dimethylcoumarone, 4,6-dimethylcoumarone, benzoic acid, α-naphthofurane, β-naphthofurane, *diphenylene oxide*, 1-methyldiphenyleneoxide, 2-methyldiphenyleneoxide, 2,3,5,6-dibenzocoumarone, 1,9-benzoxanthene.

Nonbasic Nitrogen Compounds.—methylisocyanide, *acetonitrile* (methyl cyanide), pyrrole, benzonitrile, indole, 3-methylindole (skatole), 7-methylindole, 4-methylindole, 5-methylindole, 2-methylindole, 1-naphthonitrile (1-cyanonaphthalene), 2-naphthonitrile, *carbazole*, 2-methylcarbazole, 3-methylcarbazole, 2,3-benzocarbazole.

See also references under "Coal Tar" in the Index.

(F. E. Cl.)

COAL-TAR DYESTUFFS: *see* DYES AND DYEING.

COALVILLE, an urban district in the Bosworth parliamentary division of Leicestershire, Eng., about 12 mi. N.W. of Leicester by road. Pop. (1961) 26,159. It is a town of modern growth, a centre of the coal-mining district of Leicestershire. Bricks and tiles are also made there. To the north is Whitwick, with Castle hill, formerly the site of a Norman castle.

COAST, that part of the land that borders the sea. The term is also applied to the shores of large lakes. It is also used to designate certain coastal areas such as the Gulf coast and the Malabar coast. The problem of classification of the world's coasts is difficult. Since the peak of the last glacial period all the coasts of the world have been subjected to a 200 ft. or greater rise of sea level; but during this period some coasts have been rising, some sinking and some remaining stationary.

Mountainous coasts commonly have even, smooth, regular outlines with few indentations or bays. The coast of California is one example of this type, as is much of the west coast of South America. These are rocky coasts. Another relatively smooth shore line is formed by the coastal edge of level plains. The Gulf coast of southern United States is an example. It is low, made up of unconsolidated material and marked by numerous long offshore bars. Such coasts are difficult for ships to approach, because the only access is provided by narrow channels through the offshore bars. When rougher plains are inundated by the sea a more irregular coastal outline is formed with numerous wide-mouthed bays and estuaries. Much of the northeast coast of the United States and many coastal strips in western Europe are of this type. Ria coasts are the seaward margins of hilly lands and are even more intricately and deeply indented because the lower ends of the inundated river valleys are deeper and more numerous. The classic example is the northwest coast of Spain.

Probably the most deeply and intricately indented of all coasts are the fiord (*q.v.*) coasts of Alaska, Norway, Chile and the South Island of New Zealand. Such coasts have a bewildering array of long, deep, narrow bays, islands and inner passages. (W. C. C.)

COAST DEFENSE. Throughout history military and naval forces have looked upon protection of their country's coast against attack and invasion as one of their most important missions, but only in modern times have they constructed elaborate coast defense works for the purpose. The military history of ancient Greece and Rome records countless raids on enemy coasts and actual invasions or attempted invasions by sea-borne forces, but it tells us little about fixed coast defenses. The Persian host that invaded Greece in 490 B.C. landed unopposed on a small plain at Marathon. The Greeks won the historic battle that ensued without benefit of coastal fortifications. The Romans showed a genius for constructing inland fortifications but made little effort to fortify their seacoasts. Caesar encountered no coast defense works when he invaded Britain nor did William the Conqueror more than a thousand years later.

In later years, when England had become a great seafaring nation, it placed primary reliance for coast defense on its naval power, though Henry VIII took the precaution of building a series of forts, sometimes called castles, along the southern coast. The defeat of the Spanish Armada in 1588 was brought about by British ships meeting the enemy in the channel, not by land fortifications. Other seafaring nations followed England's example for centuries, but with the development of powerful long-range naval guns the need for fixed coast defenses to protect harbours, cities and other strategic points became apparent. Such defenses relieved the navy of purely defensive functions and gave it greater freedom for maneuver and aggressive action.

During the 19th and early 20th centuries nations with exposed coastlines developed elaborate coastal fortifications, organized specially trained troops to man them and adopted ingenious techniques for dealing with naval attacks. They attempted to arm these land fortifications with guns at least equal to those of any potential enemy naval force. They stretched chains and nets across channels to block the entry of enemy ships or submarines. Mines were placed where they could be controlled and covered by artillery fire to obstruct ships. Fixed torpedo launchers and motor torpedo boats were used to augment the firepower of the main artillery.

The broad mission of the coast defense organization was to prevent the enemy from attacking vital areas or landing on the coast and to destroy or repel any successful landing before the enemy could establish a secure beachhead and push inland. The specific objectives of seacoast fortifications were to support the navy by protecting ports, supply bases and shipbuilding facilities; to protect commercial shipping from seizure or destruction; to prevent blockade of ports and coastal shipping; to protect valuable property and populated areas; and to prevent enemy forces from establishing positions along the coast for land or naval action.

Up to and including World War I this concept of coast defense was found to be effective against direct naval attack, provided the armament was protected by properly constructed concrete and sand emplacements and was manned by well-trained and determined crews. This fact was demonstrated when the Turks repulsed the Allied fleet in its attack on the Dardanelles in 1915. A much earlier example, during the 18th century, was probably the longest and most successful coast defense operation in history. The British defended Gibraltar from June 1779 to the signing of the treaty that ended the American Revolution in Feb. 1783. On the other side of the Atlantic, however, during the same period and also during the War of 1812, the lack of adequate American coast defenses permitted the British to occupy strategic coastal centres.

In 1793 George Washington advised congress that the vulnerable portion of the U.S. coastline should be fortified. His advice went unheeded for a year, but in 1794 Secretary of War Henry Knox, who had been Washington's wartime chief of artillery, drew up plans for harbour defense works for which a small amount of money had been provided. These works got little beyond the planning stage for the next 20 years. After the experience of the War of 1812, construction of defensive works was begun, and during the next 45 years most of the important harbours on the Atlantic and Gulf coasts were protected by a series of closed masonry forts. During the American Civil War many of these forts gave excellent accounts of themselves and capitulated to greatly superior forces only after extensive siege operations. After the Civil War coast defense languished for 20 years, but it received renewed attention in 1886. In the succeeding two decades defensive works designed solely to repulse attack by naval gunfire were constructed at all important harbours in the continental United States.

Sometimes coast defenses performed their function of protecting harbours, ports and naval bases merely by virtue of their existence. During World War I, for example, a superior British navy made very few attempts to destroy the artillery-protected German bases from which submarines were operating successfully against Allied shipping. Examples can be cited, of course, in which coast defenses were ineffective because their armament was inadequate or the commanders and crews failed to take aggressive action. In the battle of Manila bay during the Spanish-American War (1898) the U.S. naval force entered the bay past a strongly fortified Corregidor without a shot being fired.

Coast defenses were so expensive to build and required so many troops to man them that no country with a long coastline could afford to build and maintain a continuous system of mutually supporting forts capable of repulsing an enemy landing at any and all points. The accepted tactic for reducing a specific coastal fort was to land troops at an adjacent unprotected point and attack the fort from its vulnerable rear. To meet such tactics coast defenses had to be supported by highly mobile ground forces. Generally, because of limited troop resources, the coast defense garrison itself was trained to issue from the fort and form or become part of such a mobile force. The defenders might then defeat the landing party on the beach before it could organize and attack the fort or other vital areas.

After World War I and in the early stages of World War II all first-class military powers greatly improved their coast defenses by installing guns of larger calibre and greater effectiveness. They provided protection for more points along their coasts and improved their fire control systems. The Japanese greatly expanded their coast defenses, which they called "fortress commands," and extended them to include the Ryukyu Islands and Formosa. The United States, with extensive unprotected coasts, placed powerful guns at strategic points. It also mounted heavy seacoast artillery on railway cars so they could be moved quickly to counter an attack at any point. Mobile field guns were added to the weapons employed by coast artillery troops. Antiaircraft guns protected both the defenses and the defended areas from enemy aerial attack and observation. Sound ranging equipment, underwater listening devices and powerful searchlights helped to prevent surprise and to cover mine fields at night.

The military thinking of the period between World Wars I and II was influenced unduly by the supposed superiority of the defense. Great effort went into the construction of fortifications against land as well as sea-borne attack. Military leaders were willing to sacrifice mobility for the security which, it was alleged, fortifications provided. While the memory of many disastrous attacks of World War I was still fresh, the concept that only the offensive can win wars was subordinated.

World War II.—World War II proved that fixed defenses, whether coastal or inland, were not impregnable. They could be destroyed, isolated or bypassed. Fortified positions still were considered useful and necessary, but their most important functions were to delay enemy action and channel the attack to the advantage of the holding troops. New tactics and techniques radically changed the concept of coast defense. The factors that contributed most to this change were the extensive use of military aircraft, both land-based and carrier-based, for direct attack on fortified positions; employment of air-borne troops to outflank fortified positions and isolate or attack them from the rear; and development of amphibious landing techniques and landing craft capable of delivering troops and heavy equipment over the beaches.

The successful Japanese attack on Pearl Harbor and the conquest of the Philippines occurred despite strong U.S. coast defenses at both places. A short time later the powerful British naval base at Singapore fell to a Japanese attack from the land side. When U.S. forces took the offensive in 1942 and later years they were able to effect successful landings at selected points in the Pacific despite well-prepared Japanese fixed defenses. The Allies landed successfully on the French coast in 1944 against the most formidable barrier ever encountered by an amphibious assault. This particular area had been strongly fortified by the Germans with bunkers and trenches of concrete and steel. Heavy guns with overlapping fields of fire were sited to rake the beaches. The coast was protected by underwater obstacles, and mines were placed on the obstacles, both under water and on the beaches. The defense was supported in considerable depth by mobile forces. The German air force, however, had been so depleted that Allied bombing and naval shelling of the beaches were not effectively opposed.

World War II proved that existing coast defenses were not worth their cost. All military powers abandoned them within a few years except where the armament was mobile and could be used in a dual role for antiaircraft and coast defense. It would have been unprofitable to design and construct improved coast defenses because of tremendous postwar advances in weapons. With the advent of nuclear bombs, long-range aircraft and intercontinental missiles it was apparent that the defense of a coastline was no longer a separate coast defense problem but part of the total defense of a nation.

Postwar Developments.—The best defense against attack and invasion is, of course, the ability to attack the aggressor's homeland and invasion bases with such destructive force that the intended attack or invasion cannot be launched, or carried out if launched. Guided missiles and aircraft normally will accomplish this mission. But even though a country possesses the ability to counterattack, it cannot dispense with strictly defensive measures. It must be prepared to ward off the initial attack and to defend itself against invasion should retaliation not be effective. This is particularly true for the nation that concedes the first blow to the aggressor. Regardless of the tremendous destructive power of nuclear weapons, it was widely agreed following World War II that a war is won only when military forces have established themselves within a country for the purpose of strangling the economy and political power of the enemy. A sea-borne invasion can be carried out for this purpose only after the defenders have been sufficiently weakened.

It is unlikely that a sea-borne or air-borne invasion would be attempted against a nation known to be able to retaliate with atomic weapons until the intended victim had been defeated or rendered impotent by air or guided missile attack. All means of employing atomic weapons must be demolished because the leaders of a nation struggling for survival could be expected to utilize all methods available, regardless of any previous reluctance to use atomic weapons. An invasion force is particularly vulnerable to atomic attack during landing operations and immediately after establishing a beachhead. Targets of primary importance to the invader during preinvasion attack would include airfields, air defense installations, supply depots, communications centres, naval forces and troop concentrations in the broad area of the contemplated invasion. Roads and railroads would be strafed and bridges destroyed in an attempt to isolate the invasion area. Feints in sufficient strength would be carried out against adjacent areas to confuse the defenders. These attacks would extend to a depth far beyond that usually thought of as the coast. Protection from aerial attack requires an elaborate air defense system covering large areas. In the age of nuclear weapons, total defense becomes the objective because even a few atomic bombs delivered to the vital areas of a country could result in disaster.

The most likely invasion that a nation must be prepared to repel would be air-borne in its initial phase. In the modern era of long-range flying, an air armada of transports could take off at any time from widely separated bases or from carriers at sea and strike for an invasion point of its own choosing. Air-borne troops, however, even though successfully landed and accompanied by air-transported artillery, tanks and other vehicles, must be quickly reinforced. The invader can therefore be expected to immediately attempt a sea-borne landing to link up his main forces with the air-borne troops ashore, while they attack the coast defenses from the rear and disrupt communications. Coast defense strategy must therefore recognize the possibility of sea-borne invasion, be prepared to defend against it, but still take cognizance of the greater threat of an initial air-borne landing. A successful invasion by either method or in combination requires air superiority in the invasion area.

Coast defense by mid-20th century had become that portion of the total defense which happened to face the sea. It was no longer a separate problem for special troops with no other mission but was of concern to all the military forces of a nation. Air defense, with its radar warning and control nets, antiaircraft guns and guided missiles, and interceptor planes, was an important part. Naval forces protecting ports and harbours and patrolling the sea frontier were also a part of the defense. They included antisubmarine patrols employing sonar and other means of detecting underwater vessels, air surveillance by radar-equipped aircraft and surface vessels, and underwater mines and submarine nets.

Troop organization for coast defense was essentially the same as for other land combat. The defense was usually organized in great depth with highly mobile reserves. If the attacker had an atomic capability, troops and equipment were dispersed so that they did not present a profitable atomic target. The function formerly performed by heavy coast artillery had been taken over by guided missiles and aircraft. Airfields and missile launching sites were found within supporting distance of the coast, particularly in vital areas. Construction of bunkers and strong points all along the coast was considered wasteful because it did not provide sufficient strength to be effective at any point where an aggressor might choose to make an invasion. Nations with relatively short coasts found it profitable to distribute underwater obstacles and to mine beaches and underwater approaches if sea-borne invasion appeared imminent. Otherwise, sufficient quantities of these items were kept on hand for emplacement after the enemy had revealed his intentions or committed his forces.

A typical coast defense pattern was made up of many types of military units, operating as a single command, organized in great depth, comprising the following elements in order of their appearance from front to rear: (1) distant naval and air reconnaissance and radar to detect enemy preparations for attack or overseas movement; (2) naval and air action to counter such effort before it gets under way; (3) naval and air action to meet such effort at sea and defeat it; (4) naval and air offshore patrolling to give early warning of the approach of hostile forces and counter the threat of submarine-launched missiles; (5) naval and air inshore patrolling to cover mine fields and fixed underwater obstacles; (6) air defense systems consisting of antiaircraft weapons and interceptors; (7) ground forces of all arms, deployed at points of expected attack; (8) mobile army reserves of all arms, strategically located and capable of rapid movement to meet and destroy an enemy when he had committed his forces. *See* AIR DEFENSE; AMPHIBIOUS WARFARE; ARTILLERY: *Coastal Artillery;* CIVIL DEFENSE; FORTIFICATION.

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COAST GUARD, a force, usually naval in character, maintained in some countries for the suppression of smuggling, for the enforcement of the maritime laws and for the assistance of vessels wrecked or in distress on or near the coasts. The coast guard forces of Great Britain and the United States had a similar origin in that both were first formed to prevent infraction of the rights of the revenue. At first they developed along similar lines, but whereas the United States coast guard may now be described as the national maritime law enforcement agency, the coast guard in Great Britain has become primarily a marine lifesaving service.

UNITED STATES

Origin.—The United States coast guard traces its origin to the ten small armed boats authorized by the first congress on Aug. 4, 1790, to guard the nation's coast against smuggling from the sea and to enforce customs laws. Known first as the revenue marine and later as the revenue cutter service, it became officially the U.S. coast guard when it was combined with the lifesaving service on Jan. 28, 1915. The lighthouse service, which had come under federal control on Aug. 7, 1789, was consolidated with the coast guard in 1939, and the bureau of marine inspection and navigation was transferred from the department of commerce to the coast guard in 1942. (The latter transfer became permanent in 1946.) Thus the principal maritime agencies were organized as one united service.

Duties and Organization.—The functions of the U.S. coast guard embrace, in general terms, maritime law enforcement, saving and protecting life and property, providing navigational aids to maritime commerce and to transoceanic air commerce, promoting the efficiency and safety of the U.S. merchant marine and readiness for military operations. The primary purpose of most of these duties is to prevent avoidable loss of life and property resulting from illegal or unsafe activities. In actual practice, however, the maintenance of safety and order in maritime navigation is not limited to the strict enforcement of laws. It also encompasses a continuing program of education among ship operators and boatmen and the enlistment of their co-operation and self-regulation in the prevention of marine disasters.

The organic act of 1915, as revised, provided that the coast guard ". . . shall be a military service and a branch of the armed forces of the United States at all times." It further provided that "the Coast Guard shall be a service in the Treasury Department, except when operating as a service in the Navy." Such service in the navy takes place upon the declaration of war or when the president directs. The coast guard's peacetime organization, regulations, training and customs parallel those of the navy insofar as operations will permit. Personnel receive the same pay and allowances as prescribed for corresponding ranks, grades and ratings in the navy, and uniforms are identical except for the coast guard's shield insignia.

The coast guard, as the principal maritime law enforcement agency of the federal government, enforces or assists in the enforcement of all applicable federal laws upon the high seas and waters subject to the jurisdiction of the United States. It administers laws and promulgates and enforces regulations for the promotion of safety of life and property, covering all matters not specifically delegated by law to some other executive department. Among the more important are enforcement of the navigation and inspection laws and assistance in the enforcement of the Oil Pollution act, and of laws relating to internal revenue, customs, immigration, neutrality, and conservation and protection of fisheries and wildlife. It enforces rules governing the security of ports, anchorage and movement of vessels in territorial waters. By the early 1960s the coast guard had developed and operated nearly 40,000 aids to maritime navigation, such as lighthouses, lightships, lights, radio beacons, radio-direction-finder stations, buoys and unlighted beacons, as required to serve the needs of commerce and the armed forces.

In the promotion of safety of life and property, coast guard duties include the inspection of vessels and their equipment; investigation of marine casualties; regulation of the outfitting and operation of motorboats, of the transportation of dangerous cargoes of vessels, and of the construction and repair of vessels; enforcement of manning, citizenship, mustering, drilling of crew and load-line requirements; protection of merchant seamen; and licensing of officers, pilots, seamen and motorboat operators.

The coast guard maintains an established organization of inshore and offshore rescue surface vessels, aircraft, lifeboat stations and radio stations, together with rescue co-ordination centres in each district. It extends medical aid to crews of U.S. vessels, transports shipwrecked and destitute persons in Alaska and elsewhere and engages in flood relief work. It operates ocean stations in both the North Atlantic and North Pacific to provide search and rescue, communication and air navigation facilities in areas traversed by U.S. aircraft. Another duty is to conduct the annual International Ice patrol in the North Altantic to protect shipping from icebergs. The administrative head of the coast guard is the commandant, with headquarters in Washington, D.C. In most instances activities are directed by 12 district commanders and performed by individual operating units such as ships, aircraft and marine inspection offices.

History.—The early revenue marine soon found itself charged with many other duties in addition to the enforcement of customs laws. These activities included distinguished service in every conflict in which the United States engaged, with the exception only of the war with Tripoli. A revenue cutter, "Harriet Lane," is credited with firing the first shot in the Civil War, on the eve of the bombardment of Ft. Sumter, S.C. The cutter fleet of 28 vessels helped enforce the blockade and lent support to the army and navy striking into the south.

On April 6, 1917, when the United States declared war on Germany, the navy was augmented by 15 cruising cutters, about 200 officers, and 5,000 warrant officers and enlisted men of the coast guard. They were entrusted with the hunting of submarines and raiders and with guarding the transport of troops. A squadron of coast guard cutters, based at Gibraltar, performed escort duty between that port and the British Isles. While on this duty the cutter "Tampa" disappeared on the night of Sept. 26, 1918, with a loss of 111 coastguardmen and 4 navy men. It is believed that the "Tampa" was torpedoed. In proportion to its strength, the coast guard suffered the highest losses of any of the armed services in World War I.

The coast guard reached its peak strength in World War II. It had 802 vessels (more than 65 ft.) of its own and, in addition, manned 351 navy and 288 army craft. By June 30, 1945, its personnel numbered 171,168. Of these, 572 were killed in action. Coast guard surface craft destroyed 11 U-boats and aircraft sank another. More than 4,000 survivors of torpedoings and other enemy action were rescued from the Atlantic and Mediterranean. Another spectacular war duty was the manning of assault craft in landings in North Africa, Europe and in the Pacific. The coast guard's years of experience in operating small boats through the surf made it the logical organization to train and supply crews for landing craft from the smallest barge to the giant LST (landing ship, tank). Coast guard crews also served on many of the large assault transports which carried the barges and troops within striking distance of the beachheads. On D-day in Normandy 83-ft. coast guard cutters were given special lifesaving duties. Under fire from German guns, they rescued 1,468 men from sunken landing barges.

Military personnel on active duty in the early 1960s numbered about 30,000; reserve strength was more than 31,000 officers and enlisted men.

The motto of the coast guard is *Semper Paratus* ("Always Prepared").

See also MILITARY, NAVAL AND AIR ACADEMIES: *U.S. Coast Guard Academy.*

See S. H. Evans, *The United States Coast Guard, 1790–1915* (1949); M. F. Willoughby, *The United States Coast Guard in World War II* (1957). (A. C. RD.)

GREAT BRITAIN

In Britain, the original antismuggling force was in 1856 placed under the admiralty in order to make better provision for coastal defense, to provide a reserve for the navy in case of war and to protect the revenue. In the first half of the 19th century a number of private lifesaving companies had been formed on the coast, and, when these were taken over by the board of trade in 1854, the coast guard helped in the training of their members and assisted in dealing with wrecks. (*See* LIFEBOAT AND LIFESAVING.)

In 1923, the coast guard itself was transferred to the board of trade and became a civilian force. It is administered, primarily as a lifesaving service, by the ministry of transport and civil aviation, though it still retains the title of H.M. coast guard. Its chief function is to assist in saving lives in cases of shipwreck and distress at sea. For this purpose it has not only to maintain an extensive visual watch but also to initiate and to keep in touch with all search and rescue measures for ships in distress off the coasts of the United Kingdom.

The visual watch is maintained from about 315 lookout huts, usually sited on headlands or other vantage points overlooking dangerous waters. The distance between lookout huts is about five miles over stretches of coast where small-ship traffic is heavy and runs close inshore, but elsewhere distances are greater. The normal type of watch is a bad weather and thick weather watch and, although the coast is scanned at frequent intervals during daylight, constant watch is kept only at points where there is a large volume of small coastal and fishing-boat traffic and where the navigational hazards are such that immediate action is necessary, even in fine weather, to save lives if a casualty should occur. A night watch is kept in fine weather at a sufficient number of stations to ensure that it is set at all other stations affected on the approach of bad weather.

Search and rescue measures for vessels in distress off the coast can be undertaken and assisted by several different agencies. One of the first duties of the coast guard is to ensure that these agencies are informed of a casualty, and to keep in touch with them during the whole of the search and rescue operations.

The coast radio station of the general post office, from which a constant listening watch on the maritime distress frequencies is kept, is in direct telephonic communication with its nearest coast guard station. By this means the coast guard is kept informed of all marine distress messages and of the steps taken by other ships to go to the help of a distressed vessel.

Should the coast guard stations observe or have brought to their notice a marine casualty they at once inform the nearest lifeboat station of the Royal National Life-boat institution. This latter is a purely voluntary service, financed wholly by voluntary contributions, and it maintains a fleet of more than 150 modern motor lifeboats. These are all fitted with radios and can communicate with vessels by radio telephone on the marine distress frequencies, and also with search and rescue aircraft and helicopters by very high frequency (VHF) radio telephone.

The ever-increasing use of aircraft and helicopters in search and rescue work has had the effect of extending considerably the sea area within which a distressed vessel may expect to get shore-based aid. Consequently the coast guard has to work closely in conjunction with the Royal Air Force rescue co-ordinating centres. The coast guard stations are kept informed of all marine casualties known to be within 750 mi. of the coasts of the United Kingdom, and if they consider that aircraft would be of assistance to a casualty, either by searching for it or by dropping survival equipment, they at once inform the appropriate R.A.F. rescue co-ordinating centre.

The staff at coast guard stations is usually recruited from among pensioners of the Royal Navy and from men of the merchant navy and fishing fleets with equivalent sea service. The lifesaving equipment is kept ready for instant use at all regular and auxiliary stations and generally consists of a line-throwing projector together with rocket, whip, hawser and breeches buoy. A modern, cordite-propelled rocket will carry a 1-in. line more than 450 yd. The lifesaving equipment is worked by teams of local men formed into companies of the Coast Life-Saving corps. This corps, which has a voluntary basis, was formed in 1932 to assist the regular coast guard. Besides constituting the lifesaving companies, the members of the corps keep visual watch in bad weather from auxiliary stations and do relief work at regular stations.

Other work of a miscellaneous character is undertaken by the coast guard. This includes patrolling of the coastline for the purpose of finding and safeguarding wrecked property, the general supervision of the foreshore to prevent encroachment on land below the high water mark and the reporting of any oil pollution on the beaches.

The coast guard also carries out commercial maritime signaling and reporting at six special stations on behalf of the corporation of Lloyds. Meteorological instruments are installed at certain stations; full observations and readings are taken throughout each day and reported by telephone to a designated centre.

See also references under "Coast Guard" in the Index.

(J. H. LY.)

COAST GUARD ACADEMY, UNITED STATES: *see* MILITARY, NAVAL AND AIR ACADEMIES.

COAST PILOTING: *see* NAVIGATION.

COAST PROTECTION: *see* BREAKWATER.

COAST RANGES, mountains fringing the western coast of North America from near Santa Barbara, Calif., to the Kenai peninsula, Alaska. Eastward, the Great valley of California and the Willamette valley of Oregon border the ranges; in northern California the Klamath mountains join them to the Cascade range. Off the coast of Canada, the range submerges, becoming a chain of rugged islands, and the term "Coast range" is transferred to the northern extension of the Cascade range. In southern Alaska, the "true" Coast range is resumed in the St. Elias mountains, including Mt. Logan, 19,850 ft. (*See* ALASKA: *Physical Geography.*)

In California, the mountains are linear, separated by long alluvium-filled valleys; summit elevations average 3,000 ft. south of San Francisco; 6,000 to 8,000 ft. in northern California and 3,000 ft. in Oregon. From Washington's 8,000-ft. Olympics northward, Pleistocene glaciers carved steep-sided valleys, since drowned to make magnificent fiords. In Alaska, some glaciers still reach the sea.

Cattle graze the chaparral and oak-grass woodlands of the range in California, and the valleys support rich and varied commercial agriculture. From northern California to British Columbia, coniferous forests yield much lumber, and dairying and mixed agriculture prevail. Mining is important in the Alaskan panhandle.

See Roderick Peattie, *The Pacific Coast Ranges* (1946).

(R. F. LN.)

COAST REGION, KENYA, established at the beginning of 1963 following a reorganization of administrative units in Kenya (*q.v.*), comprises Tana River, Lamu, Taita, Kilifi, Kwale and Mombasa districts, which previously formed Coast province, and also part of Garissa district which previously belonged to the Northern Frontier district of Northern province. (Until the formation of North-Eastern region [*q.v.*] later in 1963 Coast region also included other areas of the Northern Frontier district; *i.e.*, Mandera and Wajir districts, the rest of Garissa district and part of Moyale district.) Coast region is bounded north and northeast by North-Eastern region, southeast by the Indian ocean, southwest by Tanganyika and west by Eastern region. Area about 33,000 sq.mi. Pop. (1962) 1,020,000.

There is a restricted coastal plain and inland a discontinuous chain of hills reaches about 1,000 ft., behind which the extensive Nyika peneplain rises westward. The Tana river (*q.v.*) flows along the greater part of the boundary with North-Eastern region. The high relative humidity and high, equable temperature of the coast give way to semiarid conditions inland with unreliable rainfall. The coastlands contain architectural remains of earlier Arab civilizations and of the Portuguese intrusion. The chief town is Mombasa (*q.v.*), with a population (1962) of 178,400, including most of the region's non-African population. Maize (corn), cassava, coconuts and fruits are grown for local use. The main export crops are cotton, coconuts and cashew nuts. Coastal fisheries yield about 4,000 tons a year. Mombasa, where most of the region's industrial activity is concentrated, has an airport and is the terminus of the Uganda-Kenya railway line.

COAST REGION, TANGANYIKA, established in May 1963, following a reorganization of administrative units in Tanganyika, comprises Bagamoyo, Kisarawe, Mafia (Island), Rufiji and Dar es Salaam districts, which previously belonged to the former Eastern region. It is bounded north by Tanga region, east by the Indian ocean, south by Mtwara region and west by Morogoro region. Area 13,050 sq.mi. Pop. (1957) 537,012. The region is mostly low lying, rising to 1,500 ft. in the Matumbi hills (Rufiji). Sedimentary rocks of Karoo, Jurassic, Cretaceous and Tertiary Age (including mudstones, shales, marls, sandstones and limestones, together with Recent coral limestones, marine and estuarine clays) flank the Archean plateau which is evident in western Bagamoyo. Major rivers are the Rufiji, which has formed an extensive delta, the Ruvu and the Wami. Mean annual rainfall, falling during November to May, is generally more than 40 in. near the coast (more than 70 in. on Mafia Island), but decreases inland. Extensive mangrove swamps cover much of the Rufiji delta; dry bush and woodland-savanna are common elsewhere. Regional headquarters are at Dar es Salaam (*q.v.*), the capital and major port of Tanganyika with rail connections inland and to the north. African tribes include the Zaramo, Nderenke, Kwere, Zigua and Rufiji. The population of Mafia Island is largely descended from slaves. Near the coast fishing, salt production, coconuts, cassava and rice are important, as is cotton on the Rufiji delta. Inland the water supply is limited and irrigation is necessary. The economy is based on cotton, sorghum, cassava and livestock. Mica, kaolin and limestone are made. (J. M. KE.)

COATBRIDGE, a large burgh, having the privileges of a royal burgh, of Lanarkshire, Scot., 12½ mi. E. of Glasgow by road and on the Monkland canal. Pop. (1961) 53,946. In 1931 a prehistoric crannog (an artificial island dwelling) was found in Drumpellier park during the drainage of Lochend loch.

The industrial development of the town began in 1820 when "black band" coal was discovered locally. The iron industry now centred on Coatbridge was first developed by the ironmaster James Baird, and later by Andrew and James Stewart. The town has a technical and mining college and produces malleable iron, tubes, wire and wire ropes, tin plate, chilled grain (cast iron) and steel rolls, heavy castings, prefabricated houses, knitwear and quinine. Coatbridge became a burgh in 1885.

COATES, JOSEPH GORDON (1878–1943), New Zealand statesman, was prime minister from 1925 to 1928, but is chiefly remembered for his economic policies during the 1930s. He was born at Pahi, on Feb. 3, 1878. He became a farmer, like his father, and in 1911 entered parliament for Kaipara. He was appointed minister of justice and postmaster general in 1919 and went on to become minister of public works (1920–26), railways (1923–28) and native affairs (1921–28). On W. F. Massey's death (May 1925) he became prime minister. Coates encouraged practical development in all his departments, established good relations with the Maoris through their leader, Sir Apirana Ngata, and won the approval of the British at the 1926 Imperial conference, becoming a privy councilor. His government was defeated in 1928, but in Sept. 1931 he joined the coalition formed to face the crisis of the depression. As minister of public works (1931–33) he combated unemployment, and as minister of finance (1933–35) he depreciated the exchange rate of the New Zealand pound, established a powerful, partially state-controlled Reserve bank, and forced down rates of interest. He also encouraged trade within the British empire, taking a leading part at the Ottawa conference of 1932. Labour won the 1935 and 1938 elections, but in 1940 Coates shelved party differences to assist in wartime administration, working in a two-party cabinet under Peter Fraser until his death in Wellington on May 27, 1943.

COATI (COATI-MUNDI), the name of raccoonlike mammals of the South and Central American genus *Nasua*, of the family Procyonidae. They are recognized by their long body and tail, and elongated, somewhat flexible snout. The tail is often prominently banded.

BY COURTESY OF NEW YORK ZOOLOGICAL SOCIETY

DUSKY COATI (NASUA NASUA SOLITARIA)

Coatis are gregarious and arboreal in habit, and feed on fruit, seeds, birds, eggs, lizards and insects. They are often tamed as pets.

See CARNIVORE.

COATS, JAMES (1774–1857), Scottish founder of the world's largest thread company, later known as J. and P. Coats, Ltd., was born at Paisley, Scot. When only 17, he rode to London to join the army; rejected for medical reasons, he walked home 400 mi. and worked again at the loom till Napoleon's invasion threats and his own sense of adventure drove him into the Ayrshire Fencible cavalry.

In 1800 Coats became a yarn spinner in a Paisley mill. Next, he started to make muslins and crepe shawls on his own with such skill that by 1826 he had amassed sufficient resources to build the first of the famous Ferguslie cotton thread mills. In 1830, with himself continuing as adviser, he handed it over as J. and P. Coats to his sons James and Peter, later joined by Thomas and Andrew. By 1857, when James Coats died, the business had already achieved ascendancy in the thread trade.

(D. E. K.)

COBALT, a chemical element long known in the form of impure compounds as a source of beautiful blue colours, has recently acquired importance in many branches of science and industry. Classified in Group VIII of the periodic table between iron and nickel, cobalt closely resembles these metals in both its pure and combined states.

This article is divided into sections dealing with the history of cobalt, its use, occurrence, metallurgy and properties, including chemical properties, physical and mechanical properties and analysis.

HISTORY

Ores containing cobalt have been used since antiquity as pigments, but without knowledge of the source of the colour. In China, cobalt ores were used to produce the blue colours of the porcelains of the Ming dynasty. In central Europe during the 16th century the term kobold, meaning mischievous spirit, was applied by the miners of the Harz mountains to certain ores that had been roasted for their supposed copper content. Not only did these ores fail to produce copper, but on roasting they emitted dangerous fumes. It was found that the ores, after elimination of sulfur and arsenic by roasting, could be fused with sand to produce a blue glass called smalt. In 1742 G. Brandt showed that the blue colour was due to a previously unidentified metal, cobalt.

The derivation of the term seemed prophetic after the development of the nuclear bomb, when radioactive cobalt-60 (Co^{60}) was found to be formed from ordinary cobalt-59 by neutron bombardment. Cobalt-60 emits β-rays and becomes nickel-60, an emitter of energetic γ-rays. The term "cobalt bomb" is used somewhat ambiguously to mean either an assemblage of X-ray sources for deep therapy employing multiple samples of radioactive cobalt, or a weapon in which Co^{60} might be deliberately formed by a nuclear explosion as a potentially lethal substance. The world-wide diffusion of radioactive cobalt from many such bombs would be dangerous to the race. The radioisotope Co^{60} has become a cheap and useful tool in medicine, plant physiology and industry. Its half life of 5.3 years is, however, low compared with the 30-year half life of caesium-137 which is replacing it for many purposes. (See *Uses: Cobalt-60*, below.)

The small European deposits of cobalt were surpassed after 1874 by the oxidized cobalt ores of New Caledonia. The latter were outranked after 1905 by the cobalt-silver ores of Ontario. Around 1920, extraction of cobalt from the copper-cobalt deposits of Katanga province in the Republic of the Congo (former Belgian Congo) was commenced by Union Minière du Haut Katanga, which became the dominant world producer.

With the development of the copper properties in Northern Rhodesia after 1930, the small quantity of cobalt occurring in the copper ores of Rhokana Corporation, Ltd., enabled that country to attain one of the leading positions in cobalt output. After 1933 French Morocco (after 1956 a part of the kingdom of Morocco) made varying but important contributions to the world supply. Other principal producers are Canada, the United States and Finland, with several other countries reporting small and spasmodic outputs. Statistics are lacking for production in the Soviet Union. (*See* also NATURAL RESOURCES: *Minerals: Iron and the Ferroalloys*.)

Prior to World War I, most of the world's cobalt went to the ceramic and glass industries in the form of oxide to serve as colouring agent. After this period, increasing proportions were used in the metallurgical field for tool steel, magnets, cemented carbides and high temperature alloys and about 80% of the output is employed in the metallic state.

USES

Ferrous Alloys.—*Tool Steels.*—Cobalt is one of the principal constituents of an important group of tool steels. The addition of 5%–12% cobalt to the basic 18:4:1 tungsten-chromium-vanadium high-speed steel (*q.v.*) markedly improves cutting efficiency at elevated temperatures. Such steels are recommended for heavy cuts and feeds at high speeds on hard, gritty or scaly metals, as well as machining of material like austenitic stainless steels which work harden under any form of stress.

Permanent Magnets.—The remarkable magnetic properties of steels containing high proportions of cobalt were discovered in 1916. The best permanent magnet steel in commercial use is the 35% cobalt steel, a complex alloy which also contains tungsten and chromium. After 1930 another valuable series of permanent magnet alloys was developed, known as the Alnico type. The composition of these alloys is usually: nickel 14%–30%, aluminum 6%–12%, cobalt 5%–35%, with the balance iron. They cannot be worked or machined, and must be produced by casting or powder metallurgy.

Glass-to-Metal Seals.—Special seals which have the same coefficient of expansion as glass are made with metals which contain approximately 18% cobalt, 28% nickel and 54% iron.

Other Alloys.—Cobalt is employed in alloys possessing practically zero coefficient of expansion such as stainless invar (*q.v.*), iron 36.5%, chromium 9.5% and cobalt 54%.

Nonferrous Alloys.—Cobalt will alloy with many metals such as aluminum, beryllium, chromium, copper, manganese, molybdenum, nickel, tin, titanium, tungsten and vanadium.

A useful series of cobalt-chromium-tungsten alloys, termed Stellites, are very hard and corrosion resistant. They contain roughly cobalt 42%–65%, chromium 25%–35%, tungsten 5%–19%, iron 1%–2%, carbon 1%–2%, silicon 1%–2%, and are used for cutting tools and hard-facing. A dental and surgical alloy known as Vitallium, containing essentially 65% cobalt, 30% chromium and 5% molybdenum or tungsten, is not attacked by body liquids, does not give rise to any irritation to tissues, and is electrically neutral in the body.

High temperature, high strength alloys for various components of jet aircraft and gas turbines have become of great importance. Nearly all contain from 20% to 65% cobalt, together with nickel, chromium, molybdenum, tungsten and minor quantities of other elements.

Cemented Carbides.—Tungsten carbide, one of the hardest man-made substances, is extremely valuable for machine tools, drill bits, dies and saws. In its production, a briquetted mixture of powdered tungsten carbide and cobalt is sintered at a temperature above the melting point of the latter. The cobalt melts and serves as a bond holding the hard carbides, and adding the toughness and resistance to shock needed to make these carbides of practical value. Cobalt is the most satisfactory matrix or binder for this purpose, and may be present in amounts from 3% to 20% by weight. (*See* also CARBIDES.)

Electroplating.—Although cobalt plating itself has not attained any commercial importance, cobalt is sometimes added to nickel baths to give a deposit ranging from 1% to 18% cobalt, producing smooth, bright films which are hard but yet relatively ductile.

Glasses.—Cobalt is added to impart a blue colour to structural glass, pharmaceutical, perfume and decorative bottles, and optical filter glasses. Cobalt additions of from 5 oz. to 10 lb. per ton of glass are employed.

To neutralize in plate and window glass the yellow tint of iron, small quantities of cobalt, 1 to 45 gm. per ton of glass, are required.

Ceramics.—*Body Stain.*—In the ceramic industry cobalt is used to neutralize the yellow colour of iron in pottery clays. Cobalt oxide is added in the proportion of about 1 lb. per ton of dry pottery clay. In larger quantities, cobalt will colour bodies various shades of blue.

Glaze Stain.—A rich blue colour may be obtained by adding 5% cobalt oxide to a glaze of high lead content.

Underglaze or On-glaze Stain.—For this purpose the usual stains are smalt or Thenard's blue. The latter gives a turquoise blue characteristic of cobalt aluminate, whereas smalt gives the typical violet blue of cobalt silicate.

Enamels.—Cobalt oxide is used in the production of white enamels to neutralize any yellow caused by iron. Smalt is employed to colour enamels blue, and cobalt oxide added to some mixtures gives an excellent black.

Cobalt oxide in quantities of 0.2% to 2% is used in enamel coats on steel to increase the adherence of the enamel to the metal. Cobalt is the most satisfactory substance for this purpose.

Catalysis.—Cobalt exhibits many catalytic reactions of economic importance or scientific interest.

A number of cobalt salts, particularly organic compounds, are excellent driers of paints and varnishes. Cobalt linolates, resinates and naphthenates, containing 4%–12% cobalt, are preferred.

Cobalt, usually in the form of a cobalt-thoria-kieselguhr catalyst, is used in the Fischer-Tropsch synthesis of liquid hydrocarbons from carbon monoxide and hydrogen (*see* CATALYSIS: *Practical Uses*).

Cobalt catalysts are used, or have been patented, for other reactions such as ammination of ethylene and propylene, desulfurization of crude oil, hydrogenation processes, oxidation of ammonia, carbon monoxide and hydrogen cyanide, decomposition of ethylene and acetylene and preparation of iso-octaldehyde from a heptene olefin.

Trace Element: Biological and Biochemical Relationships.—For a very long period it has been a puzzling fact that many pasture lands in various countries were unsuitable for continuous grazing by cattle and sheep. The poor condition of these animals was ascribed to mineral deficiencies, poisons in herbage or soil or to parasites, but finally around 1935 the cause was traced by workers in Australia and New Zealand to a deficiency of cobalt. Since that time, similar diseases caused by cobalt deficiency have been verified in many parts of the world, and in such areas the addition of a small quantity of a cobalt compound to the ration, water, salt lick, fertilizer or pasture amendment has become a well-established practice. In general, a content of less than 0.08 parts per million (p.p.m.) cobalt in the forage may produce deficiency diseases in cattle and sheep. The minimum level of cobalt required in the soil to yield this concentration in herbage is dependent on a number of factors of soil and climate. As a rough guide, cobalt in the soil should generally be above 5 p.p.m. for the maintenance of health in ruminants.

Physicochemical studies have shown that vitamin B_{12} contains cobalt, and it is the only vitamin known to contain a heavy metal. Pernicious anemia has been virtually eliminated in many countries by vitamin B_{12} therapy, and while the biological function of B_{12} is still unknown it may be linked in some way with the oxidation-reduction reactions of cobalt cyanides.

A number of nutritionists have suggested that cobalt should be considered a human dietary essential, but there is no indication of the quantity required. Low cobalt foods, less than 0.05 p.p.m., include apricots, carrots, cherries, corn, oats, peas, potatoes, rice and wheat.

High cobalt foods, over 0.2 p.p.m., embrace beet greens, buckwheat, cabbage, figs, lettuce, spinach and water cress.

Cobalt-60.—A radioisotope Co^{60}, prepared by exposing cobalt to the radiations of an atomic pile, is useful in industry, medicine and science. Co^{60} is used in place of X-rays or radium in the inspection of materials to reveal internal structure, flaws or foreign objects. Its advantages over radium lie in lower cost, more homogeneous γ-radiation and softer β-radiation which can be easily filtered out, no radioactive contamination from radon gas and ability to be machined or shaped in any form before irradiation to fit special requirements.

Co^{60} is used in cancer therapy, and extensively as a radioactive tracer in biology and industry. Its half-life of 5.3 years eliminates the need to consider changes in source strength and provides a tracer at moderate cost.

OCCURRENCE

Cobalt is widely diffused but is not one of the abundant elements, being usually considered to make up about 0.001% of the igneous rocks of the earth's crust, compared with 0.020% nickel and 5% iron. The element is found in meteorites, the sun and stellar atmospheres, sea and mineral waters, soils and living organisms both plant and animal. Traces of cobalt have been reported in many ores of iron, nickel, copper, silver, manganese and zinc.

The important cobalt minerals are sulfides, arsenides and oxidized compounds. In combination with sulfur it occurs as linnaeites in many localities such as the Mississippi lead-zinc deposits and the copper mines of Northern Rhodesia and Katanga. Cobalt substitutes for nickel in many of the minerals of the Sudbury, Ont., and similar copper-nickel sulfide ore bodies.

Cobalt arsenides, such as smaltite, safflorite and skutterudite, are found in Canada, Morocco and other countries. The sulfarsenide cobaltite (*q.v.*) is frequently associated with arsenides.

Oxidized cobalt minerals are an important source of this element. Asbolite, an impure mixture of manganese and cobalt oxides, is the principal cobalt mineral of New Caledonia and is also found in small quantities in Northern Rhodesia. Heterogenite, a hydrated cobalt oxide, is one of the chief minerals of the Katanga deposits.

The carbonate sphaerocobaltite is found in Katanga and to a small extent in Northern Rhodesia. Erythrite (*q.v.*), an oxidation product of cobalt arsenide minerals, is found in Canada and Morocco.

METALLURGY

Depending upon the form of cobalt in the ore, a wide variety of recovery processes may be employed to yield the refined metal.

Arsenides, sulfarsenides and mixed oxide-arsenide ores of Canada, Morocco and other countries are concentrated by hand sorting, gravity separation by jigs or tables, or by froth flotation. The concentrate is charged to a blast furnace with coke and limestone, and smelted to a speiss, or impure mixture. The latter is ground, roasted with common salt and leached with water. The insoluble chlorides are ground with sulfuric acid, washed and filtered and the combined solution after oxidation is neutralized with lime. The precipitate of basic ferric arsenate is filtered off, giving a solution containing only cobalt and nickel. Fractional additions of sodium hydroxide and sodium hypochlorite precipitate cobalt as cobaltic hydroxide, $CO(OH)_3$, at first pure and afterward as a mixed hydroxide of cobalt and nickel. The latter is recirculated to obtain pure cobaltic hydroxide.

The principle of this separation depends on the fact that in neutral solutions cobalt is more readily oxidized than nickel. The oxidized cobalt compound hydrolyzes and precipitates, leaving nickel in solution. The acid liberated by the hydrolysis must be neutralized to carry the reaction to completion.

The cobalt precipitate is dried, ground and made into thick disks or rondels, in a pelletizing machine. The rondels are dried, reduced with charcoal to cobalt metal, cooled, magnetically separated and screened for market.

From Katanga and Northern Rhodesia, where cobalt is essentially a by-product of copper production, various cobaltiferous materials are processed in electric furnaces to yield a copper-cobalt-iron alloy which is sent overseas for refining. In Katanga high-grade cobalt ores, concentrates and slags are charged to electric furnaces with coke and limestone. A crude cobalt alloy containing about 15% copper, 42% cobalt and 40% iron is produced. At Rhokana Corporation, Ltd., in Northern Rhodesia, where the sulfide ore contains about 3% copper and 0.13% cobalt, two flotation concentrates are produced. A copper concentrate containing a high copper and low cobalt content is removed first, using a minimum quantity of reagents, and then by the addition of more reagents and recirculation of various flotation pulps a cobalt concentrate, having less copper and more cobalt, is produced. These concentrates are treated separately in reverberatory furnaces and converters. The converter slags are high in cobalt and are charged, with coke, and silica if necessary, to electric furnaces. A crude cobalt alloy containing 15% copper, 40% cobalt and 45% iron is produced.

In European refineries these alloys are dissolved with hot 20% sulfuric acid, copper remaining insoluble. The solution is treated with sodium chlorate and soda ash, and the iron precipitate removed. Final precipitation of cobalt is done with sodium hypochlorite to give cobalt hydrate, which is purified in the manner described for arsenical ores.

Electrolytic cobalt has been produced in increasing quantities from Katanga and Northern Rhodesia. In Katanga the slime residues from the copper leaching plant are dissolved, the solution passed to electrolytic cells for decopperizing and the remaining copper removed by cementation on cobalt shot. Cobalt is precipitated by lime, filtered, dissolved in sulfuric acid and electrolyzed on steel cathodes using lead anodes.

In Northern Rhodesia the cobalt concentrate, obtained as outlined earlier, is roasted under controlled conditions to transform the cobalt to the sulfate and leave most of the copper and iron in water-insoluble forms. The roasted concentrate is leached with hot water and the acidity adjusted with lime to precipitate most of the copper and all the iron. The solution is passed over cobalt granules to cement out the residual copper.

Cobalt is precipitated with lime, dissolved in H_2SO_4, and electrolyzed.

An important source of cobalt is the nickel industry, where recovery may take several forms: (1) At International Nickel Company of Canada, Ltd., Port Colborne, Ont., cobalt is precipitated from the impure anolyte (the solution surrounding the anode) by chlorine and basic nickel carbonate as a cobalt-nickel-copper-iron slime. This is dissolved in H_2SO_4, the copper and iron removed, and cobalt is separated from nickel with sodium hypochlorite. (2) Cobalt is recovered at the refinery of the Mond Nickel Co., Ltd., at Clydach, Wales, where the carbonyl process is employed to produce pure nickel from Canadian nickel oxide. Residues from the carbonyl treatment are roasted, leached, copper and iron removed, and cobalt is precipitated as a crude cobaltic hydroxide, refined to high-grade black and gray cobalt oxides. (3) When lateritic nickel ores are reduced and leached with ammonium carbonate any cobalt present is largely precipitated with the basic nickel carbonate. (4) The techniques of pressure leaching of nickel sulfide concentrates in acid or ammoniacal solutions, followed by precipitation of nickel and cobalt as metals with hydrogen, furnish another source of cobalt.

PROPERTIES

Chemical Properties.—The symbol of cobalt is Co; atomic weight, 58.9332; atomic number, 27; melting point, 1,495° C.; boiling point, 2,900° C.; valence, 2 or 3. Cobalt is not attacked by air or water at ordinary temperatures. The metal is rapidly attacked by sulfuric, hydrochloric and nitric acids, but slowly by hydrofluoric acid, ammonia and sodium hydroxide.

Principal cobalt compounds are:

1. Carbides of cobalt are important in the Fischer-Tropsch synthesis of hydrocarbons (see *Uses: Catalysis,* above).

2. Cobaltous carbonate is formed when soda ash or limestone is added to a cobalt solution.

3. Cobalt carbonyl, unlike the corresponding nickel compound, is not formed when CO is passed over reduced cobalt powder at atmospheric pressure. Pressures in the region of 100 atm. and 200° C. are required for an appreciable yield of cobalt carbonyl.

4. Among the halides, cobaltous chloride is an important salt of cobalt, and cobalt fluorides are employed in the synthesis of fluorocarbons.

5. Cobaltous hydroxide, formed when an alkali hydroxide is added to a cobalt solution, is slowly oxidized by air to cobaltic hydroxide.

6. Cobaltous nitrate is produced when nitric acid is added to cobalt metal, oxide, hydroxide or carbonate.

7. Cobalt, like iron, has three common oxides:

a. Cobaltous oxide, CoO, varies in colour depending on the grain size, but is usually dark gray and is the principal constituent of the gray cobalt oxide of commerce.

b. Cobaltic oxide, Co_2O_3, is formed when cobalt compounds are heated at a low temperature in an excess of air. On prolonged heating it goes to Co_3O_4.

c. Cobaltosic oxide, Co_3O_4, is the stable black oxide resulting when cobalt salts are heated at temperatures not exceeding 850° C. It is the chief component of commercial black cobalt oxide.

8. Cobalt silicates are found in glazes and slags.

9. Cobaltous sulfate is prepared by the action of sulfuric acid on cobalt compounds.

10. Cobaltous sulfide is the black powder formed when H_2S is passed into an alkaline cobalt solution.

The higher valence states of many cobalt compounds are unknown, or prepared only with difficulty. In co-ordination complexes, however, cobalt prefers the trivalent state, and numerous ammonium compounds with cobalt have been described.

Physical and Mechanical Properties.—Cobalt when polished is silver-white with a faint bluish tinge. At ordinary temperature the stable form is the close-packed hexagonal α-cobalt, while above 400° C. the stable form is face-centred cubic β-cobalt. The metal has a specific gravity of 8.9, is ferromagnetic, and possesses in hardness, tensile strength and machinability similar properties to nickel and iron.

Analysis.—The need to determine cobalt in large numbers of samples, ranging from traces in herbage to 65% or more in alloys, has resulted in the development of many analytical methods. For small quantities, colourimetric procedures employing nitroso-R-salt or ammonium thiocyanate are recommended, or the element may be determined in certain cases polarographically or spectrographically. For large quantities of cobalt the electrolytic method is the most satisfactory. In the intermediate ranges, the gravimetric method of weighing as Co_3O_4 after separation of cobalt with α-nitroso β-naphthol—or the potentiometric procedure depending on oxidation of cobalt in ammoniacal solution by potassium ferricyanide—are reliable.

See also references under "Cobalt" in the Index volume.

Bibliography.—J. W. Mellor, *A Comprehensive Treatise on Inorganic and Theoretical Chemistry,* vol. xiv (1935); U.S. Bureau of Mines, *Mineral Yearbook* (annual); Roland S. Young, *Cobalt* (1948).

(R. S. Y.)

COBALTITE, a mineral composed of cobalt sulfarsenide, is found as granular to compact masses, and frequently as beautifully developed crystals. Brilliant crystals of cobaltite from Tunaberg in Södermanland, Swed., and from Skutterud near Drammen in Norway are well known in mineral collections. Crystals have also been found at Cobalt, Ont., and at Khetri in Rajasthan, India, and under the name *sehta* the mineral is used by Indian jewelers for producing a blue enamel on gold and silver ornaments. Cobaltite crystals have the same symmetry as the isomorphous mineral pyrite, being cubic with parallel hemihedrism. The usual form is a pentagonal dodecahedron with faces of the cube and octahedron. The colour is silver-white with a reddish tinge, and the lustre brilliant and metallic, hence the old name cobalt-glance. The formula is CoAsS or $CoS_2.CoAs_2$.

See Cobalt.

COBB, HOWELL (1815–1868), U.S. congressman, cabinet member and Confederate general during the American Civil War, was born at Cherry Hill, Ga., on Sept. 7, 1815. His father was a well-to-do planter who moved the family to Athens, Ga., seat of the state university. Cobb graduated from the university in 1834 and two years later was admitted to the bar. From 1837 to 1840 he was solicitor-general for the western circuit of his state. During these years he agreed with the Jacksonian view on the question of nullification. He later supported Pres. James K. Polk during the Mexican War and became an ardent advocate of the extension of slavery into the territories. But when the Compromise of 1850 (*q.v.*) had been agreed upon he became its stanch supporter as a Union Democrat and on that issue was elected governor of Georgia by a large majority.

From 1843 to 1851 and again from 1855 to 1857 he was a member of the U.S. house of representatives, becoming Democratic leader in that body in 1847 and serving as speaker in 1849–51. From 1851 to 1853 he was governor of his state and from 1857 to 1860 was secretary of the treasury in Pres. James Buchanan's cabinet. In 1860, upon the election of Abraham Lincoln, he ceased to be a Unionist and became a leader of the secession movement. The following year he was appointed colonel of a regiment and two years later was made a major general in the Confederate army. He died in New York city on Oct. 9, 1868.

COBB, IRVIN SHREWSBURY (1876–1944), U.S. journalist and humorist, was best known for his colloquial handling of familiar situations with ironical, penetrating humour. Born on June 23, 1876, in Paducah, Ky., the setting of his most popular stories, he left school early to work for local newspapers. At the age of 19 he became managing editor of the *Paducah Daily News*. In 1904 he went to New York city, and became a staff writer for the *Evening World* and *Sunday World*. First through syndicated newspaper features and later in magazines, he became widely known for such articles as "Speaking of Operations," which in book form sold over 500,000 copies, and for short stories, of which he wrote over 300. His stories about a shrewd and kindly Kentucky judge, Judge Priest, first brought him fame. In them he aimed to give a faithful picture of a southern community; some of these were collected in *Back Home* (1912) and *Old Judge Priest* (1916). A prolific writer, he published more than 60 books and traveled throughout the country as a lecturer and after-dinner speaker. He also wrote plays and scenarios and acted in motion pictures. He died on March 10, 1944.

See Fred G. Neumann's *Irvin Shrewsbury Cobb: His Life and Letter* (1938), Cobb's autobiography *Exit Laughing* (1941) and reminiscences by his daughter, Elisabeth Cobb, *My Wayward Parent* (1945).

COBB, JOHN (d. 1778), English cabinetmaker and upholsterer, was partner with William Vile from about 1750 to 1765 in an important London cabinetmaker's business. Vile retired in 1765 and Cobb continued alone until his death in 1778. Up to 1765 the firm supplied furniture to George III, but after Vile's retirement Cobb apparently ceased work for royalty. Records are rare; a ledger from Edgcote house, Northamptonshire, records payment of over £1,000 in 1758, and Cobb supplied furniture to Horace Walpole in 1770. Work known to be Cobb's is neoclassical in style. A bill dated 1772 shows that Cobb supplied the marquetried commode and pair of vasestands at Corsham court, Wiltshire; two similar commodes, in the Victoria and Albert museum, London, and in Holland house, may also be his.

See R. Edwards and M. Jourdain, *Georgian Cabinet-Makers* (1955); R. Edwards and P. Macquoid, *The Dictionary of English Furniture* (1954). (J. E. Le.)

COBB, TY (Tyrus Raymond Cobb) (1886–1961), one of the greatest of U.S. baseball players, won more titles (58) for offensive play than any player in major league history. He was born Dec. 18, 1886, at Narrows, Banks county, Ga., the son of a noted educator and Georgia senator. He became a major league player with the Detroit Tigers in 1905, when he was 18. Nicknamed the "Georgia Peach," Cobb, a left-handed batter and right-handed thrower, stood 6 ft. ¾ in. tall and weighed 175 lb. He spent 22 seasons as an outfielder with the Detroit Tigers of the American league and managed them in 1921–26. He was 42 years old and a member of the Philadelphia Athletics when he retired from the game in 1928. Cobb died at Atlanta, Ga., on July 17, 1961.

Cobb played in more games (3,033), scored more runs (2,244), made more hits (4,191), stole more bases (892) and finished with a higher lifetime batting average (.367) than any other major leaguer. He led the American League in batting 12 times—nine times in a row. Three times he hit .400 or better and hit .300 or more for 23 straight years. But the Cobb record that baseball historians talk most about was the 96 bases he stole in 1915.

In the first election to the baseball Hall of Fame at Cooperstown, N.Y., in 1936, Cobb received the most votes.

(J. D. McC.)

COBBE, FRANCES POWER (1822–1904), British philanthropist and writer on religious and social subjects, and prominent antivivisectionist, was born in Dublin on Dec. 4, 1822. In 1858 she began social work among the girls and boys of Bristol. She carried out various special investigations on vivisection, on destitution and on separation orders and divorce. She was a strong suffragist. From time to time she conducted services in Unitarian chapels. She died at Hengwrt, near Dolgelley, Merionethshire, Wales, on April 5, 1904. She published about 30 separate works, among which may be mentioned: *Essay on Intuitive Morals*, published anonymously (1855), *Pursuits of Women* (1863), *Dawning Lights* (1868), *Darwinism in Morals* (1872), *The Hopes of the Human Race* (1874), *The Duties of Women* (1881), her own *Life* (2 volumes, 1894) and *The Scientific Spirit of the Age* (1888).

COBBETT, WILLIAM (1763–1835), English author, journalist and radical, is one of the most representative figures in English literature, and his life and writings embody the history of the common people between the revolutions of the 18th century and the dawn of the Victorian era. He was born at Farnham, Surrey, on March 9, 1763 (not 1766, as he himself wrongly stated). His father was a small farmer and his grandfather had been a day labourer. As a boy he worked in the fields, but at 14 he began his adventures by running away to work in Kew gardens. He returned home after a while; then, at 19, again left Farnham and found employment as a solicitor's clerk in London. Soon sickening of this occupation, he joined the army. After a year at a training base, during which he read hard and discursively and taught himself grammar and writing, he was drafted, first to Nova Scotia, then to Fredericton, N.B., where he remained till 1791, rising to the rank of regimental sergeant major. Conscious of the systematic fraud and peculation that went on in the regiment (as indeed throughout the service), he began collecting evidence against the principal offenders. In 1791, when his regiment was ordered home, Cobbett at once procured his discharge and demanded a court-martial of the officers involved. This was at length granted, but Cobbett, in despair of getting the case fairly heard, failed to appear at the court-martial and fled to France (March 1792). The same year he took ship for America, where, first at Wilmington, Del., and later at Philadelphia, Pa., he supported himself by teaching English to the French *émigrés*.

So far Cobbett had written little, but in 1794 an incident occurred which embarked him on his long career as a political writer. Joseph Priestley, the great Unitarian radical, came in that year to settle in the United States, and numerous addresses of welcome were presented to him by American radical societies. These aroused Cobbett's strong pugnacious instincts and he entered the lists as a pamphleteer with his *Observations on Priestley's Emigration* (1794). From that date until his return to England in 1800, he was the most vehement and violent writer on the British side in the United States, producing a series of tirades against the French Revolution and all its works and against all Americans who ventured to give it, or any sort of radicalism, even the mildest support. *A Bone to Gnaw for the Democrats*, *A Kick for a Bite*, *The Scarecrow*, *The Cannibal's Progress*, a scurrilous *Life of Tom Paine* and the autobiographical *Life and Adventures of Peter Porcupine* are among these early pamphlets. They are all unmeasured in violence, often outrageous but always lively, readable and written in virile and forthright English. Cobbett's style was almost as good in his first unpractised writings as in the best of his more famous later work.

Cobbett was soon in trouble with the law. He libeled Benjamin Rush, doctor and well-known Democratic politician, accusing him of killing George Washington with his special "bleeding treatment." This brought a heavy fine. He then wrote scurrilous pamphlets about Thomas McKean, the judge who had tried the case and was Rush's political ally. Before long he was no longer welcome in the U.S. and in 1800 he gave up the contest and returned to England, where his writings, regularly republished, had already made him well known. He was greeted with enthusiasm as a powerful recruit to jingo journalism. He met Pitt at dinner, and was offered the editorship and ownership of one of the leading government newspapers. He refused the offer, as he had already refused government payment for his services in America, and attempted instead to start a daily newspaper of his own, *The Porcupine*. This speedily failed; but in 1802, with help from William Windham, who was for several years his chief political supporter, he started the weekly *Political Register*, which he thereafter edited, and for the most part wrote, regularly until his death in 1835.

The *Political Register*, with which Cobbett's name was from 1802 chiefly associated, began its career as an extreme anti-Jacobin journal. It strongly opposed the peace of Amiens and called for a renewal of the war with France. However, after Pitt's return to power and the renewal of the war, Cobbett slipped gradually into opposition and found himself in alliance with Windham and with Fox, the latter of whom he had hitherto vehemently denounced. In 1806, in the "ministry of all the talents," his friends came to power, but Cobbett soon fell into opposition to them also. He was by this time denouncing the "Pitt system" as the root of all evil, and attacking in particular the methods of pursuing the war, the multiplication of pensions and sinecures and the dangerous growth of the national debt. When the ministry of all the talents broke up in 1807, he was already a radical, at war equally with Whig and Tory and beginning to cry out for peace and parliamentary reform as well as for "economical reform."

So far, Cobbett was merely an outstanding political journalist, whose writings, however trenchant, had given little indication of his peculiar quality as a democratic leader. But from about 1805 a new tone began to appear in his work. That year he bought a substantial farm at Botley, near Southampton, and thereafter spent most of his time in the country. The change opened his eyes to the great contrast between the countryside as he remembered it in his boyhood and as it had become under stress of wartime prices and enclosure. He realized for the first time the misery of the labouring classes; it roused his indignation and completed his conversion to radicalism. The one articulate voice among the suffering people of the countryside, he brought a new note into radical agitation. At once he became a power, but his power brought penalties. In 1809 there was a minor mutiny among the soldiers at Ely over unfair deductions from pay. The mutiny was suppressed and the ringleaders were flogged under the eyes of German mercenaries. Cobbett wrote, denouncing the floggings, and was prosecuted for sedition. A fine of £1,000, two years in Newgate jail, bail of £3,000 and the finding of two sureties at £1,000 each, were his punishment.

From Newgate, under the lax prison discipline of the time, Cobbett continued to edit the *Register* and wrote his famous *Paper Against Gold*, in which he denounced the wartime inflation of the currency and the financial policy of Pitt and his successors. His imprisonment, however, brought him financial ruin. He went bankrupt. His farm at Botley was sold and most of his valuable properties passed out of his hands. The *Register* he barely saved. Three great publishing enterprises on which he was engaged had to be sold—the *State Trials* (known as Howell's, from the editor whom Cobbett employed), the *Parliamentary History of England* and the *Parliamentary Debates*, which were bought by his printer, Hansard, and thereafter bore the latter's name. All these were originated by Cobbett, though the actual editorship, under his control, had been mainly left to others.

When Cobbett emerged from prison in 1812 he appeared to be ruined, but he had still the *Register*, and the ending of the war, in 1815, brought him his chance. Prices fell, indeed; but the cessation of war demand and the prostration of Europe after the long struggle led to widespread unemployment and distress. Unrest grew in the industrial districts; and the farmers, pressed down by high taxation, were also in a condition of active discontent. The government had no plans for dealing with the crisis; and Cobbett, with his demands for parliamentary reform and a reduction of the heavy interest on the national debt, became the central figure in a nationwide agitation. In 1816 he began the issue of a cheap unstamped *Register* (denounced as Cobbett's "two-penny trash") addressed particularly to the journeymen and labourers of the northern and midland counties. He became suddenly the most influential leader of the working classes. By this time, however, the government was embarking on a campaign of repression, and Cobbett, in order to avoid arrest, fled in 1817 to the United States.

Settling down on a hired farm at North Hempstead, Long Island, N.Y., Cobbett set himself to write. He sent the copy regularly for the *Political Register*, which continued to be published by his agents in England. He also embarked on other literary work. To the respite which exile gave him from daily political preoccupations is owed the beginning of his great literary period. Hitherto he had written much excellent journalism but no important book. Between 1817 and 1819 he produced not only his *Journal of a Year's Residence in the United States of America* but also his famous *Grammar of the English Language*, which, despite its faults of scholarship, is still probably the best introduction to correct virile English for the working-class student. In America, too, he projected several of his other important books.

Although the repression was not over, Cobbett went back to England late in 1819 and assumed his place as an outstanding leader of working-class agitation. From 1819 to 1832 his history is, in one aspect, the history of the agitation for parliamentary reform. In addition, he found scope for other activities, above all for his *Rural Rides* through the southern half of England. His accounts of these appeared in the *Register* between 1820 and 1830, when they were first published in book form.

Rural Rides, certainly Cobbett's most widely read works except for the *Grammar*, are difficult to describe. They are, in part, a plain account of what he saw in the English countryside—of good farming and of bad, of rotten boroughs and the country houses of bankers, stockjobbers and successful army contractors, and above all of the misery and starvation of the common people. But they are far more than this. They abound in digressions, in racy snatches of autobiography, in topical political tirades and everywhere in abundant outflowings of Cobbett's own forceful and appealing personality. Though they were composed in haste and sent off to the *Register* without chance of revision, they were astonishingly well written. *Rural Rides* are Cobbett at his best, showing more sides of the man than appeared in any of his other works.

Rural Rides and the ceaseless "rustic harangues" which accompanied them did not, even with the added burden of conducting the *Register* and actively guiding a large section of the reform movement, at all exhaust Cobbett's energies. Books, for the most part good books, flowed from him—*Cobbett's Cottage Economy* and the *Sermons* in 1822, *The History of the Protestant Reformation in England and Ireland* (questionable history this, but vigorous writing) in 1824–27, *The Woodlands* in 1825, *Advice to Young Men* (next to *Rural Rides* his best book) and *The English Gardener* in 1829 and a host of others. Moreover, in 1820–21 he wholeheartedly espoused the cause of Queen Caroline against the king, acted as one of her regular advisers during the divorce proceedings and wrote ceaselessly on her behalf. He even composed a number of her own letters and messages concerned with the case. In his hands the defense of the queen became also a means of rallying the forces of the reformers.

Meanwhile, in 1820, he had rid himself by bankruptcy of some of his financial worries and had settled down to rebuild his shattered fortunes by means of his pen. Botley had been given up and for a while he had no land. Soon, however, he developed a flourishing seed farm in Kensington and began to deal also in American trees and in a variety of imported seeds and plants. He especially urged the cultivation of maize ("Cobbett's corn"), of the locust tree and of Swedish turnips, as well as the introduction of straw-plait manufacture from home-grown grasses. His seed farm and his agricultural writings brought him a large following among the farming classes.

In 1830, with the fall of Wellington and the end of the long period of Tory ascendancy, the reform agitation came to a head. The Whigs, under Lord Grey, assumed office, and reform became the one political question of the day. Immediately upon this change followed the hunger movement of the rural labourers in the southern and eastern counties. The opponents of the movement sought to trace these troubles to Cobbett's influence and the Whig government, anxious to prove its respect for property and to reassure the propertied classes on the subject of reform, prosecuted him. Refusing to employ counsel, Cobbett defended himself in a masterly speech which thoroughly turned the tables on his opponents. The jury disagreed, and no further attempt was made to molest him. The revolt, however, was savagely repressed.

At length, in 1832, the Reform act became law. Cobbett, though he had no love for the Whigs, had urged the workers to support it on the ground that no more liberal measure stood any chance of immediate success. At the election which followed he was elected M.P. for Oldham as the colleague of John Fielden, the radical and manufacturer. He had stood at Manchester also, but withdrew on learning of his success at Oldham.

This was not Cobbett's first parliamentary contest. He had stood unsuccessfully for Coventry in 1820 and for Preston in 1826. Indeed, for many years he had been seeking to force his way into parliament. At 68 years of age, he found himself a member, as strongly in opposition to the reformed parliament of 1832 as he could have been to the unreformed parliaments of earlier years. He passed his two and a half years of parliamentary life as the leader of a tiny group of extreme radicals, supported sometimes by O'Connell and his Irish, but always fighting for forlorn hopes. Especially, he put up an unavailing struggle against the "new poor law" of 1834, and his last weeks of life were spent in the endeavour to run a campaign against the act when it had been passed into law.

It is usually said that Cobbett was not a success as a parliamentarian. He could hardly have been so, for he accepted none of the rules of the game. He remained to the end the leader of an essentially extraparliamentary crusade. Furthermore, his health was failing. He had been always an indefatigable worker, rising very early and doing a good part of a day's labour before other men were astir. Now, although severe colds and coughs began to trouble him, he insisted on adding assiduous attention to his parliamentary duties to his other activities. In 1835 his health gave way under the strain and on June 18 he died of an attack of influenza. His sons attempted for a few months to carry on the *Register*, but it was nothing without his vigorous editorials and was speedily discontinued.

Cobbett's character has been variously estimated. He was always extremely pugnacious and made many enemies; he also made many firm friends. His pugnacity, which led him to quarrel almost as much with allies as with opponents, was purely political. Carlyle called him "the pattern John Bull of his century"; his fellow M.P., Silk Buckingham, said he had "a ruddy contenance, a small laughing eye, and the figure of a respectable English farmer." Hazlitt, who liked his books, also said he looked like a farmer. Cobbett was, indeed, despite his appeal to the workers of the factory districts, always at heart a countryman, with an unconquerable instinct for the land and the men of the land. He was intensely English and, in his way, intensely patriotic; it was this patriotism that roused him to the defense of his fellow countrymen, trodden under by the oppressions of war and the twin revolutions in agriculture and industry whose devastating social effects he watched from phase to phase. He was that rarest of literary phenomena—an articulate peasant. His prose is astonishingly quick in its movement and yet solid as a lump of earth. He had a marvelous facility for nicknames and for the ridicule that hurts. Above all his prose depends for its success on the personal quality that pervades it. It is spoken rather than written down, and in it the man lives. Cobbett has often been called an egoist, and he was; but his egoism—his capacity to make himself express the aspirations of a whole suffering class—is at the very root of his appeal.

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(G. D. H. C.)

COBDEN, RICHARD (1804–1865), English political economist, and the greatest apostle of free trade in early Victorian England, was born on June 3, 1804, at Dunford farm, near Midhurst, Sussex. He was the fourth of 11 children who, because of their parents' poverty, were cared for by relatives. Richard, after attending a wretched private boarding school in Yorkshire, entered his uncle's warehouse in London. In 1828 he and two other young men set up a calico-merchanting business on their own account, and three years later, after the heavy duties on calico were removed, began to do their own calico printing at Sabden in Lancashire. At this time Cobden was dominated by a "Buonapartian feeling," and "ambitious hopes and schemes almost boundless": as the ambitions took form, they led him increasingly from business into politics.

He remedied his early lack of education by reading and travel. Between 1833 and 1839 he visited France, Switzerland, the United States, the middle east and Germany. The influence of both reading and his travels can be traced in two significant pamphlets which he wrote at this time—*England, Ireland and America* (1835) and *Russia* (1836). They pointed to salient facts in the international situation that many Englishmen ignored: to the rise of the United States and its vast economic resources, to the artificiality of most current assessments of "the balance of power," particularly pro-Turk and anti-Russian biases, and to the need for Great Britain to expand its foreign trade. Such expansion was dependent on free trade, not on military power and the "false tenets of glory": "cheapness, and not the cannon and the sword, is the weapon through which alone we possess and can hope to defend or extend our commerce." Furthermore, Great Britain's interests as a trading power could point the way to a new international order, based on the increase in wealth and the free movement of resources.

Struggle for the Repeal of the Corn Laws.—Cobden was to take up the main theme of these pamphlets on many later occasions, but from 1838 to 1846 he was engaged on a practical task, which demanded the whole of his energies—the fight for the repeal of the corn laws. In Oct. 1838 the Anti-Corn Law association was founded by seven Manchester men; by March 1839 it had transformed itself into a national organization, the Anti-Corn Law league; by the end of 1840 it had become the most powerful pressure group in British politics, and Cobden had established himself as its leading personality. For Cobden and his supporters the corn law "took from the poorest of the poor to add to the richest of the rich." It was morally wrong as well as economically inexpedient. The sole class which benefited by it was the class of the landowners: it enriched them at the expense of the community. There was little original in Cobden's economic arguments: what was new was the relentless drive and tactical skill with which they were pressed on the platform, first in the manufacturing cities, then in London and the countryside. Along with men like John Bright (*q.v.*), who in 1841 pledged himself never to rest "till the corn law is repealed," Cobden carried on a perpetual agitation, linking national free-trade policy, wherever he could, to the dream of international solidarity, based on full liberty of commerce.

At the general election of 1841 Cobden became member of parliament for Stockport, and made his first speech on the corn laws during the debate on an amendment to the address. The mounting pressure of political activities compelled him to neglect his business interests, and from 1841 onward he always put politics first and business second. He soon became renowned in the house of commons as the main critic of Sir Robert Peel, countering the views of Peel and his Conservative supporters not by rhetoric but by plainness and persuasiveness. In the country he was prepared to take up more dramatic tactics, and the methods of the Anti-Corn Law league were frequently open to criticism. After he had told Peel in Feb. 1843 that he held him individually responsible for the distress in the country, there was a sharp clash between the two men, which created much argument outside Westminster. Nonetheless Peel found it increasingly difficult to counter Cobden's arguments and in March 1845, after Cobden had recapitulated the league's arguments in the commons, Peel crumpled up his notes and said to Sidney Herbert, "You may answer this, for I cannot."

Some politicians had already prophesied that Peel would crown the fiscal reforms of his 1841 ministry with the repeal of the corn laws and some members of his government had realized at the time of Peel's first budget in 1842 that the next change in the corn laws would be their total repeal. In the autumn of 1845 Peel was wavering and the prospect of famine in Ireland as a result of the failure of the potato crop hastened his conversion. The cabinet was divided, and on Dec. 5, 1845, the prime minister resigned. Lord John Russell, invited to take office, asked Cobden to join his ministry, but he refused on the ground that his mission lay outside the house of commons on the public platform. Lord John Russell failed to form a ministry and on Dec. 20 Peel resumed office. Abandoned by many of his supporters and supported by many of his opponents, he carried the repeal of the corn laws, but was immediately defeated on a different issue and resigned on June 29, 1846, paying a warm tribute to Cobden in his final speech: "The name which ought to be, and will be associated with the success of these measures is not mine . . . but one who acting I believe from pure and disinterested motives, has with untiring energy, made appeals to our reason and has enforced those appeals with an eloquence the more to be admired because it was unaffected and unadorned: the name . . . of Richard Cobden."

The seven years' struggle for repeal left Cobden a ruined man. He had made a large fortune before he devoted his time to the league, but it had disappeared, and a public subscription was raised for him in 1847 to enable him to meet his obligations. With part of the amount collected he bought his birthplace, the farmhouse of Dunford, which was henceforward to be his home. He had married a Welsh girl, Catherine Anne Williams, in 1840, and all visitors to Dunford spoke of her beauty and charm. Their only son, Richard Brooke Cobden, died suddenly in 1856 at the age of 15; they also had five daughters, one of whom, Ellen Millicent, was a novelist.

Advocate of Free Trade and Peace.—Cobden did not retire into private life, however, in 1847. He chose travel as his means of recuperation after the long repeal struggle and visited Spain and Italy in 1846 and Russia in 1847. At the general election in 1847 he was elected a member of parliament for the West Riding of Yorkshire which he continued to represent until 1857. His main preoccupations during these ten years were with the international implications of his trade policy. He considered the reduction of armaments as the logical complement of free trade, and in advocating nonintervention in Europe, opposition to the expansion of the British empire and friendship with Russia, he found himself in sharp opposition to Lord Palmerston, who after the death of Peel in 1850 became the dominant figure in British politics. In 1849 Cobden moved a commons resolution in favour of international arbitration and in 1851, the year of the great exhibition, when his ideas seemed to have converted a large section of the community, a resolution in favour of the mutual reduction of armaments. He associated himself also with the international peace movement, which organized a series of international congresses between 1848 and 1851. The mood of 1851 soon changed, and Cobden's advocacy of a cheap and passive foreign policy and an active trade policy became very unpopular in 1853 and 1854. This did not daunt him, and one of his most powerful pamphlets, *1793 and 1853 in Three Letters* (1853) was a plea to learn from the "errors of the past" and to avoid war with France. After the Crimean War had broken out he courageously restated in *What Next—And Next?* (1856) his youthful views on the Russian question. He held that the interests of trade and humanity alike pointed to friendship with Russia and not with Turkey and, like Bright, he deplored not only the loss of money and blood but also the climate of war hysteria which influenced many of his fellow countrymen. Cobden suffered directly as a result of the war. Although in 1857 he was successful in carrying a motion in parliament to condemn Palmerston's foreign policy in relation to China, he lost his seat at the subsequent election. Bright too was defeated, and the ideas for which they had both stood seemed in eclipse.

Anglo-French Commercial Treaty.—After another visit to the United States, Cobden was returned unopposed to the 1859 parliament by the electors of Rochdale and on this occasion his old enemy Palmerston asked him to serve in the new broad-based Liberal cabinet as president of the board of trade. Cobden declined, but soon afterward (Oct. 1859) embarked upon laborious and at first unofficial negotiations for a new commercial treaty with France, based on tariff reduction and the expansion of trade. Backed by W. E. Gladstone, who differed with him on several points, he was successful, and a treaty was signed in 1860, which was designed to serve as a model for other commercial negotiations. Each of the two powers, in addition to making specific concessions, engaged not to enforce against the other any prohibition on imports or exports which was not applicable at the same time against other nations. This, the "most-favoured-nation clause," was copied in many other treaties. Although the free-trade mood was to be dissipated again in the 1870s and 1880s, Cobden in 1860 made a genuine and substantial contribution to international understanding.

The last great issue of policy with which he was concerned was the American Civil War. After some initial hesitation, Cobden declared for the North, and his correspondence with Charles Sumner, to whom he had been writing since 1851, was an important unofficial contact between Great Britain and the United States. The strain of the Anglo-French negotiations and the anxiety of living through a cold and foggy winter in Paris undermined Cobden's health, and for the last five years of his life he was extremely unwell. On a visit to London to attend parliament, he made a last endeavour to get from his bed to vote against expenditure on fortifications, but the effort was too much and he died on April 2, 1865.

Character and Influence.—Cobden's career clearly illustrates the development of middle-class radical politics in the 19th century. He was a child of the Industrial Revolution, and he believed that the removal of restrictions on the free play of self interest would eventually be in the interests of all. He opposed factory legislation for most of his life, although he was prepared to support state intervention in education. He disliked trade unions, which in 1842 he claimed were "founded upon principles of brutal tyranny and monopoly," and he never fully shared Bright's enthusiasm for a wider franchise or for the political sense of the working classes. Unhappy during the political lull of the early 1860s, he went so far as to ask in 1861, "Have they [the working class] no Spartacus among them to lead a revolt of the slave class against their political tormentors?", but the question reflected his mood rather than his ideology. He was indeed essentially a middle-class spokesman, who did much to forge middle-class consciousness in English politics. He himself called the Anti-Corn Law league "a middle-class agitation" and admitted that "we have carried it on by those means by which the middle-class usually carried on its movements." As late as 1862, somewhat disillusioned by middle-class support of Palmerston, he commented that "with many faults and shortcomings, our mercantile and manufacturing classes as represented in the chambers of commerce are after all the only power in the state possessed of wealth and political influence sufficient in part to counteract in some degree the feudal governing class of the country." His greatness was that he translated the language of interests into the language of moral principles, and tried to teach the English middle classes, whom he felt that he represented, to relate their immediate operations to the whole chain of international economic activities, which he considered to be the practical foundations of world peace.

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COBDEN-SANDERSON, THOMAS JAMES (1840–1922), English book designer and binder, who contributed much to the success of the arts and crafts movement, was born on Dec. 2, 1840, at Alnwick, Northumberland. He was called to the bar but in 1883, strongly encouraged by his wife, Annie, fourth daughter of Richard Cobden, he turned to bookbinding, in which, despite technical imperfections, he rapidly won distinction. He established the Doves bindery at Hammersmith (1893), confining himself thereafter to designing, and in 1900 he founded with Emery Walker the Doves press, the restrained splendour of whose books is unsurpassed. The partnership ended in 1908, and Cobden-Sanderson ensured that no one should use its special type after the press closed in 1916; regardless of his undertaking that Walker should have it after his death, he flung it in the river Thames. All reference to Walker was excluded from his *Cosmic Vision* (1922) and *Journals 1879–1922* (2 vol., 1926). He died at Hammersmith on Sept. 7, 1922.

See A. W. Pollard and E. Johnston in *Cobden-Sanderson and the Doves Press* (1929); C. Volmer Nordlunde, *Thomas James Cobden-Sanderson* (1957). (R. C. H. B.)

COBENZL, PHILIPP (1741–1810), and **LUDWIG** (1753–1809), GRAFEN VON, Austrian statesmen, were cousins.

PHILIPP VON COBENZL was born at Laibach (Ljubljana), on May 28, 1741. From 1759 he was employed in the fiscal administration of the Austrian Netherlands. When only 26, he became a councilor of state in Vienna. In 1777 he traveled to France in the personal entourage of the emperor Joseph II. He also enjoyed the patronage of the chancellor, Prince Kaunitz. After the successful conclusion of the peace of Teschen (1779), Kaunitz nominated Cobenzl as vice-chancellor and his personal representative. In 1787 Cobenzl was sent to the Austrian Netherlands to pacify the troubles provoked there by Joseph II's reforms; peace was restored only by abandoning the imperial policy. Unlike Kaunitz, Cobenzl shared the emperor Leopold II's approval of a policy of compromise with Prussia. Leopold made him a conference minister, but he gained the commanding voice in affairs only when the emperor Francis II appointed him chancellor in succession to Kaunitz (1792). Cobenzl wished to overcome the objections of Prussia to the long-proposed exchange of the Austrian Netherlands for Bavaria. By making no protest against Prussia's annexation of Brandenburg-Ansbach-Bayreuth (1791) and countenancing Prussian designs on Poland, he thought he would gain Prussian approval for the exchange. When, however, in Jan. 1793, Prussia and Russia made the second partition of Poland without any reference to Austria, Cobenzl's policy was demolished and in March he was dismissed. From 1801 to 1805 Cobenzl served as Austrian minister in Paris but he failed to regain his position in the state. The last member of his family, Cobenzl died at Vienna on Aug. 30, 1810.

LUDWIG VON COBENZL was born at Brussels on Nov. 21, 1753.

After serving in the administration of Galicia, Cobenzl was appointed Austrian minister in Berlin in 1774 and was sent as minister to St. Petersburg in 1779. Intelligent and charming, he established excellent connections at the Russian court, receiving the special favour of the empress Catherine II. In 1795 he was able, by the third partition treaty, to get compensation for Austria's exclusion from the second partition of Poland. After this, he was called in to represent Austria at the negotiations with France, both at Campo Formio (1797) and at the congress of Rastatt (1797–99). In both cases, however, although appearing to win territorial gains for Austria, he was in fact outwitted by Napoleon, who wished, by concessions, to overcome Austrian opposition to his plans for the dismemberment of the Holy Roman empire. In 1800 Cobenzl became foreign minister and was largely responsible for the terms of the treaty of Lunéville between Austria and France (Feb. 1801), which confirmed the unfavourable terms of Campo Formio and Rastatt, effecting a total German withdrawal from the left bank of the Rhine. Cobenzl's effort to find a *modus vivendi* with France led him, in 1804, to recognize Napoleon's imperial title, but he followed this by rashly leading his country, still militarily unprepared, into the third coalition against France. The coalition was defeated at the battle of Austerlitz on Dec. 2, 1805, and Cobenzl was dismissed on Dec. 25. He died at Vienna on Feb. 22, 1809.

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(Fr. Hu.)

COBERGHER (Coeberger), **WENCESLAS** (Wensel) (1557/61–1634), Flemish painter, engraver and architect who was a leader in the development of the Flemish baroque style of architecture, was born in Antwerp. He received his education as a painter in the workshop of Maarten de Vos and by studying works of art, in Paris, Rome and Naples (1583–1604). From 1605 until his death Cobergher was painter, architect and engineer to the archduke Albert and the infanta Isabella, governors of the Spanish Netherlands. He painted altarpieces for churches in Italy and in Belgium, but his pictures are far less important than his few surviving buildings. Of these the most famous is the church of Notre Dame de Montaigu near Antwerp which is an imitation of St. Peter's in Rome. He wrote also on archaeology. Cobergher died in Brussels on Nov. 24, 1634. (A. Nh.; X.)

COBH (Cóbh pronounced "Cove"), a seaport and naval station of County Cork, Republic of Ireland, on the south side of Great Island, rising on a terraced hill above Cork (*q.v.*) harbour. Pop. (1961) 5,266. Cove of Cork, as it was formerly called, was a small fishing village until the end of the 18th century. In honour of Queen Victoria, who landed there on her first visit to Ireland in 1849, it was renamed Queenstown and it retained this name until 1922. The great Gothic-style cathedral of St. Colman, begun in 1868 and consecrated in 1919, crowns the hill and is the seat of the Roman Catholic Cloyne bishopric. Cobh became a military and naval centre and port of embarkation for troops and is the chief Irish port of call for transatlantic liners. The depth at the harbour entrance is 41 ft. (low water) while in the river it is 29 ft. at high tides and 26 ft. at low tides. There is a dockyard at Cobh and steelworks at Haulbowline Island, which is also the Irish naval base.

COBIA (Crabeater, Sergeant Fish), a strong, swift, voracious game fish (*Rachycentron canadus*), cosmopolitan in warm seas, the only genus of the family Rachycentridae, which, according to G. A. Boulenger, is allied with the mackerellike fishes. The fish is slender and somewhat pikelike, reaching a length of five feet. The head is flattened and the lower jaw projecting. The tail is strong and forked, the upper lobe slightly the longer. In advance of the long, low, soft dorsal fin are about eight low, isolated spines constituting the spinous dorsal. The anal fin is almost as long as the dorsal. The cobia is dark olive green above, shading into lighter brownish-green and silvery. On the sides two distinct dark stripes parallel each other, one from the tip of the upper jaw to tail, the other starting at the origin of the pectoral fin. *See* also Fishes.

COBLENZ (Koblenz) is a town of Germany, located after the partition of the nation following World War II in the *Land* (state) of Rhineland-Palatinate, Federal Republic of Germany. It lies at the junction of the Moselle and the Rhine (hence its old name of Confluentes), 88 km. (55 mi.) S.S.E. of Cologne by road, on the main railway from Basel, Frankfurt and Mainz to Cologne and the Ruhr. Pop. (1959 est.) 97,242. Spurs from the Hunsrück, Eifel, Westerwald and Taunus mountains surround the town. The Löhrstrasse runs from the main railway station to the old town, on the highest point of which is the Liebfrauenkirche (Church of Our Lady), a Gothic basilica standing partly on Roman walls. Its vicarage was the royal court of justice and residence of the archbishop in the days of the Frankish kings. Close by is Metternich house in which the Austrian chancellor Prince Metternich (1773–1859) was born. Eastward is the Jesuit church (1613–17) with a fine late Renaissance entrance and, connected to it the former Jesuit college (1690–1700), now the town hall. The Florins market is dominated by the basilica. A castle formerly belonging to the electorate of Trier (1273), on the banks of the Moselle to the northwest, holds the municipal library, founded in 1827. The adjacent Baldwin bridge (built by the elector Baldwin, 1343) crosses the Moselle on 14 arches. The Deutsches Eck, a point of land at the junction of the Rhine and Moselle, was set aside after 1953 as a place of dedication to German reunification. Nearby are the rebuilt Deutschherrenhaus (1216) and the Gothic Castor church (836). A few hundred metres farther east are Clemens square and the new town, containing an early classic municipal theatre (1786) and a palace, built during the reign of the elector Clement Wenceslaus (1768–1812) and rebuilt after damage in World War II. Below it, on the bank of the Rhine, is the "wine village," a centre for the promotion of the German wine trade. A memorial to Joseph von Görres (1776–1848), Catholic politician and writer and a native of the town, stands on the riverside promenade. The development of the Rhine is shown in the Rhine museum.

Ehrenbreitstein, a fortress and suburb incorporated into Coblenz in 1937, stands across the Rhine from the confluence with the Moselle on a precipitous rock 118 m. high. The winding path up the south side is heavily guarded and the citadel is flanked by a double line of fortifications. A castle was first built on the site in the 11th century by a noble named Erembert (or Erembrecht). From the 12th century it belonged to the archbishops of Trier. The fortress was blown up by the French in 1801 after a four-year siege and between 1816 and 1832 it was rebuilt into one of the strongest in Europe. The buildings survived World Wars I and II without being seriously damaged. A chair lift brings visitors to the fortress, which offers a panoramic view. The Mid-Rhine museum, with documents relating to the history of Coblenz and a valuable collection of paintings, is located there.

Coblenz has 41 schools, among them 5 *Gymnasiums* for boys and girls, a *Realschule*, a trade and technical school, the combined technical institutes, a teacher-training college and a *Volkshochschule*. The surrounding countryside is rich in woods and lakes and in the summer Coblenz is the centre of Rhine and Moselle river traffic and a popular goal for campers and tourists. The position of Coblenz made it an important commercial centre from early times. Large industrial concerns manufacture furniture, clothes, chemical articles and equipment and other industries are located on the town's outskirts. The Coblenz-Rauental harbour on the Moselle was rebuilt with numerous oil storage depots, making Coblenz one of the larger mid-Rhine petroleum ports.

One of the oldest towns in Germany, Coblenz was known to the Romans as Castellum as early as 9 B.C. In the 6th century it was a royal seat of the Franks, and in 1018 it was given to the archbishopric of Trier by the emperor Henry II. After World War I it was the headquarters of the Joint Allied Commission for the Rhineland (1919–29). During World War II it was captured by the Allies (March 1945). About 85% of the buildings were destroyed. Reconstruction gave the town a spacious modern appearance. (A. Ri.)

COBRA, the name applied to certain extremely poisonous snakes, related to the new world coral snakes and mambas, of the family Elapidae. Cobras have a more or less laterally expansible neck region, and include the genera *Naja*, *Ophiophagus*, *Hemachatus*, *Pseudohaje* and *Boulengerina*. The dilation of the neck to form a broad disk or hood is brought about by the raising and pushing forward of the long anterior ribs, the elastic skin being stretched taut over this framework. This type of hood is in marked contrast to the vertical expansion of the neck of many snakes (*e.g.*, boomslang and mamba), which is caused by the inflation of the windpipe. In all species, however, erection of the hood only occurs when the animal is annoyed or disturbed.

The genus *Naja*—the cobras proper, containing about ten species—ranges from the Cape of Good Hope throughout Africa, Arabia and India to southern China, the Philippine Islands and the Malay archipelago; *Hemachatus*, the "spuy slang" (spitting snake) of the Boers, with a single species, is confined to South Africa; *Ophiophagus*, the king cobra, ranges from Burma through the East Indies. *Pseudohaje*, the black cobra and Gold's cobra, are found in the western rain forests of central Africa; *Boulengerina*, fish-eating water cobras, inhabit the large central African lakes. These snakes are proteroglyphous, *i.e.*, with fixed poison fangs on the front of the upper jaw, and the bite of all the species is extremely dangerous. Accurate statistics of snake-bite mortality cannot be obtained, but it seems fairly certain that the common Indian cobra (*Naja naja*) is responsible for several thousand deaths annually.

As in all proteroglyphous snakes, the venom acts directly on the nervous system (neurotoxic) and so is much more rapid in its action than that (hemotoxic) of the solenoglyphic (vipers and rattlesnakes) and opisthoglyphous snakes (boomslang, mangrove snake, etc.), the toxicity of which is chiefly due to its power of destroying the blood corpuscles. In the past, despite a multitude of so-called cures and a widespread belief in the efficacy of "snake stones," no really effective treatment was available except immediate excision of the site of the bite and application of mild, even suction in order to drain off the venom; now efficient antivenins are produced from the blood sera of animals that have been immunized by regulated doses of venom. These antivenins, however, must be administered hypodermically (*see* also VENOM). The dose is large and, to be effective for the bites of proteroglyphous snakes, must be given immediately, conditions not easily obtained in most of the regions which cobras inhabit. Danger to man is further enhanced by the fact that the prevalence of rats and mice frequently attracts cobras to the vicinity of villages and houses where they are more likely to come into contact with man. In India also, cobras are often regarded with so much superstitious reverence that no attempt is made to kill them.

The best-known species is the common Indian cobra, which may reach a length of about 5½ ft. and which exhibits great variation in colour; typically it is yellowish to dark brown with a black-and-white spectacle-shaped marking on the hood, but all gradations between this form and specimens without any trace of such a mark are known. The king cobra or hamadryad (*Ophiophagus hannah*) is another oriental species; it is rarer than the common cobra, larger, reaching a length of 12 ft. or more, and feeds chiefly on other snakes. Like all the cobras it lays eggs. It exercises some parental care; a definite nest of dried leaves is made, and the parents remain in the vicinity of the nest until the eggs are hatched. There may be some care of the nest in the common cobra.

JOHN MARKHAM

INDIAN COBRA (NAJA NAJA)

In Africa there are several species, the hooded or Egyptian cobra (*Naja haje*) and the black-necked cobra (*Naja nigricollis*) being the most widely distributed. The latter species is able to spit its venom, like the spitting cobra (*Hemachatus haemachatus*), which is closely allied to the true cobras, and is notorious for its habit of spitting venom when annoyed; by muscular compression of the poison glands the venom is forced out through the fangs to a distance of several feet, and if it strikes an enemy in the eyes, intense irritation is set up that results in temporary, and sometimes permanent, blindness unless the area is promptly washed. In the accomplished venom spitters, the opening near the end of the fang faces directly forward, while in the cobras that spit only occasionally, like the common cobra, the fang openings are directed downward. (D. M. S. W.; X.)

COBURG is a town of Germany, located after the partition of the nation following World War II in the *Land* (state) of Bavaria, Federal Republic of Germany. It is on the left bank of the Itz, 110 km. (68 mi.) N. of Nürnberg by road, and on the railway from Nürnberg to Meiningen. Pop. (1961) 10,646. The duke's residence, the Ehrenburg, was converted by Duke Johann Ernst in 1547 from a religious house proscribed during the Reformation. After the abdication of the last duke in 1918, it housed the library of the *Land* and the Coburg branch of the Bavarian state archives. On the market place are the medieval *Rathaus* and the town hall, a fine example of German Renaissance style. There is a *Gymnasium*, founded in 1605. Between 1909 and 1924 the Veste or castle above the town, one of the finest castles in Germany, was completely renovated. It contains art collections founded by the dukes. From 1914 the science museum, notable for its collection of birds of the world, had its own building in the castle grounds. Industries include breweries, manufacture of meat products, machinery, light bulbs, dolls, toys, basketwork, china, glasswork and glass jars.

Coburg was a possession of the emperor Otto II (d. 983) and was first mentioned in a record of 1056. It was of considerable importance in the 15th and 16th centuries, largely because of its strongly fortified castle situated on the busy trade route from Augsburg and Nürnberg to Hamburg. In 1248 Coburg was inherited by the dukes of Henneberg, who gave it civic status. From 1343 to 1918 Coburg was in the possession of the margraves of Meissen, members of the Wettin family, who after 1826 took the title of dukes of Saxe-Coburg-Gotha (*see* WETTIN; SAXE-COBURG-GOTHA). The castle was strong enough to withstand successfully a siege by Wallenstein in 1632. In World War II Coburg was captured by the Allies in April 1945. (R. O. B.)

COCA (CUCA) (*Erythroxylum coca*), a plant of the family Erythroxylaceae (*q.v.*), the leaves of which are used as a stimulant in western South America. It grows to a height of 8 feet. The branches are straight and the lively green leaves are thin, opaque, oval and more or less tapering at the extremities. A marked characteristic of the leaf is an areolated portion bounded by two longitudinal curved lines one on each side of the midrib, and more conspicuous on the under face of the leaf. The flowers are small, and disposed in little clusters on short stalks; the corolla is composed of five yellowish-white petals, the anthers are heart-shaped, and the pistil consists of three carpels united to form a three-chambered ovary. The flowers are succeeded by red berries.

The plants thrive best in hot, damp situations, such as the clearings of forests; but the leaves most preferred are obtained in drier localities, on the sides of hills. The leaves are considered ready for plucking when they break on being bent. The green leaves (*matu*) are spread in thin layers on coarse woolen cloths and dried in the sun; they are then packed in sacks, which, in order to preserve the quality must be kept from damp.

The composition of different specimens of coca leaves is very inconstant. Good samples of the dried leaves are uncurled, deep green on the upper surface, gray-green on the lower, and have a strong tealike odour; when chewed they produce a sense of warmth in the mouth, and have a pleasant, pungent taste. Besides the important alkaloid *cocaine* (*q.v.*) there are several other alkaloids. Coca leaves and preparations of them have no external action. Internally their action is similar to that of opium, though less narcotic.

COCAINE is a white, crystalline alkaloid used for local anesthesia. It is a potent, dangerous and habit-forming drug causing serious social problems.

The only medical use of cocaine is based on its ability to interrupt conduction in nerves, thus producing local anesthesia, especially of the mucous membranes of the eye, nose and throat. The first use of its local anesthetic action was made in Vienna in 1884 by Carl Koller (*q.v.*). Cocaine was the first in a long series of local anesthetic drugs.

Cocaine is obtained from the leaves of *Erythroxylon* (or *Erythroxylum*) *cocae* (or *coca*), a bush commonly found wild in Peru and Bolivia and cultivated in many other countries, including Indonesia. For centuries the Indians of Peru and Bolivia have chewed coca leaves, often mixed with ashes of plants and with limestone, for pleasure and to enable them to withstand strenuous work, walking, hunger and thirst. When taken by mouth it produces local anesthesia of the stomach, so that hunger and thirst are not felt. It is readily absorbed from the mucous membranes and has a pronounced, highly toxic action upon the central nervous system, a stimulation followed by a depression. The cortex of the brain is first stimulated, mental power is increased, and the sensation of fatigue disappears. It causes euphoria and pleasant hallucinations. Following larger doses the spinal cord also is stimulated, and convulsions may result. The stimulation is often followed by a depression of the entire nervous system, and death may result from respiratory failure.

The greatest hazard in the use of cocaine is addiction, which may develop after a very short time, even weeks. Cocaine is called "snow," because it is a fine white powder, and it is often sniffed and absorbed from the nasal mucosa. Because of its irritating and vasoconstricting characteristics it frequently causes ulcerations in the nasal cavity. Addiction is commonest in unstable and psychopathic persons and is particularly deleterious because the addicts prefer company and try to induce their friends to share their pleasures. Gradually and increasingly a paranoiac psychosis develops. Cocaine addicts are often fearful and may suffer from the paranoiac belief of being threatened; they are dangerous and commonly carry weapons, which they are likely to use.

The hallucinations can be auditory, visual or tactual; imaginary insects are seen and felt crawling over the skin. Psychic dependence on cocaine develops, sleeplessness is common, loss of appetite, nausea and digestive disorders lead to emaciation, and convulsions are often seen. Mental deterioration takes place, and most addicts end up as pitifully reduced, grumbling and irritating inmates in mental institutions.

See also ALKALOIDS; COCA; DRUG ADDICTION; PROCAINE HYDROCHLORIDE. (E. T. M.)

COCAMA, a tribe of South American Indians which at the time of the Spanish conquest occupied the lower reaches of the Ucayali and Huallaga rivers in what is now northeastern Peru. The westernmost representatives of the widespread Tupi-Guarani linguistic family (*see* TUPIAN), the Cocama were a warlike people who took the heads of their enemies as trophies but did not practise cannibalism. In most respects their culture resembled that of other peoples of the tropical forest, but the wearing of woven garments suggests some influence from the Andean civilizations. Subsistence was derived from agriculture and from the rivers, with turtles and turtle eggs being especially important. Villages, which were largely independent of one another, were composed of several large thatched houses, each containing several families. Chiefs had little authority. Religious practises centred around the treatment of disease, which was thought to be caused by a variety of spirits inhabiting the rivers and forests.

The modern Cocama number about 10,000. Most work as peons and maintain many of the old customs.

See Alfred Métraux, "Tribes of the Middle and Upper Amazon River" in *Handbook of South American Indians*, ed. by Julian H. Steward, Bureau of American Ethnology Bulletin 143, vol. 3, pp. 687–712 (1948). (SE. L.)

COCCEIUS, JOHANNES (JOHANNES KOCH or COCH) (1603–1669), German Protestant exegete and theologian, a leading exponent of federal (*foedus*) or covenant theology, was born in Bremen on Aug. 9, 1603. Educated at Hamburg and Franeker (Netherlands), he was later professor at Bremen, Franeker and finally at Leiden until his death on Nov. 5, 1669.

The bulk of Cocceius' massive works is biblical interpretation, which was also the point of departure in his systematic thought. In his *Summa doctrinae de foedere et testamento Dei* (1648) the basic conception is that before the Fall, as well as after it, the relation between God and man was a covenant. In paradise there was a covenant of works (*i.e.*, salvation was promised on condition of perfect obedience) which, after sin made obedience impossible, was "abrogated" by the covenant of grace (salvation as a free gift of God). The gracious covenant originated in an inner-Trinitarian "pact" between the Father and the Son (Cocceius' version of predestination) and is realized in a succession or "economy" of historical steps culminating in the eternal Kingdom of God. Thus Cocceius was able to strengthen biblical piety and introduce the idea of the history of salvation, including an uncharacteristic millenarianism, within scholastic Reformed theology. The covenant of works reflected in the conscience of all mankind provided a broad base for theological treatment of social and political life; the gracious covenant, first stated in Gen. iii, 15, allowed the interpretation of much of the Old Testament as types or symbols of Christ.

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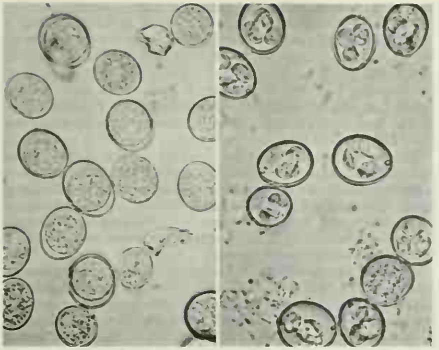
COCCIDIOSIS, in the generalized sense, is infection of an animal (the host) with one of the parasitic microbial animals collectively known as coccidia. There are at least as many kinds of coccidiosis as there are species of coccidia. The parasites infect farm animals and occasionally man.

The life cycles of certain species of coccidia span two kinds of hosts; *e.g.*, *Hepatozoon muris* passes part of one life cycle in a mammal, the common rat, and the rest of it in its transmitter, a mite that sucks the blood of its host. The coccidia of major economic importance are of the one-host, filth-borne sort, whose survival depends on the production and mechanical spread of their infective stages.

Life Cycle of One-Host Coccidia.—The basic life cycle is ordinarily divisible into two successively recurring phases: endogeny, which is the total development that ordinarily takes place within the body of the host; and exogeny, which occurs in the environment outside the bodies of animals but inside the walls of the oöcysts, the terminal stages produced during endogenous development. Oöcysts are shed from infected tissues such as the lining of the intestine and reach the outer world in the feces. As viewed through the microscope at about 400 magnifications, one oöcyst consists of a roundish or oval parasite containing a nucleus and enveloped by a more or less firm wall. At ordinary temperatures and in the presence of air and moisture, the parasite forms one, two or more thin-walled lemon-shaped spores; from the content of each of these in turn are developed two or more naked, banana-shaped sporozoites, each containing a nucleus. It requires a minimum of one to six days for the completion of the exogenous phase, depending on the species concerned. The sporozoites are the infective stages; they are capable of living for weeks, months, or even one or two years under favourable conditions of temperature and moisture, because of the protection afforded them by the walls of



ELERY R. BECKER

OÖCYSTS OF EIMERIA BRUNETTI FROM CHICKENS

(Left) freshly discharged oöcysts; (right) oöcysts at completion of exogenous development

oöcyst and sporocyst, but most eventually perish from aging or weathering.

When the environment is sufficiently contaminated, sooner or later a susceptible animal will swallow some of the infective stages with its food or drink, or while licking or preening itself or others. In the digestive tract the sporozoites become active, escape from their enveloping walls and invade the epithelial (lining) cells or the deeper layers of the intestinal wall. Some species enter minute blood vessels to be carried to such sites as liver or kidney. Once the sporozoite is within its preferred type of cell, it starts its endogenous development and is henceforth known as a schizont. It grows, and its nucleus undergoes a series of divisions, at the completion of which the schizont divides into as many merozoites as there are nuclei; this completes one round of a process known as schizogony. The merozoites enter other suitable cells and grow into either second-generation schizonts or gametocytes, depending on the species. In certain species schizogony occurs only once, in others twice, in still others three times.

Some or all of the merozoites produced from one of the last schizont generations enter suitable host cells and grow into immature sexual forms known as gametocytes. The macrogametocyte (female) matures into a nonmotile, walled macrogamete (egg) with one nucleus, while from the microgametocyte (male) are created a swarm of extremely small, comma-shaped microgametes (sperms) capable of movement with the aid of their flagella. The macrogamete becomes fertilized when a microgamete enters it at one end through a minute opening in the wall; it is thereafter called an oöcyst.

Kinds of Coccidia.—The sporulated oöcysts of the genus *Eimeria* possess four spores, each holding two sporozoites, while those of *Isospora* have two spores, each with four sporozoites. A number of other genera are also recognized, but the species of greatest economic importance in livestock and man belong to these genera. Wildlife such as bony fishes, amphibia, reptiles, birds and mammals also harbour these and other genera. Each category of livestock—chickens, cattle, sheep, etc.—has its own coccidian parasites not shared with others, a fact that simplifies tracing outbreaks to their source.

Eimerias of Economic Importance.—These occur in chickens, turkeys, geese, rabbits, pigs, cattle, sheep and goats. The greatest losses from coccidial disease occur among chickens, cattle, sheep and rabbits. Young chickens are frequently victims of caecal coccidiosis, caused by *Eimeria tenella*. The disease is characterized by bleeding into the caeca and bloody droppings. Chickens are also severely attacked under certain circumstances by three other species of *Eimeria*, as well as by several others whose effects are less severe. Seven species are known to infect turkeys, but only two of them cause severe symptoms or death. The tame rabbit is the host for possibly a dozen species of *Eimeria*, all inhabiting the digestive tract except *E. stiedae*, which grows in the liver. The latter species is especially deadly in heavy infections. Feeder sheep and lambs in confinement are subject to serious disease and death from infection with one or more of three intestinal species. Cattle harbour about 11 species in their digestive tracts, of which 3 are notable as causes of serious losses among dairy calves in moderate climates; *E. zurnii* does the most damage because it produces red diarrhea, so-called because of the bloody liquid feces. Serious outbreaks of coccidiosis can occur among feeder cattle, confined in lots, a few weeks after they have been brought in from the range.

Isosporas of Economic Importance.—Economically important species of *Isospora* are found in man, cats, dogs and certain fur-bearing carnivores. Two species occur in man, though rarely. The commoner of the two, *I. belli*, is believed to undergo endogeny in the epithelium of the small intestine. Symptoms in the severe form of the disease are diarrhea, diarrhea alternating with constipation, abdominal pain, fever, nausea, headache, loss of appetite and loss of weight. The other species, *I. hominis*, is similar to *I. bigemina* and may be identical with it. The latter species is parasitic within the intestinal villi of dogs and cats, and its oöcysts undergo exogeny before they are shed. Either the sporulated oöcysts or the spores are discharged with the feces. Two other species, *I. felis* and *I. rivolta*, whose oöcysts are not sporulated when passed, also occur in dogs and cats. It is only when dogs and cats are kept under extremely unsanitary conditions that coccidial infections become serious.

Control.—Coccidiosis is not a serious problem in livestock under good management with sanitary conditions and adequate diet, though there are exceptions to this rule. Certain sulfonamides, arsenicals, antibiotics and other drugs can be used as additives to feed or drinking water to supplement environmental control or for treatment.

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COCCUS, a bacterium of spherical shape. *See* BACTERIOLOGY.

COCHABAMBA, a department in central Bolivia bounded north by El Beni, south by Chuquisaca and Potosí, east by Santa Cruz and west by La Paz and Oruro. Pop. (1959 est.) 554,967; area 21,479 sq.mi. It is located in a region half temperate and half semitropical with a wide range of elevations; the average elevation is about 8,000 ft. It consists in large part of immense plains and great valleys, open to the south and starting from the Cordillera Real, with an abundance of streams. The foremost concentration of settlement in Bolivia is found in the Cochabamba basin, an area about 15 mi. long by 6 mi. wide, where the rural population density exceeds 300 per sq.mi.

The department is commonly referred to as "the granary of Bolivia," for it is highly productive of farm commodities and livestock. Agricultural products include wheat, maize, barley, quinoa, potatoes and coffee in the more elevated regions, and sugar cane, coca, cacao, tobacco, citrus and other fruits from the lowlands. The forests supply lumber, dyewood and rubber. Mineral resources worked comprise tin, gold, silver, tungsten, wolfram and copper. The Cochabamba department was established in 1826 and is made up of the following provinces: Cercado, Arque, Quillacollo, Tapacarí, Capinota, Ayopaya, Chaparé, Germán Jordán, Esteban Arce (Tarata), Punata, Arani, Carrasco, Mizque and Campero. The completion of a pipeline from the Camiri oil field to the refinery in Cochabamba city, in 1954, further enhanced the economic status of the department. Rivers of consequence include the Mamoré, Chimoré, Ichilo, Rocha, Chaparé and Isiboro.

The department is linked to the lowlands by the Cochabamba-Santa Cruz highway, with Oruro by railroad and with La Paz by highway. (J. L. TR.)

COCHABAMBA, a city of Bolivia, capital of Cochabamba department and of the province of Cercado. The population, which is largely Indian and mestizo, was estimated at 99,099 in 1959. The city, founded by Sebastián Barba de Padilla with the name of Villa de Oropeza in 1574, was named Villa de Cochabamba in 1786. It lies at an elevation of 8,392 ft. and the climate is mild, 57° F. being the average of its coldest month, and 63.1° F. the annual average temperature. The rainfall averages about 18 in. annually. A diversity of crops including barley, maize, wheat and fruit are cultivated in the surrounding rural district.

Cochabamba is the cultural as well as politico-economic centre of the department and contains a number of fine buildings including the University of Sao Simón, the museum, the municipal library, the cathedral and the government palace. The Plaza 14 de Septiembre, located in the centre of the city, commemorates the date on which the local patriots took up arms in the War of Independence. Important satellite towns are Vinto, Quillacollo, Sipesipe and Sacaba.

Industries in the city are varied and small, mainly supplying the local market and provinces. The economic position of the city has been greatly enhanced by the completion of the Cochabamba-Santa Cruz highway and the construction of a pipeline into the department from the Camiri oil field. Cochabamba is connected by rail with Oruro (131 mi.) and by highway with La Paz (285 mi.). It is on the established air routes. (J. L. Tr.)

COCHIN (KOCHCHIBAND), a port on the southwestern or Malabar coast of India, lies 580 mi. S. of Bombay and about 130 mi. N. of Cape Comorin. Formerly the capital of a princely state of the same name, it is now in the state of Kerala (*q.v.*). Pop. (1961) 35,076. The contiguous and larger town of Mattancherri (*q.v.*) is also in Kerala. Pop. (1961) 83,896.

The princely state had an area 1,493 sq.mi. and a population of over 1,400,000 at the time of India's independence in 1947. It was then united with Travancore as Travancore-Cochin until 1956, when the boundaries were enlarged and the state of Kerala was formed.

Cochin town is situated on the northern tip of a narrow tongue of land barely a mile wide which separates the deep Arabian sea from one of the shallow lagoons typical of this coast. These lagoons are often connected with the sea by shallow channels. In the case of Cochin the channel (though blocked by a sand bar) was sufficiently deep to allow the passage of fishing and coastal vessels. The British Indian government in consultation with the Raja of Cochin began the construction of the modern port in 1920 by dredging the entrance to the lagoon. The first ocean-going steamer entered the harbour in June 1928. In 1936 the port administration was taken over by the Indian government and Cochin was declared a major harbour. It is now open for deep-water traffic even in the worst of the monsoon. Cochin is an ideal distributing and collecting centre for Kerala (formerly dependent on the long rail haul to Madras). Facilities include the Cochin harbour railway linked with the broad-gauge Southern railway, coaling berths, ship repair yards and hotels. Ernakulam on the mainland shore of the lagoon is a considerable trading centre.

Cochin was the earliest European settlement in India, the first occupants being the Portuguese. Vasco da Gama founded a factory in 1502 and Affonso de Albuquerque built the fort (the first European one in India) in 1503. The British made a settlement in 1634 but retired when the Dutch captured the town in 1663. Under the Dutch the town became a great trading centre. In 1795 Cochin was captured again by the British and in 1806 the fortifications and many buildings were destroyed. (L. D. S.)

COCHIN CHINA, a colony of French Indochina between 1862 and 1948, now that part of South Vietnam which lies south of Phan Thiet. Before the French period, no one native state covered exactly the area that became Cochin China, but part had been included in Champa, a kingdom of the Hindu colonial period; part was the kingdom of Nguyen phua Anh, who entered into first treaty relations with the French in 1787. Cochin China included the fertile outer delta of the Mekong river, together with contiguous deltas farther north, and was largely opened to immigrant rice farmers during the French period, when Saigon became the capital and a major international port. The National Assembly of Cochin China voted in 1949 that Cochin China should become part of the new unified state of Vietnam. For subsequent developments, *see* VIETNAM. (E. H. G. D.)

COCHINEAL, a natural dyestuff used for the production of scarlet, crimson, orange and other tints, and for the preparation of lake and carmine. It consists of the dried, pulverized bodies of the females of *Dactylopius coccus*, a hemipterous insect of the family Coccidae, which feeds upon various species of cactus, especially nopal, *Nopalea cochenillifer* (*Opuntia coccinellifera*), a native of Mexico and Peru.

The male of the cochineal insect is half the size of the female, and, unlike it, is devoid of nutritive apparatus; it has long white wings and a body of a deep red colour, terminated by two diverging setae. The female is wingless, and has a dark-brown plano-convex body; it is found in the proportion of 150–200 to 1 of the male insect. The dead body of the mother insect serves as a protection for the eggs until they are hatched.

Cochineal is now cultivated chiefly in Honduras and the Canary Islands, but is furnished also by Mexico, Peru, northern Algeria and southern Spain. It is collected thrice in the seven months of the season. The insects are carefully brushed from the branches of the cactus into bags, and are then killed by immersion in hot water or by exposure to the sun, steam or the heat of an oven—much of the variety of appearance in the commercial article being caused by the mode of treatment.

The dried insect has the form of irregular, fluted and concave grains, of which about 70,000 go to a pound. The best crop is the first of the season, which consists of the unimpregnated females; the later crops include an admixture of young insects and skins, which contain proportionally little colouring matter. Its tinctorial power is attributed to the presence of a substance termed cochinealin or carminic acid, $C_{22}H_{20}O_{13}$ (the formula shown by Dimeoth in 1920), which may be prepared from the aqueous decoction of cochineal.

Cochineal also contains a fat and wax; cochineal wax or coccerin, $C_{30}H_{60}(C_{31}H_{61}O_3)_2$, may be extracted by using benzene; the fat is a glyceryl myristate, $C_3H_5(C_{14}H_{27}O_2)_3$.

The dye was introduced into Europe from Mexico, where it had been used long before the entrance of the Spaniards. Cochineal has almost entirely been replaced by aniline dyes, but it is still used principally as a colouring agent for cosmetics, beverages, etc.

COCHLAEUS, JOHANNES (JOHANN DOBENEK or DOBNECK) (1479–1552), German humanist and a leading Roman Catholic opponent of Martin Luther (*q.v.*), was born of peasant stock at Wendelstein, near Nürnberg. University studies in humanism and theology at Cologne (1504–10) were followed by five years as head of a boys' school at Nürnberg. While there he published several highly esteemed textbooks, which notably improved instructional methods in Latin grammar, geography, history and music. In Italy he studied humanism and law at Bologna (1515–17), gained a doctorate in theology at Ferrara (1517) and was ordained priest while in Rome (1517–19). On his return to Germany he held ecclesiastical benefices as dean at Frankfurt am Main, canon at Mainz, court chaplain to Duke George of Saxony and canon at Breslau.

Cochlaeus' early sympathy with Luther changed about 1520 into unremitting criticism. As adviser to papal nuncios and other ecclesiastical and secular dignitaries, he was prominent at important gatherings striving to mend the religious split—at the diet of Worms; at *Reichstags* in Nürnberg, Ratisbon and Speyer; at the diet of Augsburg (1530), where he was one of the theologians selected to draw up a refutation of the Lutheran *Augsburg Confession;* and at the famous if indecisive conferences at Hagenau, Worms and Ratisbon. More influential, however, were his numerous writings in Latin and German, predominantly concerned with religious controversy.

Noteworthy among his historical productions were the *History of the Hussites* (1549) and *Acts and Writings of Luther* (1549), his best-known book. This partisan biography coloured Roman Catholic portrayals of Luther into the 19th century. Not an outstanding theologian nor profoundly learned, Cochlaeus displayed nonetheless extensive knowledge, and ranked among the most capable contemporary authors. In external labours he was zealous, self-sacrificing and completely dedicated to his cause.

Cochlaeus died at Breslau on Jan. 10, 1552.

See K. Schottenloher, *Bibliographie zur Deutschen Geschichte im Zeitalter der Glaubensspaltung, 1517–1585,* vol. i (1933) and vol. v (1939), the fullest bibliography of the period; J. Janssen, *History of the German People at the Close of the Middle Ages,* 17 vol. (1896–1925). (Jn. F. B.)

COCHRAN, SIR CHARLES BLAKE (1872–1951), English theatrical manager and impresario, the first nights of whose productions were great social events, was born at Lindfield, Sussex, on Sept. 25, 1872. After a period on the stage in the U.S. during the 1890s, he set up as a theatrical agent in London, where he presented a wide variety of entertainments ranging from boxing to Max Rheinhardt's *The Miracle* and the Diaghilev ballet. Among the personalities he brought to London were Mistinguett, Houdini, Sarah Bernhardt, Eleonora Duse, Fyodor Chaliapin and the Guitrys. He became best known as a producer of reviews and musical plays, including a number of which Noel Coward was author and composer, such as *This Year of Grace* (1928), *Bitter Sweet* (1929), *Cochran's 1931 Revue* and *Cavalcade* (1931). Other successes were *Nymph Errant* (1933) and *Bless the Bride* (1947). Cochran was knighted in 1948 and died in London on Jan. 31, 1951.

COCHRANE, ELIZABETH: *see* Bly, Nelly.

COCKADE (Fr. *cocarde,* with allusion to a cock's comb), a bow or knot of ribbons worn in the hat. Cockades from being simply ornamental early came to be used as party badges. Before the introduction of uniforms (*q.v.*) however, a ribbon or a sprig of foliage was on occasions worn in soldiers' hats to distinguish members of opposite forces. Before the brim of the soldiers' felt hat was looped up, it was sometimes ornamented with a band and knot of ribbon; when the brim came to be cocked up on three sides, a bow of black ribbon was fastened on the left side with a button and loop. At first this bow had no national significance, and the idea that it was introduced into the British army by the Hanoverians is disproved by paintings and the murals made for the great duke of Marlborough, which show his troops all wearing black cockades in their hats. Moreover, in 1763, many of the regiments of the French army, including the *gardes Françaises,* wore black cockades. With the outbreak of the French Revolution, Camille Desmoulins is said to have proposed a green cockade for partisans of the new order, but the blue, white and red cockade which was finally adopted simply took the colours of the royal livery (blue coats, faced red, and ornamented with a white lace with a red chain pattern). Later, French *émigrés* fighting against the Revolution assumed a white cockade if they were serving in the army of the prince de Condé (Louis Joseph de Bourbon) or in the British army, an orange cockade if they were serving in the Dutch forces, and a black and yellow cockade if they were serving in the Austrian.

In the armed forces cockades went out of use when the army and navy ceased to wear cocked hats. A leather cockade, however, still survives in the headgear of the liveried coachmen and chauffeurs of high officials. (C. C. P. L.)

COCKAIGNE (Cockayne), **LAND OF,** the name of an imaginary country, a medieval Utopia where life was a round of luxurious idleness. The origin of the word has been much disputed; the most usually accepted derivation is from the Latin *coquere* ("to cook") and the German *kuchen* ("cake"), the literal sense thus being "The Land of Cakes." In Cockaigne the rivers were of wine, the houses were built of cake and barley sugar, the streets were paved with pastry and the shops supplied goods for nothing. Roast geese and fowls wandered about inviting folks to eat them, and buttered larks fell from the skies like manna. There is a 13th-century French *fabliau, Cocaigne,* which was possibly intended to ridicule the idea of the mythical Avalon, "the Island of the Blest." The 13th-century English poem *The Land of Cockaygne* is a satire on monastic life. The name has been humorously applied to London and was so used by Sir Edward Elgar as the title for his *Cockaigne* overture. It has been confused with Cockney (*q.v.*).

COCKATOO: *see* Parrot.

COCKATRICE (Basilisk), in Hellenistic and Roman times, was a small serpent, possibly the Egyptian cobra, known as a *basilikos* ("kinglet") and credited with powers of destroying all animal and vegetable life (except the weasel, which secreted a venom deadly to the snake) by its mere look or breath. By the time of the 17th-century naturalist Ulisse Aldrovandi, more marvels had been added. The snake (called a cockatrice in English, apparently a corruption of Latin *calcatrix,* "treader," through French *cocatris,* and popularly associated with "cock") was said to be generated from an egg laid by a cock and hatched by a serpent. The weasel, which was still its enemy, was fortified by rue before and after attacking it. Another enemy was the cock: if the basilisk heard a cock crow, it would shortly die; hence travelers in regions infested by the basilisk took cocks with them. A kind of early cannon was called a basilisk. Cockatrice on occasion means a spiteful and dangerous person. (H. J. R.)

COCKBURN, SIR ALEXANDER JAMES EDMUND, 10th Baronet (1802–1880), lord chief justice of England from 1859 to 1880, was born on Dec. 24, 1802. Scion of a distinguished Scotch family, his immediate predecessors in title were his uncle James, a major general, undersecretary for war and governor of the Bermudas; his uncle George, an admiral and co-commander of the British forces which advanced on Washington, D.C., in 1814 and burned the U.S. capitol; and his uncle William, dean of York. Alexander's father, a younger son of the 6th baronet, had been ambassador to Colombia; his mother was the daughter of the Vicomte de Vignier.

Cockburn was privately educated in Britain and on the continent, where he became fluent in French, German, Spanish and Italian. He was a first class scholar at Trinity college, Cambridge, where he took a degree of bachelor of civil laws and was elected to a fellowship. He entered the Middle Temple in 1825 and was called to the bar in 1829. Initially, he achieved greater success at the sessions than in London, but in 1832 he brought out a volume of reports on election cases that led to a great demand for his services in this form of parliamentary practice. His circuit practice was also flourishing and he became recorder for Southampton. In 1841 he became queen's counsel. Cockburn was an admirable trial lawyer and gained great repute for his successful defense, on grounds of insanity, of Daniel McNaghten, who had killed Sir Robert Peel's secretary. The resulting "McNaghten rules" have controlled the law of insanity as a defense in most Anglo-U.S. jurisdictions ever since. Cockburn represented his uncle in a suit against the archbishop of York, in which he vanquished John Campbell, the attorney general, Thomas Wilde, the solicitor general, Dundas and Phillimore.

In 1847 he was elected to the house of commons from Southampton as a liberal reformer. When, in 1850, the house of lords voted a censure of Lord John Russell's government for Palmerston's handling of the "Don Pacifico" dispute with Greece, it fell to Cockburn to defend the government against Gladstone's attack. His speech to the commons helped prevent the fall of the Russell cabinet, and he was rewarded with the post of solicitor general. When Sir John Romilly was made master of the rolls, Cockburn became attorney general. Meanwhile his practice was abundant, for at that time the law officers of the crown were permitted to engage in private practice. His most famous cases were the defense of John Henry Newman on a charge of criminal libel leveled by the recusant Dominican monk Achilli and his successful prosecution of William Palmer for the poisoning at Rugeley of John Parson's cook. The Palmer case turned entirely on circumstantial evidence, and the success of the prosecution was due wholly to Cockburn's magnificent advocacy, which in turn depended, as all great legal advocacy must, on thorough preparation. In 1854 Cockburn became recorder for Bristol. He was truly the leader of the bar when he was appointed chief justice of the common pleas in 1856. When Palmerston returned to power in 1859, Cockburn hoped for the great seal, but Campbell was made lord chancellor and Cockburn succeeded him as lord chief justice.

Throughout his judicial career Cockburn was a better nisi prius judge than he was an appellate judge. He presided at the famed Tichborne trial, involving a contested inheritance, which took 188 days (*see* Tichborne Claimant). Cockburn's charge to the jury took 18 days and won from Disraeli the statement in commons that Cockburn was "a man of transcendent abilities." His most important extrajudicial role was that of arbitrator in the "Alabama" claims (*see* "ALABAMA" ARBITRATION), though he dissented from the majority decision. Cockburn's leisure was spent in hunting, yachting, music and literature; he never married. He was a person of wide intellectual attainment and excellent disposition. He died in London on Nov. 21, 1880. (P. B. K.)

COCKBURN, ALICIA (also called ALISON) (1713–1794), Scottish author of the first version of the ballad "Flowers of the Forest" and famous for her wit and brilliance as a hostess, was born on Oct. 8, 1713. Her lines beginning "I've seen the smiling of Fortune beguiling," set to the old air of "Flowers of the Forest," were probably written before 1731, and were occasioned by the failure of seven Selkirkshire lairds in their financial speculations. Her version, which is the one usually sung, was not published until 1765 in *The Lark*, and was unknown to Jane Elliot (*q.v.*). After her marriage to Patrick Cockburn of Ormiston, Alicia was hostess to many literary and political celebrities, among them David Hume and Lord Monboddo, and she was also a close friend of Sir Walter Scott. Her other writings, including parodies, toasts and character sketches, are of little merit. She died in Edinburgh on Nov. 22, 1794.

COCKBURN, SIR GEORGE, BART. (1772–1853), British admiral, entered the navy at the age of nine, though he did not go to sea until 1786. After serving on the home station and in the East Indies and the Mediterranean, he assisted, as captain of the "Minerve," at the blockade of Leghorn in 1796, and fought a gallant action with the Spanish frigate "Sabina," which he took. He was present at the battle of Cape St. Vincent. In 1809, in command of the naval force on shore, he contributed greatly to the reduction of Martinique, and signed the capitulation by which that island was handed over to Great Britain.

After service in the Scheldt and at the defense of Cadiz he was sent in 1811 on an unsuccessful mission for the reconciliation of Spain and its American colonies. In 1813–14, as second in command to Sir J. B. Warren, he took part in the War of 1812, especially in the capture of Washington. In the autumn of 1815 he carried out, in the "Northumberland," the sentence of deportation to St. Helena which had been passed upon Bonaparte. He was promoted admiral in 1837; he became senior naval lord in 1841, and held office in that capacity till 1846. In 1851 he was made admiral of the fleet. Cockburn died on Aug. 19, 1853.

COCKCHAFER (*Melolontha melolontha*), a common European beetle whose larva is destructive to the roots of crops. The white grub spends several years in the soil before emerging as a large beetle that feeds on the leaves of trees and that may often be seen flying in large numbers at dusk.

See CHAFER; BEETLE.

COCKCROFT, SIR JOHN DOUGLAS (1897–), British physicist and co-winner, with E. T. S. Walton, of the Nobel prize for physics in 1951. At a meeting of the Royal society on April 28, 1932, Lord Rutherford announced that two of his workers at the Cavendish laboratory, Cambridge—Cockcroft and Walton—"had successfully disintegrated the nuclei of lithium and other light elements by protons entirely artificially generated by high energy potentials." On Nov. 15, 1951, the Royal Swedish Academy of Sciences announced the award of the Nobel prize for physics jointly to Cockcroft and Walton for "their pioneer work on the transmutation of atomic nuclei by artificially accelerated atomic particles."

Born in Todmorden, Yorkshire, Eng., on May 27, 1897, he was educated at Todmorden Secondary school, at Manchester university and at St. John's college, Cambridge, of which he was a fellow from 1928 to 1946 and an honorary fellow from 1947.

Cockcroft was Jacksonian professor of natural philosophy in Cambridge university, 1939–46; from 1941 to 1944, however, he served as chief superintendent, air defense research and development establishment, ministry of supply, and from 1944 to 1946 he was director of the atomic energy division, National Research council of Canada. In 1946 he became director of the atomic energy research establishment, ministry of supply, at Harwell, Eng. He was also chairman of the defense research policy committee and scientific adviser, ministry of defense, from 1952 to 1954, and served as a member of the British Broadcasting corporation's Scientific Advisory committee, 1948–52. Cockcroft was elected a fellow of the Royal society in 1936, was knighted in 1948 and created knight commander of the Bath in 1953.

END OF VOLUME FIVE

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